School of Engineering and Applied Sciences
Sport & Exercise Science

Children’s fitness, physical activity and motor competency; before, during and in the recovery from the COVID-19 pandemic.

Amie Bethan Richards
BSc (Hons) MSc PGCE FHEA

Submitted to Swansea University in fulfilment of the requirements for the Degree of **Doctor of Philosophy**

Swansea University
2023

ABSTRACT

Children do not engage in sufficient amounts physical activity, to promote fitness and motor competence, which is essential for children's health, growth, and development. More evidence is required on physical activity levels, associations between motor competencies and fitness, and perhaps most importantly, the potential long-term effects of the COVID-19 pandemic. The overarching aim of this research was to investigate children's physical activity, fitness, and motor competence. Given the COVID-19 pandemic and unprecedented impact that had on individual behaviours whilst this project was ongoing, this research also investigated the impact of this on physical activity levels in children before, during and in the recovery from the pandemic.

Study one synthesised pre-pandemic data to produce the Active Healthy Kids Wales 2021 Report Card. The results highlighted that 8/11 grades remained the same or decreased between 2016 and 2018. For deeper insight the second investigation found that physical fitness was associated with swimming and cycling competencies after accounting for age, body mass index, deprivation, gender, and sports club attendance and our third study, revealed a significant inequality in motor competence between children with and without additional learning needs.

The natural experiment that occurred through COVID-19 allowed for the fourth piece of empirical work to use a qualitative approach to explore parents and children's perceptions of children's physical activity and sedentary behaviours within the home during the first lockdown of the COVID-19 pandemic. Results revealed a decrease in the children's physical activity and an increase in sedentary behaviour; with barriers to physical activity including home-schooling and access to media equipment and facilitators including siblings and outside space. As an extension to study 4, the final study explored changes in children's physical activity and sedentary behaviour at three time points throughout the pandemic. Reductions in children's autonomy and relatedness during the lockdown restrictions led to decreases in physical activity and increases in sedentary time, some of which remained low when restrictions were eased.

This novel body of research reiterates children's low levels of physical activity while noting the importance of swimming and cycling competencies for fitness. Moreover, children's activity remains below pre-COVID levels and public health messages for parents and teachers are imperative for children's healthy development and wellbeing. There remains a need for additional nationwide mixed-methodology research into these levels and attributes of children's physical activity.

Scientific Outputs

Papers

Richards, A. B., Klos, L., Swindell, N., Griffiths, L. J., De Martelaer, K., Edwards, L. C., Brophy, S., & Stratton, G. (2021). Associations between swimming & cycling abilities and fitness in 9–11-year-old boys and girls. *Journal of Sports Sciences*, 40(6), 658–666. https://doi.org/10.1080/02640414.2021.2013616

Richards, A. B., Minou, M., Sheldrick, M. P., Swindell, N., Griffiths, L. J., Hudson, J., & Stratton, G. (2022). A Socioecological Perspective of How Physical Activity and Sedentary Behaviour at Home Changed during the First Lockdown of COVID-19 Restrictions: The HomeSPACE Project. *International Journal of Environmental Research and Public Health*, 19(9), 5070. https://doi.org/10.3390/ijerph19095070

Richards, A. B., Mackintosh, K. A., Swindell, N., Ward, M., Marchant, E., James, M., Edwards, L. C., Tyler, R., Blain, D., Wainwright, N., Nicholls, S., Mannello, M., Morgan, K., Evans, T., & Stratton, G. (2022). WALES 2021 Active Healthy Kids (AHK) Report Card: The Fourth Pandemic of Childhood Inactivity. *International Journal of Environmental Research and Public Health*, 19(13), 8138. https://doi.org/10.3390/ijerph19138138

Richards, A. B., Sheldrick, M. P., Swindell, N., Barker, H. G., Hudson, J., & Stratton, G. (2023). Qualitative changes in children's physical activity and sedentary behaviours throughout the COVID-19 pandemic: The HomeSPACE project. *PLOS ONE*, 18(1), e0280653. https://doi.org/10.1371/journal.pone.0280653

PRESENTATIONS

Richards, A.B, Stratton, G. Developing a sustainable programme for assessing fitness and lifestyle behaviours of children in Bridgend, Pan-Wales Postgraduate Conference in Sport and Exercise Sciences, Cardiff, UK. May 2019. Oral Presentation.

Richards, A.B., Stratton, G. Are those who can swim, cycle and play sport fitter than those than don't? United Kingdom & Ireland Motor Competence Network Meeting, Liverpool, UK. January 2019. Oral Presentation.

Richards, A.B., Klos, L., Swindell, N., Griffiths, L.G., DeMartelaer, K., Edwards, L., Brophy, S., Stratton, G. The influence of swimming & cycling abilities on the fitness of 9–11-year-old boys and girls, International Motor Development Research Consortium, Virtual (South Carolina, USA). September 2020. Oral Presentation.

Richards, A.B., Minou, M., Sheldrick, M.P., Swindell, N., Griffiths, L.J., Hudson, J., Stratton, G. A socioecological perspective of how physical education & home-schooling impacted physical activity and sedentary behaviour during the COVID-19 restrictions – The HomeSPACE Project, 32nd Pediatric Work Physiology Conference, Virtual (Swansea, UK). September 2021. Oral Presentation. Prize Awarded for Early Career Researcher Finalist.

Richards, A.B., Beaney, M., Barker, H., Williams, E., Tyler, R., Griffiths, L.G., Stratton, G. Does children's motor competence differ between ethnicities & gender: A cross sectional evaluation, International Motor Development Research Consortium, Virtual (Greece). September 2021. Poster Presentation.

Richards, A.B.; Mackintosh, K.A.; Swindell, N.; Ward, M.; Marchant, E.; James, M.; Edwards, L.C.; Tyler, R.; Blain, D.; Wainwright, N.; Nicholls, S.; Mannello, M.; Morgan, K.; Evans, T.; Stratton, G. WALES 2021 Active Healthy Kids (AHK) Report

Card: The Fourth Pandemic of Childhood Inactivity, International Society of Physical Activity and Health Conference, Abu Dhabi, United Arab Emirates. October 2022. Poster Presentation.

Declarations and Statements

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed [redacted] (candidate)

Date: 29/05/2023

This thesis is the result of my own investigations, except where otherwise stated. Other sources are acknowledged by footnotes giving explicit references. A bibliography is appended.

Signed: [redacted] (candidate)

Date: 29/05/2023

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Signed: [redacted] (candidate)

Date: 29/05/2023

Authorship Declaration

The following people and institutions contributed to the publication of work undertaken as part of this thesis:

Author	Name and Institution
Author 1	Kelly Mackintosh, Swansea University
Author 2	Nils Swindell, Swansea University
Author 3	Malcom Ward, Swansea University
Author 4	Emily Marchant, Swansea University
Author 5	Michaela James, Swansea University
Author 6	Lowri Edwards, Cardiff Metropolitan University
Author 7	Richard Tyler, Edge Hill University
Author 8	Dylan Blain, University of Wales Trinity Saint David University
Author 9	Nalda Wainwright, University of Wales Trinity Saint David University
Author 10	Sarah Nicholls, Swansea University
Author 11	Marianne Mannello, Play Wales
Author 12	Kelly Morgan, Cardiff University
Author 13	Tim Evans, Sport Wales
Author 14	Gareth Stratton, Swansea University
Author 15	Leon Klos, Karlsruhe Institute of Technology
Author 16	Lucy Griffiths, Swansea University
Author 17	Kristine De Martelaer, Vrije Universiteit Brussel
Author 18	Sinead Brophy, Swansea University
Author 19	Harriet Barker, Swansea University

Author	Name and Institution
Author 20	Emily Williams, Swansea University
Author 21	Lawrence Foweather, Liverpool John Moores University
Author 22	Masoumeh Minou, Swansea University
Author 23	Michael Sheldrick, Swansea University
Author 24	Joanne Hudson, Swansea University

Paper 1: WALES 2021 Active Healthy Kids (AHK) Report Card: The Fourth Pandemic of Childhood Inactivity
Located in Chapter: Four

Candidate: Conceptualisation, methodology, data collection, formal analysis, writing – original draft prep, writing – reviewing and editing, funding acquisition, project administration. (55%)
Author 1: Methodology, data collection, formal analysis, writing - original draft prep, writing – reviewing and editing. (3%)
Author 2: Methodology, data collection, formal analysis, writing - original draft prep, writing – reviewing and editing. (3%)
Author 3: Conceptualisation, methodology, data collection, formal analysis, writing - original draft prep, writing – reviewing and editing. (3%)
Author 4: Methodology, data collection, formal analysis, writing - original draft prep, writing – reviewing and editing. (3%)
Author 5: Methodology, data collection, formal analysis, writing - original draft prep, writing – reviewing and editing. (3%)
Author 6: Methodology, writing – review and editing. (2%)
Author 7: Methodology, data collection, formal analysis, writing - original draft prep, writing – reviewing and editing. (3%)
Author 8: Methodology, data collection, formal analysis, writing - original draft prep, writing – reviewing and editing. (3%)
Author 9: Conceptualisation, methodology, data collection, formal analysis, writing - original draft prep, writing – reviewing and editing. (3%)
Author 10: Methodology, data collection, formal analysis, writing - original draft prep, writing – reviewing and editing. (3%)
Author 11: Conceptualisation, methodology, data collection, formal analysis, writing - original draft prep, writing – reviewing and editing. (3%)
Author 12: Methodology, data collection, formal analysis, writing - original draft prep, writing – reviewing and editing. (3%)
Author 13: Methodology, writing – review and editing. (2%)
Author 14: Conceptualisation, methodology, writing – reviewing and editing, funding acquisition, project administration, supervision. (8%)

Paper 2: Associations between swimming and cycling abilities and fitness in 9–11-year-old boys and girls.
Located in Chapter: Five

Candidate: Conceptualisation, methodology, data collection, formal analysis, writing – original draft prep, writing – editing and reviewing, project administration. (71%)
Author 2: Methodology, data collection, formal analysis, writing – editing and reviewing (4%)
Author 6: Data collection, writing – reviewing and editing, project administration (3%)
Author 14: Conceptualisation, methodology, data collection, formal analysis, writing – reviewing and editing, project administration, supervision. (5%)
Author 15: Methodology, formal analysis, writing – reviewing and editing. (7%)
Author 16: Methodology, formal analysis, writing – reviewing and editing, supervision. (4%)
Author 17: Writing – reviewing and editing. (3%)
Author 18: Methodology, writing – reviewing and editing (3%)

Paper 3: Motor competence between children with and without additional learning needs: a cross sectional population-level study
Located in Chapter: Six

Candidate: Conceptualisation, methodology, data collection, formal analysis, writing – original draft prep, writing – reviewing and editing, project administration. (66%)
Author 1: Methodology, data collection, formal analysis, writing – reviewing and editing. (4%)
Author 2: Methodology, data collection, formal analysis, writing – reviewing and editing. (4%)
Author 7: Conceptualisation, methodology, data collection, writing – reviewing and editing, project administration. *(6%)*
Author 14: Conceptualisation, methodology, data collection, formal analysis, writing – reviewing and editing, project administration, supervision. (7%)
Author 16: Methodology, writing – reviewing and editing, supervision. (3%)
Author 19: Data collection, writing – reviewing and editing, project administration. (2%)
Author 20: Data collection, writing – reviewing and editing, project administration. *(2%)*
Author 21: Conceptualisation, methodology, data collection, writing – reviewing and editing, project administration. (6%)

Paper 4: A socioecological perspective of how physical activity and sedentary behaviour at home changed during the first lockdown of covid-19 restrictions: The HomeSPACE Project
Located in Chapter: Seven

Candidate: Conceptualisation, methodology, formal analysis, writing – original draft prep, writing – reviewing and editing, project administration. (71%)
Author 2: Methodology, writing – reviewing and editing, project administration. (3%)
Author 14: Conceptualisation, methodology, formal analysis, writing – reviewing and editing, funding acquisition, supervision. (7%)
Author 16: Methodology, writing – reviewing and editing, supervision. (3%)
Author 22: Conceptualisation, methodology, data collection. (5%)
Author 23: Conceptualisation, methodology, writing – reviewing and editing, funding acquisition, project administration. (6%)
Author 24: Formal analysis, writing – reviewing and editing, supervision. (5%)

Paper 5: Qualitative changes in children's physical activity and sedentary behaviours throughout the covid-19 pandemic: The HomeSPACE Project
Located in Chapter: Eight

Candidate: Conceptualisation, methodology, data collection, formal analysis, writing – original draft prep, writing – review and editing, project administration. (76%)
Author 2: Conceptualisation, methodology, writing – review and editing, project administration. (3%)
Author 14: Conceptualisation, methodology, writing – review and editing, funding acquisition, supervision. (7%)
Author 19: Writing – review and editing, project administration. (3%)
Author 23: Conceptualisation, methodology, writing – review and editing, funding acquisition project administration. (5%)
Author 24: Methodology, formal analysis, writing – review and editing, supervision. (6%)

We the undersigned agree with the above stated “proportion of work undertaken” for each of the above published peer-reviewed manuscripts contributing to this thesis.

Candidate	
Author 1	
Author 2	
Author 3	
Author 4	
Author 5	
Author 6	
Author 7	
Author 8	
Author 9	
Author 10	Sarah Nicholls
Author 11	
Author 12	

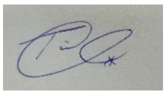
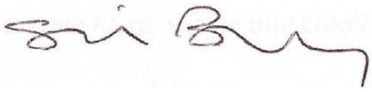
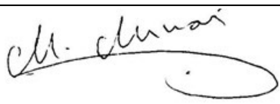
Author 13	
Author 14	
Author 15	
Author 16	
Author 17	
Author 18	
Author 19	
Author 20	
Author 21	
Author 22	
Author 23	
Author 24	

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

I am grateful for the funding from Knowledge Economy Skills Scholarships (KESS 2). KESS 2 is a pan-Wales higher level skills initiative led by Bangor University on behalf of the Higher Education sector in Wales. It is part funded by the Welsh Government’s European Social Fund (ESF) convergence programme for West Wales and the Valleys.

I would like to acknowledge numerous members of family, friends, colleagues, and the community, without whom completion of this thesis would not have been possible.

First and foremost, I am extremely grateful to my Supervisors, Professor Gareth Stratton and Dr. Lucy Griffiths. Gareth’s enthusiasm in the subject and the way he challenged and inspired me during the interview process convinced me that this was my destiny. He has continued to challenge me in many ways including to improve my academic thinking, my independent learning and to talk more! I look forward to working together in the future and through his expertise being further challenged and innovative. Lucy became my second supervisor midway through my programme and although we didn’t meet frequently, she made it clear that her door was always open, or due to the COVID-19 pandemic, her Zoom was always on. I have also had much additional support from various staff and student members of the A-STEM Research Centre and co-authors from across the World. I am also very grateful for their insightful comments, suggestions, and feedback. Thanks also to Dr Lowri Edwards who supervised me for the first few months of my PhD, before furthering her career in a different role.

My company partner cannot go without mention. The Active Young People Department at Bridgend County Borough Council provided me with access to schools, where I met many of my participants, and also an understanding of the practicalities of conducting research in a ‘real-world’ setting. A particular thanks to Karen Winch and Joanne Delve who have been a great support to me and to the wider team who provided many laughs and uplifting days in the office.

I would also like to extend my sincere thanks to my friends. They have had to put up with me often being unavailable to make social events and putting them to one side throughout this research process, but they have always been on the end of the phone for support and advice.

I must mention my family, and particularly my close family group whose support has been unwavering throughout this process. My Welsh family, who I don't see often, but are only a phone call away. UJ and Dot – thank you for asking me every week if I'd written my introduction yet and providing numerous 'dad' jokes to keep me smiling. My Aunty Anne who has continued to provide pictures of food for inspiration! My cousins Tor and Kas, who are like the sisters that I never had. My partner Andrew, the days when I can't find a reason to smile, you give me that reason and I am extremely grateful for your love, patience, and support. I just wish that you could see yourself the way that I see you. My parents, what can I say – thank you. The opportunities, the love, the support. Unwaivered, unquestioned, unequalled. I will forever be thankful for everything that you have provided me with. Mom – as you often tell me, you gave up your high-flying career to care for and nurture me whilst Dad was the provider. You did it right. I was and continue to be the luckiest girl in the world because you are my parents.

Lastly, but perhaps most importantly, I would like to thank all the children and parents who took part in my research. Also, the children I met through previous employment who inspired me to undertake this research and opened my eyes to a world I had only seen in documentaries.

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

20mSRT	20 Metre Shuttle Run Test
ADHD	Attention Deficit Hyperactivity Disorder
AHK	Active Healthy Kids
AHKGA	Active Healthy Kids Global Alliance
ASD	Autism Spectrum Disorder
A-STEM	Applied Sport, Technology, Exercise and Medicine
AYPD	Active Young People Department
BMI	Body Mass Index
BMI z-scores	Measure of relative body mass adjusted for child age & sex
BPNT	Basic Psychological Needs Theory
CAMSA	Canadian Agility and Movement Skills Assessment
CHAT	Child Health and Activity Tool
CI	Confidence Interval
Cm	Centimetre
CRF	Cardiorespiratory Fitness
CVD	Cardiovascular Disease
DCD	Developmental Coordination Delay
FMS	Fundamental Movement Skills
FSM	Free School Meals
HIIT	High Intensity Interval Training
HRF	Health-Related Fitness
ICC	Intraclass Correlation
ID	Intellectual Disability
IPLA	International Physical Literacy Association
Kg	Kilogram
LPA	Light Physical Activity
m	Metre
MABC-2	Movement Assessment Battery for Children (version 2)
METS	Metabolic Equivalents
MICT	Moderate-Intensity Continuous Training
Min(s)	Minute(s)
MVPA	Moderate to Vigorous Physical Activity
N	Number
P	Level of Significance
PA	Physical Activity
PAL	Physically Active Learning
PE	Physical Education
RCT	Randomised Control Trial
S(s)	Second(s)
SD	Standard Deviation
SDT	Self-Determination Theory

SE	Standard Error
SEM	Socioecological Model
SES	Socioeconomic Status
SHRN	Schools Health Research Network
SOP	Standard Operating Procedure
TGMD 3	Test of Gross Motor Development (version 3)
TPA	Total Physical Activity
UK	United Kingdom
VPA	Vigorous Physical Activity
WHO	World Health Organisation
WIMD	Welsh Index of Multiple Deprivation

1. INTRODUCTION

1.1 RATIONALE & BACKGROUND

Physical inactivity is the fourth leading cause of mortality worldwide (World Health Organisation, 2010) and is therefore a major public health concern. Children and young people are not meeting the recommendations for daily physical activity (Guthold et al., 2018); which is having negative implications on their physical (Hills et al., 2011) and mental health (Biddle & Asare, 2011). Low levels of childhood physical activity have been correlated to the growing frequency of overweight and obesity within children (World Health Organisation, 2022). Inactive children are likely to become inactive adults (Telama et al., 2014), leading to further negative health outcomes such as heart disease, hypertension, and certain types of cancer (Cleven et al., 2020; Lee, 2003). In Wales specifically, where this body of doctoral work is set, levels of children's physical activity are particularly low when compared to other developed countries (Aubert et al., 2018); alas, there are also high rates of overweight and obesity in children and young people in Wales (Crowther et al., 2022).

According to Stodden's Developmental Model (Stodden et al., 2008), physical activity is associated with motor competence and physical fitness. All three elements, physical activity (Kohl et al., 2013), fitness (Boddy et al., 2012; Stratton et al., 2007; Tomkinson et al., 2019), and motor competence (Duncan et al., 2022) levels in children have been declining over the decades and this has led to an increase in research in this area to inform interventions, with the aim of reversing the downward trend. Evidence has recently been scrutinised for this Developmental Model and Barnett et al. (2022) has proposed the strength of links between physical activity, motor competence and physical fitness. However, a larger evidence base is needed to provide further clarity about the strength and depth of these associations in larger, more representative samples and in different population groups, such as those living with disabilities.

Research has shown that the COVID-19 pandemic, which swept the world in 2020, had a profound impact on children's levels of physical activity (Jago et al., 2023; Yomoda & Kurita, 2021), and physical fitness (Chambonnière et al., 2021). This also had a detrimental impact on body composition, with more children being classified as obese or overweight than before COVID-19 (Jarnig et al., 2021). There are inconsistent findings from work examining the impact of the pandemic on children's motor competence, however, some have indicated a decline in motor competence assessments (Chambonnière et al., 2021; Pombo et al., 2021). Further, emerging evidence suggests that levels of motor competence in children have not recovered since the lifting of pandemic restrictions (Carballo-Fazanes et al., 2022). The longer-term effects of the pandemic are yet to be seen and longitudinal research is warranted to do this.

Although there is a substantial, existing evidence base on children's physical activity, fitness, motor competence, and of children particularly during the COVID-19 pandemic, there is a lack of population-level data. Population-level explorations allow for subgroup analysis, such as gender, ethnicity, and disability. Directing research towards the gaps in the current literature would provide a greater insight and a further understanding of children's physical activity, fitness, and motor competence at a pan-Wales level, including children with additional learning needs. Such research should focus on the COVID-19 pandemic, given the severity of the world-changing events during the past few years.

1.2 Problem Statement

Despite the many health benefits that being physically active and reducing sedentary time can have on both children and adults, a minority of the child population estimated at between 27 and 33% (Aubert et al., 2022), meet the physical activity and sedentary behaviour recommendations, which is a major public health concern. There is growing importance for identifying physical activity levels at a national level to inform policy and practice; whilst work on associations between physical activity, fitness and motor competence are ongoing to provide a greater depth of understanding (Barnett et al., 2022). Specific populations need to be studied to understand inequalities and measures that can be implemented to reduce these inequalities. Research has shown that inequalities have further increased during the pandemic. Changes to children's behaviours need to be monitored to identify any cause for concern and place early interventions to reduce any detrimental behaviour changes. Ultimately, research needs practical recommendations to bridge the gap between research and practice.

1.3 THESIS AIMS

The overall aim of the body of research was to investigate children's physical activity, fitness, and motor competence, and subsequently the effects that the socioecological context had on these during COVID-19 lockdown restrictions. This thesis is divided into five study chapters:

Study 1: The aim of Study 1 was to summarise the findings of the Active Healthy Kids Wales 2021 Report Card process and to present and interpret the results for eleven quality indicators of physical activity in children and young people.

Study 2: The purpose of Study 2 was to examine the associations between fitness and swimming and cycling proficiency in primary school boys and girls.

Study 3: The objective of Study 3 was to examine motor competence in children with and without additional learning needs at a population-level.

Study 4: The intention for Study 4 was to improve understanding of the impact of COVID-19 lockdowns on children's physical activity and sedentary behaviour at home using the socioecological model as a theoretical framework. A secondary aim was to make recommendations to improve children's physical activity at home and their subsequent health and wellbeing.

Study 5: The aim of Study 5 was to investigate causal factors that influenced changes in experiences of children's physical activity and sedentary behaviour across time related changes in COVID-19 pandemic restrictions and in the context of the self-determination theory.

2 LITERATURE REVIEW

2.1 INTRODUCTION

In view of the importance of physical activity, physical fitness, and motor competence on health outcomes, specifically within the child population, this literature review aims to summarise the research in this area, exploring correlates and determinants, environmental influences in the context of current thinking and scientific evidence.

The structure of this literature review follows the phases of the behavioural epidemiology framework suggested by (Sallis & Owen, et al., 2000). Each section critically discusses the (i) relationships between behaviour and health (phase one), (ii) methods for measuring the behaviour (phase two), (iii) factors that influence behaviour (phase three), and (iv) an evaluation of interventions that aim to change behaviour (phase four). The final thesis synthesis focuses on the translation of research into practice (phase five).

2.2 MODELS AND THEORIES

It is important to consider theories and models when conducting research. Theories are used to inform thinking, assist with generating research questions and designs, and can also be useful in interpreting data and offering explanations of the results (Reeves et al., 2008). Extensive reading and literature reviewing was conducted prior to, and during this body of work to understand theories and to make educated decisions with regards to research questions and chosen methods. Three theories underpin this research, the Developmental Model (Stodden et al., 2008), socioecological Model (Sallis & Owen, 2015) and the Self-Determination Theory (Ryan & Deci, 2017). These three pieces of theory enabled a greater depth of understanding throughout the process of this research and allowed a more comprehensive and thorough insight into children's physical activity, fitness, and motor competence.

2.2.1 Developmental Model

Linking together the elements of this literature review including physical fitness, motor competence, and physical activity, is the Developmental Model by Stodden et al., (2008). This model explains the role of motor competence in children's physical activity, health-related fitness, and perceived motor competence, which in turn are associated with the risk of obesity. This model underpins the elements of this literature review and the overall body of work.

Following the development of this conceptual model, motor development research has increased importance in public health (Clark, 2017), potentially due to the direct pathway that the model proposes between motor competence and physical activity. Stodden et al. (2008) suggest that the direction of this association changes as children develop with age. The model proposes that during early childhood higher physical activity leads to a greater level of motor competence, whereas during middle to late childhood the direction is reversed whereby having higher motor competency implies higher levels of physical activity. Stodden's (2008) model (Figure 1) conceptualises that all associations between physical activity and motor competence, as well as health related fitness and perceived motor competence across early, middle, and late childhood. The model indicates that early childhood associations are one directional, whereas middle to late childhood associations are often bi-directional. Perceived motor competence and health-related fitness is of increasing importance for physical activity involvement and weight status as children get older (Robinson et al., 2015; Stodden et al., 2008). Stodden et al. (2008) propose that children in early childhood have varying levels of motor competence due to experiences and differences in socioeconomic status, parental influence, and physical education. The Developmental Model (Stodden et al., 2008) was intended to bridge gaps within the literature surrounding the role of mediating variables such as perceived motor competence, health-related physical fitness, and obesity; all of which impact the association between physical activity and motor competence.

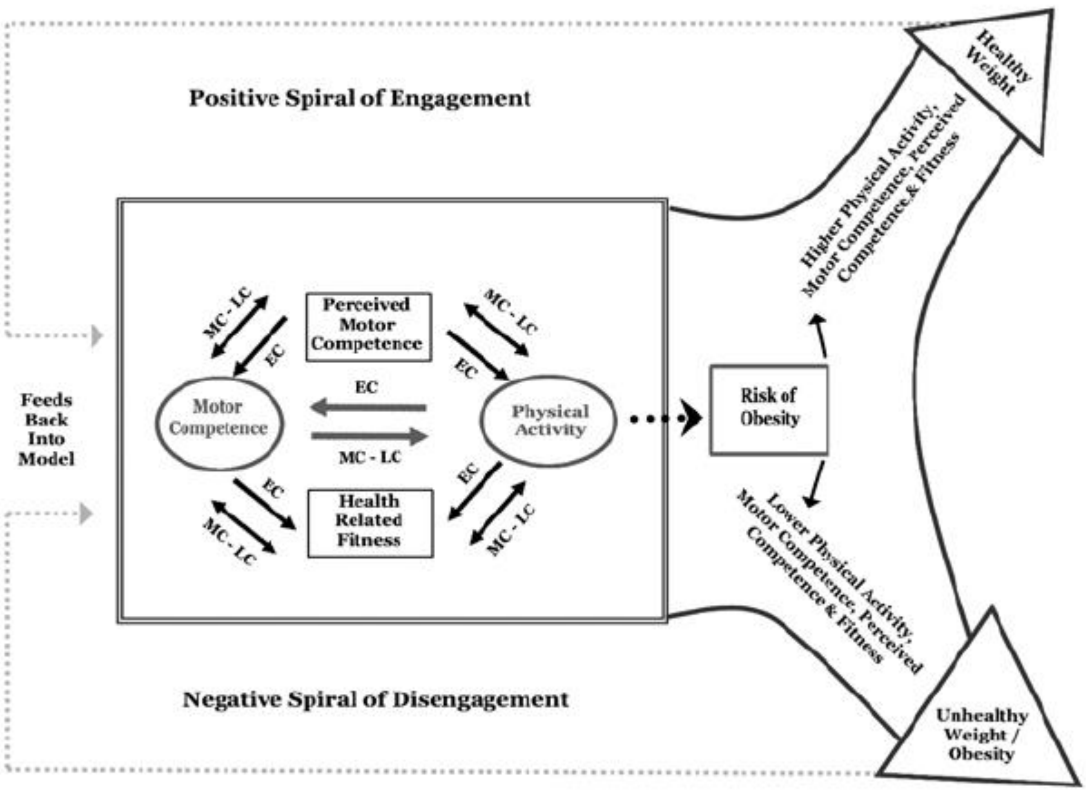


Figure 1: *Developmental model proposed by Stodden et al (2008)*

A limitation that Stodden et al. (2008) specified was that many of the hypotheses, made in relation to the conceptual model, had not been sufficiently addressed within previous literature. Therefore, Robinson et al. (2015) reviewed research which could substantiate the Stodden et al. (2008) conceptual model and found strong evidence that motor competence is associated with physical activity, fitness, and healthy weight status. Robinson and colleagues (2015) demonstrated that the strength of associations between motor competence and health-related fitness increases from childhood into adolescence. They also noted a need for causal pathways to be tested across time together with a necessity to continue to test the associations proposed within the model through longitudinal or experimental research to reduce speculative evidence.

Taking into consideration the limitations highlighted by Robinson et al. (2015), Barnett et al. (2022) agreed with the limited analysis of longitudinal and experimental studies, resulting in an updated, systematic review. Barnett et al. (2022) highlights that more studies, including multiple or all variables from the model, need to be conducted and that longitudinal research would be highly beneficial. Barnett's review of studies found that there was a strong positive pathway from motor competence to health-related fitness, but indeterminate in the opposite direction. The pathway between motor competence and physical activity and the inverse route showed indeterminate and no evidence results respectively. There was, however, strong positive evidence that health-related fitness mediated the pathway in both directions between motor competence and physical activity. Again, there was indeterminate and no evidence that perceived motor competence mediated the pathway between physical activity and motor competence and the reverse.

Through this body of doctoral work, Barnett et al.'s, (2022) update on the Developmental Model will be used as a basis to conduct research to provide further evidence to fill in the present gaps; in turn, this aims to aid interpretation of Stodden et al's. (2008) Developmental Model. Through this body of work, there is an opportunity to produce empirical evidence that will support the understanding of this model with large, representative samples and using valid, yet novel methods to collect data in this area.

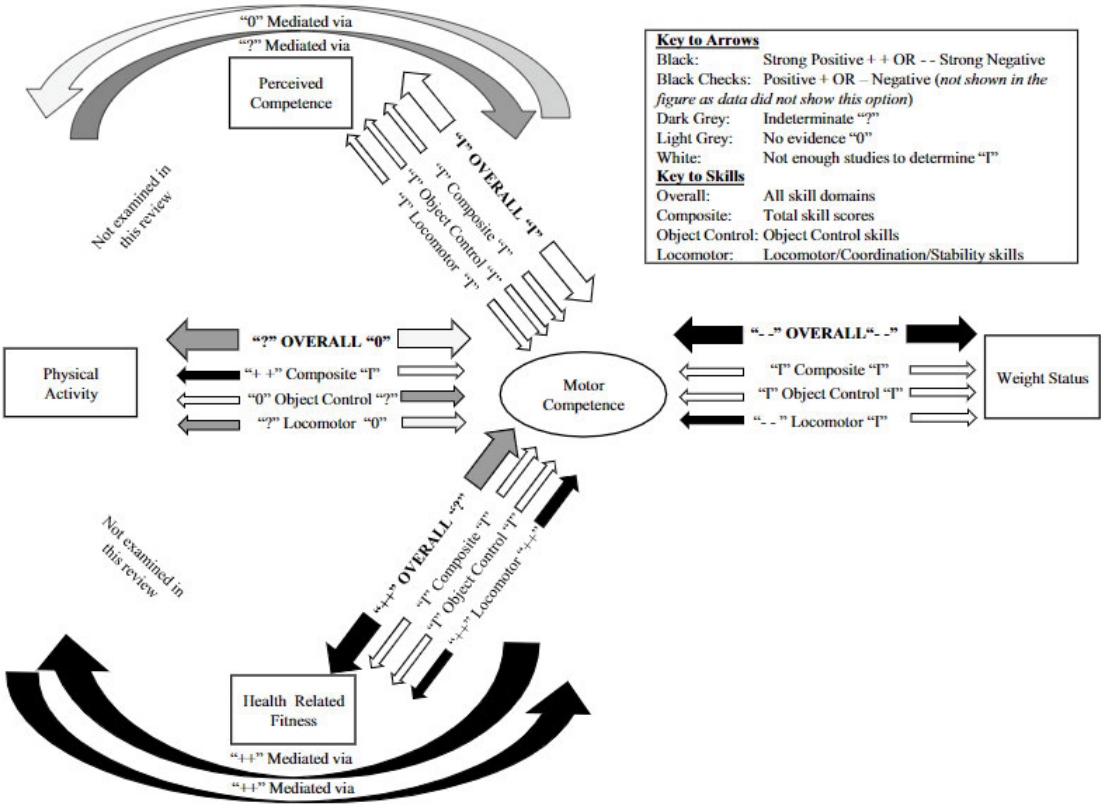


Figure 2: *The level of evidence for each of the proposed pathways based on the findings from Barnett et al (2022).*

Specifically considering the Developmental Model, in the context of this body of research, the empirical studies directly contribute towards the research base for this model. **Study 1** provides a comprehensive back drop to the model and provides a longitudinal approach to support the proposed need for longitudinal research. The grades assigned in **Study 1** can be evaluated over time as the same methodology has been used. **Study 2** provides further strong evidence for the pathway between motor competence and health-related fitness. **Study 3** questions the reviews used to develop this model as the population with additional learning needs or disabilities was not mentioned in Barnett's review. Both HomeSPACE studies, **Study 4 and 5**, reflect the lack of exposure to physical activity in developing motor competence, moreover, **Study 5** also delivers a longitudinal approach.

2.2.2 Ecological Model

Ecological models are commonly used to provide context to influencing factors for physical activity and sedentary behaviours (Zhu & Owen, 2017) and conceptual models are often used as a guide within observational studies (Sallis et al., 2000). The socioecological model proposes that behaviour can be influenced at five levels: individual, interpersonal, organisation, community, and policy (Sallis & Owen, 2015). To better understand this, within the context of this thesis, physical activity behaviour should be evaluated across multiple levels simultaneously (Stokols, 1996). Psychosocial theories only target behaviours at an individual level and whilst this is important to consider in some contexts, the socioecological model provides considerations from a wider lens. Evaluating physical activity behaviours across multiple levels of the socioecological model simultaneously entails examining various aspects at individual, interpersonal, organisation, community, and policy levels. This holistic approach provides a comprehensive understanding of the factors influencing physical activity and facilitates the development of more effective interventions. One effective strategy to gauge physical activity and sedentary behaviours across multiple levels simultaneously is through conducting systematic reviews that span all tiers of the model. This methodology has been employed previously, as evidenced by studies such as a systematic review exploring interventions to mitigate children's sedentary behaviour, which encompassed more than two levels. It was discovered that interventions spanning all four levels yielded the most significant effectiveness (Cholley-Gomez et al., 2023). Moreover, a recent study utilised a multilevel model to identify the necessity for a multidimensional approach in comprehending the determinants of physical activity, incorporating individual characteristics along with social and physical environments (Lee & Park, 2021). The socioecological model has also found application in researching children's motor competence, where logistic regression models were employed, progressively adding an additional level of variables (Van Kann et al., 2022).

The socioecological model will be considered throughout this body of work to provide a holistic understanding of physical activity, motor competence and fitness; with specific focus on Chapter 7, where the model underpinned the research directly.

2.2.3 Self-Determination Theory

The Self-Determination Theory (SDT) is a popular interpretive framework used to explore motivation, specifically within the context of physical activity and sedentary behaviour (Ryan & Deci, 2017) and has widespread use within this context (Brustad, 2010). This psychosocial theory has more recently been used to analyse health-related behaviours during the COVID-19 pandemic (Porat et al., 2020; Šakan et al., 2020). There are six mini-theories within SDT, including the Basic Psychological Needs Theory (BPNT), which claims that optimal functioning is predicted by autonomy, relatedness, and competence. These three psychological needs contribute to the knowledge development in understanding an individual's levels of motivation and engagement. Autonomy is the sense of having a choice and making decisions. Relatedness implies a connection and feeling significant to others and when relatedness is lacking an individual can feel lonely and excluded. Competence is satisfied when an individual can capably take part in activities, whereas when this need is not achieved an individual can feel a sense of failure or helplessness.

2.2.4 Conclusion

There are many models and theories that underpin work in the physical activity, fitness, and motor competence field. However, the three outlined above will be used throughout this body of work as a basis for providing empirical evidence. Examples of where the models and theories are paramount in this body of work include:

Study 1: The indicators that are graded are at all levels of the socioecological model, however, these interact to provide a more comprehensive understanding of children and young people's physical activity.

Study 2: Stodden's Developmental Model is particularly pertinent in this study as the associations between motor competencies, specifically swimming and cycling and motor fitness, are assessed and provide further evidence for the model.

Study 3: Also relevant to Stodden's Developmental Model as the research which looks at differences in motor competence between different populations will continue to add to the research base in this area.

Study 4: The socioecological model was used specifically as a framework within this study to provide barriers and facilitators at all levels of the model.

Study 5: Self-Determination Theory was used specially as a framework within this study to provide further insight into the children's motivations to be physically active across varying levels of lockdown restrictions.

2.3 PHYSICAL LITERACY

Physical Literacy will be used as an umbrella term and the principles and components of physical literacy such as fitness, physical activity, motor competence are included in each empirical study of this thesis. Physical literacy as a construct has received wide attention over the last decade (Jurbala, 2015) and its value should replicate that of literacy and numeracy (Tremblay, 2012). The pioneer behind physical literacy, Margaret Whitehead, acknowledged the importance in differentiating between physical activity and physical literacy and offered a definition of “the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life,” (Whitehead, 2013). This is the definition adopted by the International Physical Literacy Association (IPLA) and it suggests that physical literacy is multifaceted and promotes interconnectedness between the physical, cognitive, behavioural, and affective domains (Gunnell et al., 2018). This holistic approach further confirms the attachment between the body and mind (Durden-Myers et al., 2020).

Elements of physical literacy have been widely studied, yet few researchers have bought together all elements of physical literacy. A few associations that have been recognised are those between physical literacy and health outcomes such as body mass index and waist circumference (Delisle Nyström et al., 2018). The association between physical literacy and aerobic fitness has been found to be mediated by moderate to vigorous physical activity (Caldwell et al., 2020); however, this study was of cross-sectional design and no causal relationship can be established. There have been positive associations found between children meeting the physical activity guidelines and physical literacy scores for physical competence, motivation, and confidence (Belanger et al., 2018). Differentiations should be made between the two terms of physical activity and physical literacy; however, it is important to note the associations between the two and the lack of cause-effect evidence within this realm. Therefore, further longitudinal, and longer-term intervention studies are required to fill these gaps in our understanding (Lopes et al., 2021).

Dudley (2015) proposes that physical literacy should be used as an umbrella concept, and that will be done throughout this body of work. By way of explanation, all involvement in active pursuits, lead to the development of physical literacy, particularly in children. As such, investments should be made by governments to invest in schools, play, and active communities, and to developing safe cycling and aquatic skills and behaviours; further, to aid the development of physical literacy within the home environment. These targets should all be considered within equality, inclusion, and diversity, as those with additional learning needs or disabilities may require additional support to become physically literate, an area currently lacking research. Although, one study exploring physical literacy and disability highlighted the need to listen to the views of those living with disabilities to fully comprehend their physical literacy journeys (Pushkarenko et al., 2023).

Wales has been described as a flagship of worldwide physical literacy dissemination (Carl et al., 2023). When comparing and amalgamating physical literacy research from European countries, Carl et al., (2023) provided detail on the research and the policy from Wales specifically regarding physical literacy highlighting that legislation through the Well-being of Future Generations Act (Well-Being of Future Generations (Wales) Act, 2015) emphasised the importance of physical activity and health behaviours in children. It was also identified that Sport Wales adopted the IPLA definition to produce education materials and invested funds (£1.78million) for the 'Physical Literacy Programme for Schools.' Despite the positive messages from Wales about physical literacy promotion, the new Curriculum for Wales (2022) contains no reference to physical literacy, however, it's Health and Wellbeing Area of Learning and Experience is based on the core principles of physical literacy (Welsh Government, 2020).

2.4 PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR

Physical activity is defined as "bodily movement that is produced by skeletal muscles resulting in energy expenditure higher than resting" (Caspersen et al., 1985). The seminal work of Jeremy Morris revealed that more active individuals were at far lower risk of heart attack than more sedentary workers, as explored between bus drivers and conductors (Morris & Crawford, 1958). This research started a flurry of exploration into physical activity and the numerous positive health outcomes that being physically active can have. Physical activity has been strongly associated with better physical and mental health outcomes including a reduced risk of heart disease and diabetes (Cleven et al., 2020), certain types of cancer (Lee, 2003), and depression and anxiety (Ströhle, 2009). Conversely, being physically inactive has many health consequences and is the fourth leading cause of mortality globally (World Health Organisation, 2010). It is important to note that being physically inactive does not necessarily correlate with being sedentary and the two terms are often confused (Pate et al., 2008). One could be physically active, meeting the guidelines for physical activity, yet spend most of their waking hours engaging in sedentary behaviours. Sedentary behaviour has been defined as any waking activity in a sitting, lying or reclining position with an energy-expenditure of less than 1.5 metabolic equivalents (METS; Tremblay et al., 2017). Sedentary behaviour has also been widely investigated in recent years with findings demonstrating an undesirable correlation with health outcomes (González et al., 2017).

This body of work focuses on the paediatric population and physical activity and sedentary behaviour, recognising that a good start in life is crucial for future health and wellbeing (Well-Being of Future Generations (Wales) Act, 2015). Physical activity and sedentary behaviours have been shown to track from childhood into adolescents and further into adulthood (Telama et al., 2014). Regular physical activity in children is associated with numerous physical and psychosocial health benefits, including a reduced risk of obesity (Brown et al., 2019), anxiety and depression (Biddle & Asare, 2011). Associations have been made between children's physical activity levels and their academic attainment (Howie & Pate, 2012) and motor competence (Stodden et al., 2008). Gaining a deeper understanding of children's physical activity levels and behaviours, can assist in developing interventions to increase physical activity in the paediatric population, with the aim of developing healthy, active behaviours at a young age and carrying this through to adulthood.

Physical activity has sub-dimensions that include the frequency, intensity, time, and type, referred to as FITT. Gabriel et al., (2012) explored the FITT principle and referred to frequency as the rate that physical activity occurs over a given period, for instance a day, a week, or a month. The intensity of physical activity was described as the level of effort or physiological demand being exerted; this ranges from light physical activity (LPA), to moderate to vigorous physical activity (MVPA) through to vigorous physical activity (VPA). Light physical activity is anything between one and a half and three METS, such as a light walk. MVPA is measured as an activity which increases the heart rate such as jogging or cycling which will be between three and six METs. Vigorous physical activity is anything over six METS. When considering the intensity of physical activity, research has shown that children should aim for at least moderate intensity, but VPA will accrue even better health benefits, such as a decrease in obesity and blood pressure (Janssen & Leblanc, 2010). The time element was the number of minutes or hours spent being physically active. The type of activity indicates the form of engagement for example, walking, strength training, organised sport, play or active travel. The FITT principle has been applied when developing the recommendations and guidelines for physical activity.

2.4.1 Physical Activity and Sedentary Behaviour Guidelines and Prevalence

The aforementioned benefits of physical activity have led to the production of guidelines and recommendations for weekly and daily activity levels. There are guidelines provided by the World Health Organisation (WHO) for the frequency, intensity, time, and type of physical activity that should be undertaken by people of different ages and with various health conditions. The range of guidelines include for children of various ages, starting with children under one, through to adults aged 65+.

There are also specific guidelines for pregnant and postpartum women, people with chronic conditions, and those living with a disability. With the focus of this research being on children and adolescents, the current guidelines for five- to seventeen-year-olds include doing at least an average of 60 minutes of MVPA per day, mostly aerobic physical activity, across the week. This age group should also incorporate VPA, and bone and muscle strengthening activities at least three times per week. There is mention of reducing sedentary time, particularly recreational screen time (World Health Organisation, 2020).

Despite the recommendations and the well-cited health benefits of being physically active during childhood, levels of physical activity worldwide are poor and have been decreasing over time (Kohl et al., 2013), having a harmful effect on physical (Hills et al., 2011) and mental health (Biddle & Asare, 2011). The nature of the urbanised world means that populations are less active now than previously. Automobiles are no longer a luxury, but a necessity, reducing the habitual activity to travel between places (Kjellström et al., 2007). Sedentary, desk-based jobs have increased, meaning that as a population we are far less active than our predecessors and engage in more sedentary activities (Wareham et al., 2005). Increases in children's screen-time is a prime example of engaging in more sedentary behaviours (Mullan, 2018). It is important to track physical activity prevalence and sedentary behaviour levels to gain an understanding of changes over time and to implement interventions to reverse the downward trend and try to increase physical activity levels with the aim of improving overall health.

Due to the urgent need to address the declining levels of physical activity, members of the WHO advocated for a global action plan on physical activity. This plan was launched at the World Health Assembly in 2018 and a target was set for a 15% relative reduction in insufficient physical activity amongst children and adolescents by 2030. In 2022, the WHO issued an update on progress towards this figure through their 'Global status report on physical activity 2022' document, with the overall message that movement towards the target, is slow and unequal (World Health Organisation, 2022). Physical activity levels in children and young people are less than might be expected, with recent worldwide data showing 81% of young people aged 11-17 years not achieving the recommended one hour per day of MVPA (Guthold et al., 2018). The WHO report slight increases in physical activity for adolescents, but this is only for boys, further increasing inequalities between the sexes.

In the context of the children who were sampled as part of the studies in this body of work, recent figures suggest that approximately one third of children in the United Kingdom (UK) meet the national recommendation of 60 minutes of MVPA per day (Salway et al., 2022). Yet in Wales (StatsWales, 2020) only 51% of children and young people aged 3-17 years meet the recommended guidelines of at least 60 minutes of physical activity, every day of the week; and only between 13 and 17% of 11–16-year-olds meet the guidelines (Health Social Care and Sport Committee, 2019). Unfortunately, these figures indicate that Wales has some of the worst levels of physical activity globally (Aubert et al., 2018; Hanson et al., 2017).

2.4.2 Physical Activity & Sedentary Behaviour Measurements and Monitoring

Many of the data presented above are measured using self-reported physical activity which has some significant response bias (Chinapaw et al., 2010). Physical activity is difficult to assess (Dugdill et al., 2007) due to its complex nature and 'FITT' components. The creation and subsequent development of accurate measurements of behaviour has been highlighted as a key phase in the behavioural epidemiology framework (Sallis, et al., 2000). Methods for measuring the behaviour is positioned early within the framework as it is essential for all stages of the research. Within this framework, Sallis et al., (2000) state that determining current measures' validity and reliability, together with developing new measures and field-testing any new tools, are key when considering measurements and monitoring of health behaviours such as physical activity. When developing research methodologies and approaches, researchers must consider how best to capture quality and quantity of physical activity. There are a range of valid methods used to measure physical activity, from surveys to devices, and the choice of method relates to the research questions in hand, resources available, and practicalities of the research study. Measurements are split into subjective measures, including self-report and observation, for which reliability and validity can be reduced by reporting errors and recall bias (Chinapaw et al., 2010; Sabia et al., 2014); and device-based measures including accelerometery, which are not yet feasible for large scale use because of high costs and also researcher and participant burden due to the time taken to collect the data (Skender et al., 2016). When approaching methods to measure and monitor levels of physical activity, it is vital to consider the instrument and/or tool to use, but also the procedure itself. Subjective decisions need to be made by researchers after methods have been deployed, relating to type of analysis, acceptable device wear time, and completeness of reporting. All of these factors demonstrate potential researcher bias/influences in the design and implementation of methods used in physical activity research.

Subjective data, such as self-report using survey or interview data, has been used at a large scale to capture data on physical activity and sedentary behaviour. Self-report measurements, such as physical activity questionnaires, are comparatively inexpensive and convenient to administer to gain a greater awareness of physical activity in a large population (Chinapaw et al., 2010). However, subjective measures have been criticised for known issues with recall and social desirability (Chinapaw et al., 2010; Sabia et al., 2014). When asked about levels of physical activity, children in particular, struggle to understand questions and have difficulties in recalling activities (Janz et al., 2008). Children may overestimate or underestimate overall physical activity levels when using self-report (Adamo et al., 2009).

Due to these limitations, studies have investigated the validity, reliability, and accuracy of various physical activity surveys for children. Within this body of research, one of the surveys that is used is the Childhood Activity Tool (CHAT; Todd et al., 2016) and this has shown validity through a study with the use of wearable cameras (Everson et al., 2019). The School Health Research Network (SHRN; Page et al., 2021) also delivers the Health Behaviour of School Children (HBSC; Morgan et al., 2016) survey in a large population of young people across Wales. When assessing the reliability and validity of the HBSC questionnaires, Su et al. (2022) reported that the HBSC is a reliable method in assessing physical activity and sedentary behaviour in adolescents. Su et al. (2022) report that the HBSC is a reliable method in assessing physical activity; however, evidence is currently lacking on the validity of its assessment of sedentary behaviour.

Another subjective measure of physical activity is interviews. Research has shown that when children are interviewed in familiar surroundings i.e., their home, they often feel more relaxed and at ease (Moyson & Roeyers, 2012). The method of interviewing children within the home environment eliminates potential issues relating to school-based interviews, where children may identify the researcher as a teacher (Kellet & Ding, 2004) and they may feel that they have more of a voice within their home (Powell et al., 2012) However, interviews within the home present alternative challenges where it can be difficult to find a quiet space, especially where there may be a large family (Mcdonald et al., 2006). Individual interviews with siblings are preferable as it can be hard to manage group interviews for children of varying ages and abilities, and by interviewing individually removes any chance of confrontation or argument (Punch, 2007). Another benefit of conducting interviews online is that, since the COVID-19 pandemic, children have experienced greater exposure to digital technology through online learning and are more comfortable using this technology (Vargo et al., 2021). Although, it can be harder for a researcher to build rapport with a child via online engagement (Fargas-Malet et al., 2010). It has been reported that there is great value to longitudinal research with children to explore changes across space and time (Crivella, 2017). However, Morrow (2009) claims that qualitative longitudinal research with children and young people produces both ethical and methodological challenges. There is good evidence which suggests that conducting interviews online remove some of the ethical issues around child protection, when conducting an interview with a child in the home environment in a private space (McDowell, 2001). However, more recently, and particularly since the COVID-19 pandemic, online interviews with children have been scrutinised with the importance of parent consent and child assent being highlighted (Canning & Robinson, 2021). A recent review concluded that there is a lack of research exploring the use of digital interviews with children and this should be studied in more depth (Thunberg & Arnell, 2022). Considering longitudinal research, the right to participate overtime being a key ethical issue (Clark, 2005) ensuring that informed assent and consent must be present to eliminate this ethical challenge.

To achieve quality and quantity of data, many researchers now seek to employ both subjective and device-based measures to capture physical activity and sedentary behaviour data. Sub-samples for this more time consuming, expensive approach are often considered (Van Kuppevelt et al., 2019). There is no gold standard for measuring physical activity yet using Microelectromechanical systems (MEM's) devices, such as accelerometers, provide valid objective measures (Ekelund et al., 2011). However, accelerometers are not able to capture the type of physical activity behaviours which limits interpretation and the ability to design interventions. Whilst the WHO has noted that there have been improvements in cost-effective wearable technology, there is still restricted use at a population-level to obtain and track physical activity (World Health Organisation, 2022). This body of work did not use accelerometery as a measure of physical activity due to being costly and time-consuming. Accelerometery was not needed as this research looked to explore perceptions, barriers, and facilitators of physical activity, which cannot be captured through accelerometery.

2.4.3 Physical Activity & Sedentary Behaviour Correlates and Determinants

By using the measures and monitoring methods described, researchers can go on to recognise correlates and determinants of physical activity and sedentary behaviours which is imperative when developing evidence-based interventions (Sallis, et al., 2000). It has previously been identified that, as researchers, we must distinctly differentiate between "correlates" and "determinants" (Bauman et al., 2002). A correlate mostly results from cross-sectional studies and cannot describe causal relationships; whereas a determinant illustrates a causal relationship this is often ascertained through randomised controlled trials (RCT's) or longitudinal studies. Put simply, determinants can "cause" changes in physical activity levels, whereas correlates are associated with such levels.

A review by Sallis et al. (2000), found that 60% of reported associations with physical activity were statistically significant, including sex (male), physical activity preferences, previous physical activity and facility access together with time spent outdoors. On the other hand, for adolescents', associations included ethnicity (white), age (inverse) and depression (inverse). A more recent systematic review exploring correlates and determinants in younger children of 0-6 years of age, highlighted that there were few studies found from low-income countries and few that were high quality (Bingham et al., 2016). Findings included that sex (male), parental PA (+), parental support (+) and time outdoors (+) were all correlates of total physical activity but only sex was a correlate of MVPA. An umbrella review highlighted the lack of conclusive evidence regarding biological determinants of physical activity and sought to summarise the evidence using available systematic reviews and meta-analyses (Aleksovska et al., 2019). Findings demonstrated positive associations between physical activity and younger age, being male and a higher health status.

When examining the correlates and determinants of sedentary behaviour in children, van Sluijs et al. (2010) identified that these were different across the world, with high computer use and no television use before school being associated with sedentary behaviour in Norway, whilst being sedentary during school breaks in Estonia was associated with sedentary behaviour. Portuguese children who had a television in their bedroom were more sedentary. One study found seven correlates of device-based measures of physical activity and sedentary behaviour in English children, however, only four were potentially modifiable: child weight status, child interest in active play, active commuting to school and parenting practice; gender, maternal age and season were identified as non-modifiable correlates (King et al., 2011). Linking to interventions, factors that are modifiable are the most important to consider.

The correlates and determinants of physical activity are required to develop effective interventions, barriers and facilitators should also be acknowledged.

2.4.4 Physical Activity and Sedentary Behaviour Barriers and Facilitators

At the turn of the millennium there was an increase in qualitative research focussing on the barriers and facilitators to physical activity and sedentary behaviour allowing for a deeper understanding of young people's perspectives and experiences (O'Sullivan & MacPhail, 2010). Understanding why some children and young people are physically active, and others are not, will offer additional insight for effective intervention development; with the aim of removing barriers and increasing facilitators to encourage more physical activity and have an improvement in the population's health.

Barriers and facilitators to children's physical activity includes seven themes: the child, the home, out-of-home childcare, parent-childcare provider interactions, environmental factors, safety, and weather (Hesketh et al., 2017). These themes span each level of the socioecological model: individual, interpersonal, organisational, community and policy. This framework was derived from a systemic review synthesising 43 qualitative papers exploring barriers and facilitators to physical activity in 0–6-year-olds. Most cited barriers were at the interpersonal level, implying the importance of parent or caregiver role models at a young age (Hesketh et al., 2017).

An additional review of barriers and facilitators found that young children's main facilitators of physical activity were parental support and experimentation. Their barriers included competitive sports and highly structured activities. For older children facilitators included weight management and peer support, whilst common barriers were negative school experiences and peer pressure (Allender et al., 2006). A more recent review (Martins et al., 2014) reports that key barriers and facilitators to physical activity included attitude, friends and physical activity opportunities and access. Other common facilitators to children's physical activity include dog ownership (Gadomski et al., 2017), having siblings (Kracht & Sisson, 2018) and parental support (Rebold et al., 2016). A recent review of reviews into adolescent girls' barriers and facilitators to physically activity highlighted that common facilitators were weight loss, support from peers, family, and teachers (Duffey et al., 2021). Girls have reported significantly higher levels of perceived barriers than boys, except for the lack of resources which is equally reported in both boys and girls (Rebold et al., 2016). Lack of resources include limited financial support, which has been referred to as a barrier to physical activity within the child and adolescent population, particularly in the low socioeconomic groups (Brockman et al., 2009). Adolescents have recommended that lowering or removing the cost of activities without diminishing the quality, would aid with increasing physical activity opportunities (James et al., 2018).

2.4.5 Interventions to Increase Physical Activity and Reduce Sedentary Behaviour

In 2012, Stanley et al. reported that interventions to improve physical activity had modest effects, potentially due to methodological inconsistencies in research exploring correlates and determinants whilst Sallis and Owen, (1999) attributed the modest effects to the fact that the crucial determinants of physical activity were not being targeted.

Interventions to increase children's physical activity and reduce their sedentary time have been conducted across numerous settings from schools to home environments (Brown et al., 2016). Schools provide an inclusive setting to place interventions to improve physical activity levels (Mura et al., 2015), whilst specifically classroom based physical activity and physically active learning (PAL) has gained much momentum over the last decade (Daly-Smith et al., 2018). One meta-analysis, exploring classroom based physical activity interventions, concluded that this type of intervention can be practical and of a low-cost. These interventions can be effective in increasing academic attainment and decrease the time that children spend off-task in the classroom; there is potential to increase physical activity levels through these interventions, but more research is needed to address inconsistent results (Watson et al., 2017).

Research has shown school-based interventions have a small-to-medium sized impact on increasing physical activity enjoyment in children and adolescents (Burns et al., 2017). However, when measuring MVPA using an accelerometer, school-based interventions have not been effective in increasing children's daily time spent in MVPA (Love et al., 2019). When exploring specific populations, there is no evidence to suggest that current interventions increase the physical activity of overweight or obese children (Nooijen et al., 2017).

Although school-based interventions can provide access to a large pool of children or adolescents including those that may be hard to reach or at-risk (Pamungkas & Chamroonsawasdi, 2019), combinations made up of multiple settings are most effective (Mulrine, 2013), especially those that extend into the home which actively involve parents (Wilson et al., 2011). The finding that parents are key in influencing their child's behaviour (Danford et al., 2015), suggests that a home-based intervention may be effective at increasing physical activity and reducing sedentary behaviour (West et al., 2010). Home-based interventions are effective at reducing childhood obesity (Stark et al., 2014; West et al., 2010); whilst also reducing television watching (French et al., 2011). For home-based interventions to be effective in increasing children's physical activity, parents should be positive role models (Colley et al., 2012), although involving parents can be challenging (Smith et al., 2011).

2.4.6 Conclusion

Physical inactivity and a rise in sedentary behaviour is a real concern to the health of the population. The negative associations with health outcomes have led to physical inactivity being the fourth leading cause of mortality globally (World Health Organisation, 2010). Measuring and tracking levels of physical activity and sedentary behaviours is of paramount importance to gain a deeper understanding of patterns and trends that may be occurring within the child population. A mixed methods approach is advocated to enable accurate, valid, and reliable measures of physical activity. However, there is need for qualitative insights to couple with this to provide rich detail about reasoning behind these levels. This mixed methods approach will enable an insight into factors that impact levels of physical activity and sedentary behaviour together with providing recommendations for interventions that may be effective in increasing healthy behaviours.

2.5 PHYSICAL FITNESS

Physical fitness is “the ability to carry out daily tasks with vigour and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies” (Caspersen et al., 1985) and includes: “a set of attributes that people have or achieve that relates to the ability to perform physical activity” (U.S. Department of Health and Human Services, 1996). Physical fitness is mainly determined by environmental factors; however, genetic variables also play a part (Wilder et al., 2006). Physical fitness is made up of five health-related and six skill-related fitness components (Corbin, 2009). Health-related components include body composition, flexibility, muscular strength, muscular endurance, and cardiorespiratory fitness. Whilst the six skill-related components are: agility, speed, power, balance, coordination, and reaction time. Physical fitness components are positively related to several health outcomes (World Health Organisation, 2018). Within each component of fitness, it is therefore important to consider: the definition, any guidelines including most recent prevalence, any correlates and determinants, methods to measure the component and lastly the impact of an intervention on the specific component of fitness.

2.5.1 Health-Related Components of Fitness

2.5.1.1 Body Composition

There has been much focus on body composition over the last few decades as unhealthy weight is increasing and more children are overweight or obese than ever before (NCD Risk Factor Collaboration, 2020). Body composition is simply how the body is made up of fat, bone and muscle, and healthcare professionals together with researchers use body composition to check for healthy weight status. The three most common methods to assess body composition include hydrostatic weighing, skinfold measurements, and anthropometric measurements (Wilder et al., 2006). The most popular method being the measurement of anthropometrics through body mass index (BMI), as this is easily collected and has been recommended for use in all age groups

(Kuczmarski & Flegal, 2000). The definitions of overweight and obesity have altered over time and between studies (Kuczmarski & Flegal, 2000), but the current adult BMI cut-off points are for obesity (≥30) and overweight (≥25); these cut-off points are needed to assist with public health population descriptions (Hubbard, 2000). The measure of BMI has been highly criticised as it does not differentiate between excess fat mass and excess lean mass (Must & Anderson, 2006). Researchers have found that other methods of measuring body fat are more accurate but can be expensive, time consuming and can only be conducted in specialist settings, reducing the capability to study a large sample (Ceniccola et al., 2019). Body mass index has been correlated with other measures of fatness (Pietrobelli et al., 1997). Researchers have concluded that the advantages of using BMI as a measure of body composition and adiposity outweigh the limitations (Must & Anderson, 2006).

Within the child population BMI z-scores have been developed to enable comparisons between ages. The cut points for adults do not differ between ages and sexes, however, in children for the measure to be meaningful it needs to consider the age of the child. Various BMI for age and sex references have been developed both nationally and internationally (Must & Anderson, 2006). The International Obesity Task Force (IOTF) used data from children in the United Kingdom (UK), United States of America (USA), Hong Kong, Brazil, The Netherlands, and Singapore. Whilst the IOFT reference curves provide more recent data, the UK 1999 Growth Reference Curves are nation specific and can be applied to studies in the UK (Cole et al., 1995). Researchers have reported controversy around what conditions warrant a national or international reference as best practice (Deurenberg, 2001; Janssen, Katzmarzyk, Srinivasan, et al., 2005; Reilly, 2002). Upon the decision of a suitable reference, together with a child's age, sex and BMI a BMI z-score can be calculated. Using the UK 1990 Growth Reference Curves allows researchers to categorise the children as up to the 2nd centile as underweight, 85th as overweight and 95th as obese (Cole et al., 1995). When conducting research in fitness is it important to consider the role of weight as potential mediating factor, specifically for the muscular fitness component.

A national-level scheme “The Childhood Weight Measurement Scheme” that collects data on children in primary schools is in place in the UK where in England children’s BMI is measured when they enter school aged 4 and when they leave primary school aged 11 to enable a tracking method throughout primary school (Office for National Statistics, 2021). In Wales this scheme is only for children in reception of primary school, aged 4 or 5 years (Hobson et al., 2021). During the year 2016 it was estimated that worldwide over 340 million children aged 5-19 years old were overweight or obese, this is just over 18% of the population, this has risen dramatically since 1975 where the same measure was just 4% (World Health Organisation, 2021). In Wales, UK, where this body of work has been conducted, the overweight and obesity levels are higher than that reported worldwide, with 27% of children being overweight or obese, during the last full cycle of the Childhood Measurement Programme for Wales in the 2018-19 academic year (Hobson et al., 2021). This report also details inequalities in obesity levels where the number of obese children was significantly higher in the areas with the highest levels of deprivation and significantly lower in the most affluent areas. A growing inequality also exists as 7% more children are obese in low compared to high socioeconomic areas. This is consistent with previous findings which highlighted the differences in obesity prevalence between socioeconomic groups (Vazquez & Cubbin, 2020; Wang & Lim, 2012). Obesity prevalence is also higher in black children compared to white, Asian, mixed or Chinese children (Hobson et al., 2021). Numerous reasons have been proposed for the causes behind childhood obesity including activity level, family factors, psychological factors, and food choices (Sahoo et al., 2015). Whilst reasons for an increase in childhood obesity over the past 30 years include increases in consumption of high calorie beverages, high fat food, decreases in physical activity and by sedentary recreation (World Health Organisation, 2020; Boddy et al., 2013). Many of the influencing factors and behaviours relating to childhood obesity are controllable, at both an individual (physical inactivity, dietary habits, and sedentary behaviour) and a societal level (obesogenic environment, marketing strategies for energy-dense foods), and Figure 3 proposed by Weihrauch-Blüher & Wiegand, (2018) details these.

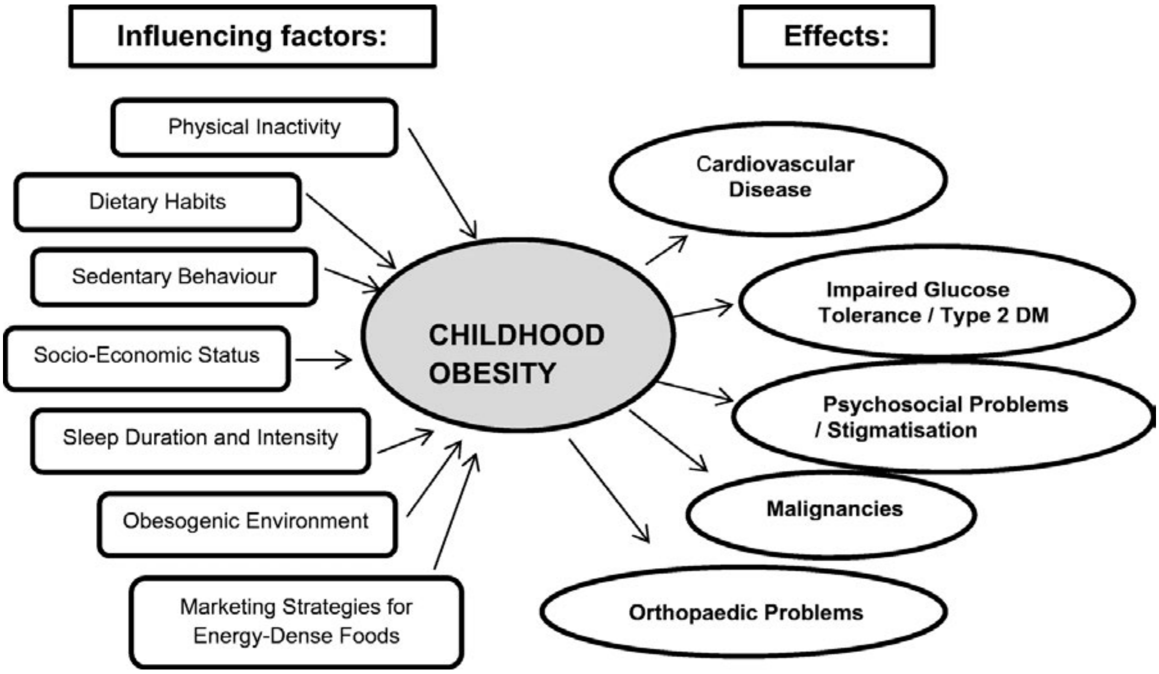


Figure 3: *Risk Factors and Implications of Childhood Obesity from Weihrauch-Blüher & Wiegand (2018)*

High levels of childhood overweight and obesity are concerning as this condition has both short and long-term physical and mental health consequences (World Health Organisation, 2021). For example, over 50% of children and young people who are obese have at least one cardiovascular risk factor and 25% have two (Ng et al., 2014). Childhood obesity is also associated with health risks during adulthood including disability, a higher chance of adulthood obesity and premature death (World Health Organisation, 2021), and an increased risk of cancer later in life (Weihrauch-Blüher et al., 2019).

Due to the negative health implications researchers and practitioners have implemented interventions to try and tackle the pandemic of childhood obesity. Interventions have included increasing physical activity levels (Cao et al., 2015; Herscovici et al., 2013) and or changing and educating on dietary changes (Klein et al., 2010; Papadaki et al., 2010). One systematic review aimed to determine the effectiveness of interventions, which used dietary or physical activity elements or both, in preventing obesity in children (Brown et al., 2019). They evaluated 153 RCT's, where most trials targeted children aged 6-12 years of age and in this age range, they concluded that interventions focussing only on physical activity were effective in reducing BMI, but there was no evidence that diet focussed only interventions were effective. Physical activity and diet interventions showed that they might be effective (Brown et al., 2019); another review confirmed this finding, concluding that a combination of interventions would be most effective, such as diet and exercise for preventing obesity, and diet, exercise, and behavioural therapy for managing obesity (Salam et al., 2020). Recognising who to target with these interventions is important and an umbrella review highlighted that most interventions that were family-based, were effective at improving child weight (Chai et al., 2019). Involving parents in the process of goal setting and role modelling is of paramount importance to aid the effectiveness of the intervention and conducting the interventions in a community setting were more effective at improving physical activity and/or diet than school or home-based interventions (Enright et al., 2020). It is important to reduce obesity as this can in turn improve cardiorespiratory fitness, as strong associations have been found between the two (Aires et al., 2010).

2.5.1.2 Cardiorespiratory Fitness

Cardiorespiratory fitness (CRF) has been defined as the capability of the cardiorespiratory system to deliver oxygen to the muscles during continued exercise (Raghuveer et al., 2020). Perhaps the most important health-related component of fitness, research has heavily focussed on the cardiorespiratory component of fitness as it can be strongly associated with health factors (Ruiz et al., 2009). Cardiovascular disease is the leading cause of death in adults (Mendis et al., 2015) and risk factors can develop during childhood, indicating that the disease can start as a child (Friedemann et al., 2012; Juonala et al., 2011). Low levels of fitness are a key risk factor of cardiovascular disease in adulthood (Ross et al., 2016). Research has suggested that physical fitness levels in children and young people may predict cardiovascular health in adulthood (Ortega et al., 2008). Recently, research has focussed on children's CRF and associated physical and psychosocial factors. Aside from improved cardiometabolic health (Aadland et al, 2019), a higher level of CRF has been associated with lower adiposity (Tuan et al, 2019), better cognitive function (Donnelly et al, 2016) and lower depressive symptoms (Alves Donato et al., 2021). Good CRF may also be associated with increased academic attainment (Blair et al., 2001), improved self-esteem (Greenleaf et al., 2010) and a lower risk of developing high blood pressure, and type 2 diabetes at a younger age (Ortega et al., 2010).

Despite the importance of CRF for health outcomes, it has been declining in children over time (Boddy et al., 2012; Stratton et al., 2007; Tomkinson et al., 2019). A study in Liverpool, UK showed a 23% reduction in fitness levels over a six-year period (Stratton et al., 2007). Yet, a study spanning eleven developed countries estimated a more modest decline at 0.43% per year and initial results showed that this rate of decline was similar in boys and girls (Tomkinson et al., 2003). However, further research suggests that these decreases are greater in girls than boys (Sandercock et al., 2010). In the USA in the year 2000, 52.4% of children had an adequate level of CRF and that had declined to 42.2% in 2012, this did not differ by race or by family income-to-poverty ratio and a higher percentage of boys had adequate levels of CRF than girls across both time points (Gahche et al., 2014). Whilst the decline in the USA was approximately 10% across twelve years, updated evidence suggests that the rate of decline has slowed (Tomkinson et al., 2019). These rates and declines have largely been measured through field-based assessments.

Cardiorespiratory fitness is regularly assessed in children as it is a good measure of not only current health but also future health (Ortega et al., 2008). Most methods used to measure CRF in children and young people are objective, whilst one International Fitness Scale is subjective (Ortega et al., 2011). The objective measures can be labelled as laboratory-based or field-based methods (Tomkinson & Olds, 2008). The laboratory-based measures, such as VO2 peak frequently used in a child population (Rowland, 1992), are often not feasible to use with larger populations as they require the use of expensive equipment, and are time-consuming to conduct (Lang et al., 2018). Field-based measures include distance runs and shuttle runs and are valid and reliable estimates of predicting VO2 peak (Castro-Piñero et al., 2010; Tomkinson & Olds, 2008). The most widely used field-based measure is the 20m shuttle run test (20mSRT; Lang et al., 2018) because it is simple to use, easy to interpret, low cost and can be conducted with a large group of children simultaneously (Ruiz et al., 2009; Tomkinson & Olds, 2008). Evaluations of the 20mSRT showed criterion-related validity to be moderate-to-high (Mayorga-Vega et al., 2015; Ruiz, Silva, et al., 2009), and a high level of reliability (Artero et al., 2011; Tomkinson & Olds, 2008). Despite these high levels of validity and reliability, there is concern that the 20mSRT may be impacted by psychosocial factors such as motivation and self-efficacy, whilst the performance may also be determined by a child's ability to pace their running (Tomkinson & Olds, 2008). Debate has been present in the literature with contrasting views on whether raw values such as the number of shuttles or stages should be used or whether these should be converted into Vo2 peak, for which there are different equations available to complete this calculation (Batista et al., 2013). Raw scores have been used to develop normative-referenced standards (Catley & Tomkinson, 2013; Tomkinson et al., 2017), meaning raw scores may be easier to interpret in relation to performance (Lang et al., 2018). However, using Vo2 peak can be related to health outcomes, whereas using raw 20mSRT scores cannot and the reference standards often relate to the minimum cardiorespiratory health for good health (Lang et al., 2018), which in turn has provided numerous different definitions and guidelines (Lobelo et al., 2009; Ruiz et al., 2007, 2016). However, children can be categorised into high, average, or low levels of cardiorespiratory by age and sex on the 20mSRT following the development of centile ranks (Lang et al., 2019) and the information gained from doing this can help develop, inform, and target interventions.

With low levels of CRF present, interventions have been evaluated to determine their effectiveness. Studies have compared the impact of high-intensity interval training (HIIT) and moderate-intensity continuous training (MICT), suggesting that both methods can improve CRF (Hottenrott et al., 2012); whilst a meta-analysis confirmed that whilst both methods made improvements, HIIT training was more effective than MICT in children aged 6-17 years (Cao et al., 2019). When exploring schools as a setting to improve CRF, a systematic review by Pozuelo-Carrascosa et al., (2018 concluded that school-based physical activity interventions are effective in improving children's CRF, more so in girls than boys. The same meta-analysis found that both MVPA and VPA interventions improved CRF, but the duration and frequency of the intervention sessions did not have an effect on the results of the intervention. This was consistent with Burns et al. (2018) who studied moderators of school-based interventions on CRF and found that single component interventions may have the same impact as a multi-component intervention and that the length of the intervention did not make a difference. In contrast, a systematic review on this topic recommends that interventions should be at least six weeks long and sessions should occur three to four times a week to have an impact on CRF (Braaksma et al., 2018). An internet-based, school-based, education intervention for teachers, improved children's CRF after 12 months and effects continued even after the intervention was over, with measures at 24 months suggesting another almost doubling of CRF levels using the 20mSRT (Lonsdale et al., 2021). The internet-based study was low-cost and across several schools, indicating that an internet-based training intervention for teachers could be scaled up and effective in improving children's CRF (Lonsdale et al., 2021). In interventions targeting fitness components, it is important to consider and control for baseline fitness level as children with the lowest initial CRF levels show larger improvements than those with higher baseline levels of fitness (Hartwig et al., 2021; Resaland et al., 2011).

2.5.1.3 Muscular Fitness

Muscular fitness can be split into two categories muscular strength and muscular endurance (Sandercock & Cohen, 2019). As part of the physical activity guidelines for children and adolescents, discussed in the previous chapter, the WHO recommends muscle strengthening activities alongside aerobic activities (World Health Organisation, 2020). Despite these recommendations on the importance of muscular fitness for health research has indicated that muscular fitness levels in children and young people are decreasing (Moliner-Urdiales et al., 2010; Sandercock & Cohen, 2019).

Poor muscular fitness has been associated with poor metabolic profile, several non-communicable diseases (Ortega et al., 2008) and mortality in adulthood (García-Hermoso et al., 2018). There is a strong inverse relationship between low muscular fitness and the risk factors of cardiovascular disease (Ramírez-Vélez et al., 2017) and low muscle fitness in childhood is associated with low muscular fitness in adulthood (Fraser et al., 2017). One systematic review that explored the health benefits of muscular fitness for children and adolescents concluded that that there was a strong inverse association between muscular fitness and cardiovascular disease, whilst there was a positive relationship between muscular fitness and bone-health, self-esteem, and perceived sport competence (Smith et al., 2014).

There are a range of methods used to measure muscular fitness and these vary in complexity. Field-based measures such as handgrip strength and standing long jump, have been significantly associated with isokinetic peak torque and power showing that they can be used to assess young people's muscular fitness when a laboratory method isn't available or appropriate (Artero et al., 2012). The hand-grip test specifically has been further validated for use with children and people young people (Castro-Piñero et al., 2010) to assess maximal isometric strength and is used in various fitness batteries (Adam et al., 1988). Both the handgrip strength and standing long jump are easy to administer and require minimal training for assessors. When analysing muscular fitness, it is important to control for body mass as strength is higher in children that are overweight (Thivel et al., 2016).

Interventions to improve muscular fitness in children and adolescents have been examined finding that school-based muscular fitness interventions have small to moderate effects in adolescent boys; whilst using weight machines and free weights may be more impactful than other forms of strength training (Cox et al., 2020). A recent systematic review highlighted that there were significant moderate increases in muscular endurance, muscular strength and muscular power with the higher impacts being from interventions where there were three or more sessions per week (Villa-González et al., 2023).

2.5.1.4 Flexibility

Flexibility has been defined as the maximum range of motion in a joint (McHugh et al., 1998). Poor hamstring flexibility has been related to lower back pain and subsequently is related to issues with daily life activities (Hori et al., 2021). However, studies suggest that muscular strength and CRF are both stronger indicators of health than flexibility (Fowles et al., 2014; Lang, Larouche, et al., 2019). On the other hand, a recent systematic review found that flexibility in childhood has been associated with flexibility adulthood (García-Hermoso et al., 2022) and a more flexible adult is likely to experience less falls (Iwamoto et al., 2009) and therefore stay healthier for longer. Therefore, developing flexibility in children is important to consider.

Flexibility can be measured in various parts of the body, but the most common field measure of flexibility is the sit and reach test to assess the flexibility of the hamstring muscles and lower back, originally developed by Wells and Dillon (Wells & Dillon, 1952). This test has been included in numerous fitness batteries such as Eurofit (Adam et al., 1988) as it is easy to administer and score. When analysing and interpreting a result from the sit and reach test, a general assumption would be that the higher the score the better trunk and hip flexibility (Bandy, 1998). However, the tests validity has been queried in children and young people as it does not consider differences in limb length (Hoeger et al., 1990; Mosher et al., 1982). A modified version has been developed to take this into account (Hoeger et al., 1990), however this requires specialist and more expensive equipment and one study found that the modified test is not more valid than the standard test (Castro-Pinero et al., 2009). A meta-analysis also confirmed that the standard sit and reach test is a better indicator of hamstring flexibility than the modified version (Mayorga-Vega, Merino-Marban, & Viciana, 2014). Studies have used the sit and reach test to develop normative-referenced percentile values both in Europe (Tomkinson et al., 2018) and Australia (Catley & Tomkinson, 2013), this allows for comparisons to be made and to evaluate where children are performing in relation to their peers of the same age and sex.

Little research has investigated the correlates and determinants of flexibility however, girls have been found to consistently outperform boys in terms of their flexibility across a variety of settings (Catley & Tomkinson, 2013; Tomkinson et al., 2018). With the sit and reach test only measuring the hamstring flexibility researchers have suggested that hamstring flexibility can be impacted by kicking a ball (Rahnama et al., 2005), and that girls are less likely to do this than boys (Sport Wales, 2022) Further interpretations of this finding include that during physical education lessons girls are often exposed to gymnastics and dance more so than boys and so develop their flexibility more (Sport Wales, 2022).

Interventions have been placed to improve flexibility in children, finding that eight weeks of a stretching programme improved hamstring flexibility of 9- and 10-year-old boys and girls, but after five weeks of no training, this additional flexibility was lost; implying that training needs to be a continuous process (Mayorga-Veg et al., 2014). These findings were echoed within an exercise programme where children took part in resistance and flexibility exercises for fifty minutes, twice per week for six weeks and hamstring flexibility significantly improved (Moreira et al., 2012). A meta-analysis found that all but one out of the eleven included studies, which used the sit and reach test, favoured the intervention group, all of which were conducted in a school based physical education setting and ranged between five and 32 weeks in duration (Vigo et al., 2022).

2.5.2 Skill-Related Fitness

Skill related fitness components have been described as the “motor potential to carry out physical activity with regard to speed, agility, power, balance, coordination and reaction time” (Hoeger & Hoeger, 2014). Many of the skill-related components of fitness also fall under the motor skill bracket within this body of work and will be discussed more in the next section which explores motor competence.

2.5.3 Conclusion

The low levels of physical fitness in the child population are worrying, given the associations between physical fitness and health-related outcomes, particularly that of the health-related components of fitness. Measuring and monitoring levels of physical fitness can provide an insight into the health of the children and young people and can predict health into adulthood. Whilst there are many methods that are validated to measure children's fitness the most accurate of which are laboratory-based and time consuming. Field-based methods have been validated for use in larger samples to capture data at a population-level. Interventions that aim to improve children and young people's physical fitness can work. An improvement in fitness is associated with higher health outcomes, physical activity, and motor competence in children.

2.6 Motor Competence

To explore a range of physical activity opportunities it is important that children are physically literate and are proficient at movement. Motor competence has been defined as ‘a person’s ability to execute a wide range of motor acts in a proficient manner, including coordination of fine and gross motor skills that are necessary to manage everyday tasks, such as walking, running, jumping, catching, throwing, kicking, and rolling’ (Morano et al., 2020). Unlike the habitual process that is physical activity, motor competence and fundamental movement skills are not developed naturally through movement (Gagen & Getchell, 2006), or through maturation (Clark, 2005); but instead required to be learned, practised, and reinforced (Robinson & Goodway, 2009). Three categories are often discussed when considering fundamental movement skills and motor competence: stability or balance skills (non-locomotor skills such as bending), locomotor skills (running, hopping, jumping, sliding, galloping, leaping) and object control skills (kick, throw, roll, and catch; Goodway et al., 2012). It is imperative that children develop their motor competence during early childhood to enable them to execute a broad range of physical activities using more complex movements (Clark, 1994). Sporting activities such as basketball for example, would require individuals to have sufficient motor competence in running, catching, and throwing. There is uncertainty surrounding the terms motor competence and fundamental movement skills which are often used interchangeably. Some researchers use the term fundamental movement skills to describe general motor competence (Fisher et al., 2005; Ziviani et al., 2009); whilst some (Clark & Metcalfe, 2002; Haywood & Getchell, 2009) use the term fundamental movement skills for the specific description of skills that are clearly needed to partake in physical activity. From here on in, the term motor competence will be used to encompass fine and gross motor skills together with fundamental movement skills.

2.6.1 Motor Competence Guidelines and Prevalence

There are no specific guidelines for motor competency, however, there are suggested development milestones which practitioners and parents often look to for a guide to assess whether their child is developing appropriately. These milestones are split into social and emotional, cognitive, language/communication and movement/physical development (Centers for Disease Control and Provension, 2022). The Centers for Disease Control and Prevention have published their milestones to include examples such as by 2 months old a baby should hold their head up when on their tummy, by 9 months they should sit without support, by 1 year they should walk holding onto something, by 2 years they should run and kick a ball and by 4 years catch a ball most of the time (Centers for Disease Control and Prevention, 2022). The National Curriculum for physical education in England states that children should be proficient in running, jumping, throwing, and catching in Key Stage 1 and be able to use these skills in a sporting context in Key Stage 2 (Department for Education, 2013).

Despite the importance placed on motor competence and its associations with physical health benefits and cognitive development, motor proficiency in children and adolescents is low (Duncan et al., 2022). Excluding running, leaping, and sliding children aged 4-7 years of age in the United Kingdom do not meet any of the National Curriculum targets for motor skill proficiency (Morley et al., 2015). Out of the four motor skills identified by the National Curriculum (running, jumping, throwing, and catching) less than one-fifth of 6–9-year-olds and a quarter of 6–8-year-olds are proficient in all four (Duncan et al., 2020). Eyre et al., (2018) found that 5-year-olds have poor overall motor competence. Similar trends of poor motor competence were found in Wales where Stratton et al. (2017) highlighted that 60% of 10–12-year-olds were not proficient in motor competence and inequalities were also evident; for example, girls, Asian and children with lower socioeconomic status all score lower than their demographic counterparts. Using the Test of Gross Motor Development-2 (TGMD-2), Lawson et al. (2021) found that 27% of children aged 7-10 years were not proficient in any of the skills assessed. Having proficient motor competence enables a child to access a range of physical activities, subsequently improving overall health. The clear low level of motor competence proficiency evidenced across the literature calls for more research in this area. This would provide further insight on reasons why motor competence is so low and the effect of inequalities on motor competence, and whether there are subgroups whose motor competence needs to be targeted with interventions to improve the motor competence of the child population.

Various assessment tools and measures have been developed to monitor and track motor competence and therefore a first line of defence in understanding why such low levels of motor competence are evidently very prevalent in the UK (Duncan et al., 2022).

2.6.2 Motor Competence Monitoring and Measurements

Children's levels of motor competence vary across country, sex, age and disability, and there is an expansive range of assessment tools that accommodate for different needs. Researchers have doubted the generalisability of monitoring levels of motor competence or fundamental movement skills using different types of assessment (Stodden et al., 2008). Ultimately, the primary objectives of assessing motor competence are to recognise developmental delays, to construct effective interventions and to quantify levels of motor competence (Bardid et al., 2019; Barnett et al., 2016; Hulteen et al., 2015). Bardid et al. (2019) recognised the importance of validity and reliability in motor skill assessments for children and young people as developing motor competence is vital in these age groups.

By comparing commonly used assessment measures, most have relied on product- *or* process-orientated scoring. Product scores focus solely on the outcome of the movement, not how the movement is performed whereas, process scores concentrate on whether the movement is performed correctly (Logan et al., 2017). Product scores are quantitative and generally easier to score and less time consuming than process scores (Hands, 2002). On the other hand, process scores can provide more specific feedback on skill performance (Burton & Miller, 1998) but more time-consuming training is needed to score and assess process-orientated measures (Griffiths et al., 2018). Exclusively using a product or process assessment may be limited (Logan et al., 2017) therefore hybrid approaches using both assessment types have been created (Longmuir et al., 2017; Tyler et al., 2018), potentially producing an enhanced, holistic understanding of motor competence (Hulteen et al., 2020).

Hulteen et al. (2020) conducted a systematic review to explore validity and reliability of evidence of motor competence assessments in children and adolescents and found a total of 57 different skill assessments where reliability was more explored than validity. Tests included: Athletic Skills Track-1 (AST-1), Movement Assessment Battery for Children-2 (MABC-2), Test of Gross Motor Development 3rd Edition (TGMD-3) and Canadian Agility and Movement Skill Assessment (CAMSA). One assessment measure that was not explored in this review was the Dragon Challenge (Tyler et al., 2018). This is a dynamic assessment of motor competence which is used as a method in this body of work and has been validated for use in children aged 10 – 14 years of age (Tyler et al., 2018). The Dragon Challenge is an example of a hybrid assessment, utilising both process and product scores and a timed element to the overall scoring.

Motor competence assessments are vital tools to provide measures for the primary objectives; they also provide quantitative-based measures to allow researchers to explore correlates and determinants between motor competence and other health-related factors.

2.6.3 Motor Competence Correlates and Determinants

When exploring biological associations, it is well recognised that sex is a commonly researched correlate (Barnett et al., 2016). Being a boy is positively correlated with both object control and locomotor skills (Robinson, 2011; Spessato et al., 2013), whilst being a girl has been correlated with stability or balance skills (Olesen et al., 2014; Venetsanou & Kambas, 2011); although Barnett et al's (2016) systematic review showed that the latter association was inconsistent. An increase in age has shown positive correlations with motor competence across object control, locomotor, and stability skills (Barnett et al., 2010; Spessato et al., 2013). Much research has focused on motor competence in children who are obese or overweight, using BMI as a measure. A higher BMI is negatively correlated with stability skills, but evidence is lacking for associations with object control or locomotor skills (Barnett et al., 2016). Waist circumference and body fat percentage have both been negatively correlated with motor competence (Joschtel et al., 2021; Trecroci et al., 2021). Whilst the same was true for perceived motor competence, these results should be viewed with caution as the qualitative analysis (risk of bias assessment) showed that these associations continue to be uncertain. Associations have also been detected in longitudinal studies where motor competence has negatively been related to BMI over time (Erwin & Castelli, 2008; Martins et al., 2010).

Alongside biological associations are the demographic correlates including socioeconomic status (SES), which Barnett et al. (2016) concluded as producing inconsistent results. However, higher SES has been found to be positively associated with locomotor and stability skills (Woodard & Yun, 2001). Academic school year has been identified as a confounding factor in this association, with SES only influencing young children's object control and stability and not older children's (McPhillips & Jordan-Black, 2007). Ethnicity in relation to motor competence has received less attention. Early research found no significant differences in motor competence between ethnicities (McKenzie et al., 2002), whilst more contemporary research has consistently highlighted that those children identifying with a South Asian ethnicity had poorer locomotor skills that children with a white or black ethnic background (Eyre et al., 2018).

Another factor that has been explored in relation to motor competence is special educational needs or disabilities, but this has generally focussed on clinical populations. Studies include children with autism spectrum disorder (ASD; Pan et al., 2009), Down Syndrome (Volman et al., 2007) and attention deficit hyperactivity disorder (ADHD; Villa, 2018). These studies found that children living with these conditions have poorer motor competence than typically developing children. Studies exploring motor competence in clinical populations, such as children with special educational needs, are limited by their sample size (Downs et al., 2020), whilst other studies in this population are limited by a lack of female participants (Kaiser et al., 2015). One study with a particular focus on coordination and children with ADHD was conducted at a population-level (Opper et al., 2022). However, there have been no population-level studies to date that have considered motor competence using a hybrid, dynamic assessment type and grouping special educational needs and disabilities together as one whole population.

There is compelling evidence that motor competence is associated with a wide range of physical health outcomes, including physical activity (Barnett et al., 2016). The established relationships between motor competence, physical activity, and fitness are particularly important to recognise, due to the positive health outcomes that being sufficiently fit and physically active can have. Low proficiency of motor competence in children is associated with less physical activity and lower CRF (Hardy et al., 2012). This relationship is stable over time as there is a strong positive association between motor competence at age six years and physical activity levels twenty years later at the age of 26 (Lloyd et al., 2014). A contemporary, comprehensive systematic review identified strong positive evidence for a pathway from motor competence to physical activity, but not the reverse relationship (Barnett et al., 2022). Whilst much research has been invested into physical activity as a correlate of motor competence, the same is not true for sedentary behaviour (Barnett et al., 2016); although, one study found that less time spent sedentary was associated with higher levels of motor competence (Lopes et al., 2012). There is strong evidence that motor competence is positively associated with CRF and musculoskeletal fitness, but the association with flexibility is unclear (Cattuzzo et al., 2016). Cross-sectional research has highlighted that children who regularly participate in organised sport have more proficient motor skills than those who do not (Graf et al., 2004; Queiroz et al., 2014). Longitudinal research highlighted the cross-sectional nature of these studies as a limitation and sought to identify any predictions over time, with findings suggesting that children's motor competence positively predicted sports participation two years later (Vandorpe et al., 2012). This is also true for pre-school children (Henrique et al., 2016).

In addition to physical health outcomes, motor competence has been associated with cognitive and socio-emotional development (Gandotra et al., 2022). Cognitive development includes the improvement of executive functioning, which can be made up of working memory, cognitive flexibility, and response inhibition (Miyake et al., 2000), all of which are positively associated with motor competence (Ludyga et al., 2019). Together with cognition, social and emotional functioning have also been associated with motor competence (Piek et al., 2015), whereas fine and gross motor skills are strongly correlated with prosocial behaviours (Gandotra et al., 2022).

Barnett et al. (2016) identified further correlates of motor competence, including: adoption status, parental skill confidence, playground size at school, maternal and paternal education, and birth weight although a greater body of research is required to substantiate these findings. Motor competence interventions should therefore be focussed on altering any modifiable correlates or determinants.

2.6.4 Motor Competence Interventions

A meta-analysis by Logan et al. (2012) demonstrated improvements in fundamental movement skills (both object control and locomotor skills) following motor skill interventions; however, this meta-analysis only included interventions that used the Test of Gross Motor Development as an assessment tool. When studying just object control skills, it was found that after a nine-week intervention, providing motor skill instruction, there was a significant time by treatment interaction, demonstrating that appropriate interventions are effective (Robinson & Goodway, 2009). A ten-week after-school physical activity and motor skill programme, providing children with a wide range of activities to develop locomotor and object control skills in Australia, also revealed significant increases in motor competence in overweight and obese children (Cliff et al., 2007). However, evidence in this area is largely limited to participants with poor motor competency, and few have focused on typically developing children. A twelve-week intervention applied to children in the bottom five percent of their class, involving participation in skills assessed when completing the TGMD found improvements in both locomotor and object control skills (Valentini & Rudisill, 2004). Although the type of intervention had an impact on the degree to which these skills improved; children in the mastery-climate group had significantly better locomotor skills than the low-autonomy group. Having a mastery-climate during an intervention therefore seems to impact on the quality of the intervention as does the person who leads the intervention. Compiling teacher-led, child-centred, and parent-led interventions research has highlighted a large effect on object control skills and a moderate effect on locomotor skills (van Capelle et al., 2017). This same research found that interventions where sessions were longer than 30 minutes and were delivered four to five days per week delivered greater improvements in motor competence; the authors suggested that this may be due to repeated practice (van Capelle et al., 2017). The same frequency message was found in a review exploring motor skill interventions and physical activity levels in pre-school children, where there were significant improvements in motor competence during interventions that took place three or more times per week (Engel et al., 2018). In another study involving a group of children with developmental coordination disorder (DCD), it was found that children need to be exposed to a motor competence intervention three or more times per week to have a positive impact on their motor skills (Pless & Carlsson, 2000).

2.6.5 Conclusion

Having a proficient level of motor competence enables children to access a range of physical activity and sporting opportunities. Measuring children's motor competence allows for proficiency to be tracked across time and for effective interventions to be planned and implemented. However, furthering our understanding of correlates and determinants of motor competence enables interventions to focus on changeable correlates. As motor competence is not developed habitually (Gagen & Getchell, 2006) or through maturation (Clark, 2005), the environment in which it is developed needs to be inclusive. The next section will explore the environments where motor competence can be developed and some of the influences that these environments can have on physical activity, motor competence and fitness.

2.7 ENVIRONMENTAL INFLUENCES

The physical and social environment influences physical activity, fitness and motor competence, and ecological models emphasise this (Sallis & Owen, 2015). The Ottawa charter consecrates the need for environments that promote healthy choices (World Health Organisation, 1986). There has been an increase in research surrounding the impact of various environmental factors on physical activity (Maddison et al., 2009); such as neighbourhood walkability and access to open spaces (Owen et al., 2004), and the presence of green space (Wendel-Vos et al., 2004). Most studies that have evaluated environmental impacts on physical activity levels have focussed on adults and have not considered children and young people (Maddison et al., 2009). However, a small number of studies have found that time spent outside is associated with children’s physical activity levels (Davison & Lawson, 2006); whilst one large Australian study on children found associations between physical activity and both environmental and social factors (Timperio et al., 2006). Two environments that are studied within this body of work are the school and home environments including built and social aspects.

2.7.1 School Environment

Children spend a large amount of their time within an education setting, particularly a school environment; therefore, schools are believed to be an important place to provide opportunities for children to be physically active. Additionally, schools provide an environment where most children and young people can be reached, regardless of their background and therefore are an obvious setting to reach a wide range of children. Opportunities to improve physical activity levels, physical fitness and motor competence can be provided throughout the school day in the forms of structured physical education (PE) lessons, break and lunchtime free play and extra-curricular activities. Schools have very different physical and social environments providing context specific opportunities for children to engage in physical activity and current research often fails to account for these variances. Within quantitative research, a multi-level model could be used to ensure that any variance is accounted for.

Moreover, there are also temporal factors, both day to day and season to season. Research has explored physical activity levels present throughout different parts of the school day. Findings suggest that simply the movement between classes provides an opportunity for physical activity with associations reported between a physically larger school site and an increase in physical activity (Cradock et al., 2007). During breaktimes children accrue between 5% and 40% of their daily physical activity recommendations; however, it is important to note the inequalities present as MVPA and VPA is higher for boys than girls (Ridgers et al., 2011). One study found that during PE lessons, children spend up to 34% of the time in MVPA (Fairclough & Stratton, 2006). Many elements of the school day provide an opportunity for children to be physically active, whilst a recent meta-analysis reports that PE lessons have a large effect on motor development for children and adolescent (Lorås, 2020). Lorås et al. (2020) further suggest that the lessons should be specialist teacher-led, deploying a specific curriculum which includes fundamental movement skills, physical literacy and gymnastics which are all effective when compared to a non-standardised PE curriculum.

As quality physical education has a significant impact on children and young people's physical activity, motor competence and fitness levels it is interesting to note the recently implemented curriculum in Wales focuses on "areas of learning", where PE is integrated into the Health and Wellbeing Area of Learning and Experience (Welsh Government, 2020). This should be monitored closely during national roll out, which will commence in September 2023, to ensure that children and adolescents are progressing their physical literacy at school. The AHK-Wales 2016 and 2018 Report Cards results (Edwards et al., 2018; Tyler et al., 2016) also provide indicators for investments in these areas. The 2016 AHK-Wales Report Card emphasised the importance of providing opportunities both during curriculum time and as extra-curricular provision (Tyler et al., 2016). The importance of making extra-curricular opportunities accessible for students, by providing transport and ease of access to facilities after the school day, has also been reported (Sharp et al., 2022). The AHK-Wales 2018 Report Card provided an inconclusive grade for the school indicator, due to a lack of data, warranting a need to further investigate changes in physical activity within the school environment in the future to assess the impact of the new curriculum.

Interventions are often conducted in school-based settings as this approach has the widest reach but there is mixed evidence on whether school-based interventions are effective at improving physical activity levels (Dobbins et al., 2009). A recent systematic review on school-based interventions, in promoting physical activity and fitness and the prevention of obesity, found that in all studies at least one outcome was improved and that physical activity-orientated interventions had a high success rate (Yuksel et al., 2020). Evidence suggests that changing traditional school environments to more activity-permissive physical activity learning (PAL) environments increase children's physical activity (Lanningham-Foster et al., 2008). PAL aims to break up sedentary time in schools by incorporating physical activity throughout the school day, not just in PE lessons. Countries across the world are implementing various versions of PAL initiatives (Blom et al., 2018; McKay et al., 2015; Resaland et al., 2016) and findings suggest that there are benefits in both short-term and long-term PAL on physical activity, health, and academic performance (Daly-Smith et al., 2018; Watson et al., 2017) across all demographics (Bartholomew et al., 2018).

2.7.2 Home Environment

Children spend more time in their home environment than anywhere else, and this is largely time spent indoors (Matz et al., 2014). The home is where children accrue high quantities of their daily physical activity and sedentary time (Tandon et al., 2014). The home is a dynamic environment where both physical and social factors can influence children's behaviour (Maitland et al., 2013, 2014; Sheldrick et al., 2019; Sheldrick et al., 2022).

Research has focussed on the availability and accessibility of various equipment within the home in altering levels of physical activity and time spent in sedentary pursuits. Maitland et al., (2013) found that children having media equipment in their bedroom reduces their physical activity levels. Concurrent with this research, a study spanning twelve countries found that if children have at least one piece of media equipment in their bedroom, they partake in less MVPA (Harrington et al., 2016). Inverse associations between media equipment and physical activity levels in children are well established, unlike the associations between equipment used for physical activity and physical activity levels which produce more mixed results (Maitland et al., 2013). However, when studying specific pieces of equipment, bikes (in Australia) and basketball hoops (in the USA), are positively associated with physical activity and MVPA (Dumuid et al., 2016; Tandon et al., 2014). Aside from equipment, another physical factor within the home is the garden or access to outdoor space; as physical activity at home typically happens outside (Biddle et al., 2009). Alas, there is a lack of evidence to support the hypothesis that a garden space augments physical activity (Maitland et al., 2013). On the flip side, sedentary behaviour has been inversely associated with time spent outdoors (Gray et al., 2015), garden accessibility and garden size (Hales et al., 2013).

The home social environment has been more widely explored, and studies have examined the influence of parents, siblings, and pets on activity levels. Parental support has been consistently associated with an increase in children's physical activity (Edwardson & Gorely, 2010; Maitland et al., 2013); whilst their role modelling of physical activity has mixed results (Beets et al., 2010; Yao & Rhodes, 2015). Associations have been found between parents overall sedentary time and children's overall sedentary time (Jago et al., 2010). Parental rules and supervision have also been explored, with supervision of physical activity positively associated with physical activity (Cleland et al., 2010). Further, children with a sibling who participates in physical activity are likely to have higher levels of physical activity than being an only child (Daw et al., 2015). There is also evidence that girls with brothers participate in more physical activity than girls with sisters (Bagley et al., 2006) and that younger siblings are more likely to model their behaviour on an older sibling if they partake in physical activity (Ebihara et al., 1981). Dog-ownership has also been explored in relation to children's physical activity levels and a large cohort study found that children whose families owned a dog frequented in LPA and MVPA more so than children without a dog (Owen et al., 2010; Westgarth et al., 2013). Australian research showed that young children, aged five and six, were less likely to be obese if they were a dog-owning family than those not owning a dog (Timperio et al., 2008). An intervention in the UK showed an increase in device-based measures of physical activity in the intervention group where families were given a dog to encourage physical activity, compared to the control group (Morrison et al., 2013).

Both the physical and social home environments have therefore shown associations with physical activity and sedentary time. Combining these factors and considering the home as a dynamic environment will increase the understanding of these behaviours at home.

2.7.3 Conclusion

The home and school environments represent the places where children spend most of their time and the physical and social elements of these environments can influence children's physical activity, fitness, and motor competence (Maitland et al., 2014; Sheldrick et al., 2019). Schools can provide opportunities for physical activity at many points throughout the day, including both in curricular and extra-curricular time. Despite this, schools have different approaches to this, with very few prioritising physical activities (Hills et al., 2015). The home physical and social environment has been explored in relation to physical activity opportunity with findings that having access to media equipment, particularly in the bedroom, reduces time spent in MVPA (Harrington et al., 2016). Socially within the home, parental support and role modelling are imperative for the promotion of children's physical activity (Beets et al., 2010). Exploring both home and school environments, their social and physical elements, are of paramount importance to understand children's physical activity, fitness, and motor competence across settings.

2.8 COVID-19

On 30th January 2020 the World Health Organisation (WHO) declared the severe acute respiratory syndrome (SARS)-CoV-2 virus a public health emergency of international concern. The SARS-CoV-2 virus causes Coronavirus disease, COVID-19, with a global pandemic declared on 11th March 2020. Leaders of countries worldwide started to impose restrictions of varying levels to contain the spread of the virus, including closing borders, social distancing, closure of shops, and some countries enforced curfews and rules for time allowed to be spent outside of the home. Unless otherwise stated, from here on in, the term pandemic refers to the COVID-19 pandemic.

Schools closed their doors to the majority of children, although not those of keyworkers, to mitigate the spread of the virus, and teaching and learning activities were moved online. This was of concern as children's physical activity levels are lower on non-school days (Brooke et al., 2014). This new home-schooling approach removed opportunities for children to socialise, learn and be physically active. Emerging evidence suggests that the pandemic has had a profound effect on the physical activity, sedentary behaviour, fitness, and motor competence of children as described below.

2.8.1 COVID-19 and Physical Activity

Physical activity levels in children declined over the COVID-19 period (Yomoda & Kurita, 2021); there are concerns that these changes may become permanent (Dunton et al., 2020) with long term impacts on children's health (World Health Organisation, 2020). A recent scoping review (Rossi et al., 2021) reported that children reduced their daily physical activity levels by 45 minutes (Aguilar-Farias et al., 2021), to 91 minutes per day (Medrano et al., 2021) during the pandemic. Despite these decreases some studies reported increases, no changes, or mixed results (Rossi et al., 2021). That said, many of the studies included in the review by Rossi et al. (2021) were cross sectional and lacked device-based measures.

Whilst most studies have reviewed changes in the frequency of physical activity over the pandemic, some have explored the changes in intensity of physical activity. One systematic review and meta-analysis (Neville et al., 2022) concluded that the reduction in physical activity during the COVID-19 restrictions for children and adolescents was larger for higher intensities of physical activity, such as MVPA. Tulchin-Francis et al., (2021) used proxy methods to report that MVPA decreased significantly, whilst LPA remained unchanged. Whereas ten Velde et al., (2021) used device-based measures to demonstrate that Dutch children also decreased their TPA, LPA and MVPA; moreover, ten Velde also found that children with higher baseline MVPA had a greater decrease in time spent in MVPA than those with lower baseline levels.

In general, children's physical activity decreased during the pandemic, with several barriers and facilitators implicated for changes in physical activity. The most common individual-level facilitators were prior fitness status, male gender and taking part in online PE classes. Having access to a bigger outdoor space, more than one child in the household and parental encouragement also facilitated children's physical activity. Constraining factors included an increasing age and a lower level of caregiver's education (Rossi et al., 2021). These barriers and constraining factors could potentially further increase inequalities. Most known facilitators to children's physical activity were removed during the pandemic, such as accessible facilities and structured family, social and community support (van Sluijs et al., 2008).

In relation to environmental influences, the pandemic had a vast impact on the time spent within the home environment as schools were closed to contain the spread of the virus. One study, in Wales, explored the impact of the lockdown restrictions on children's physical activity and sedentary time within the home environment. The study found changes in the home environment such as increases in electronic media equipment and sitting time and decreases in physical activity equipment, standing behaviours and physical activity (Sheldrick et al., 2022). This was a quantitative study and did not consider perceptions of parents or their children in changes in physical activity or sedentary behaviours. Together with the home environment, research considering the impact of school closures in Wales found that physical activity declined during the school closures, but children's physical activity levels significantly increased upon return to school (Hurter et al., 2022).

Although not specifically targeted toward the child population, an interesting commentary paper was published during COVID-19 detailing the 'tale of two pandemics' (Hall et al., 2021); this paper discussed the physical inactivity and sedentary behaviour pandemics that have been present for several years, and speculated that the COVID-19 pandemic has the potential to accelerate the physical inactivity and sedentary behaviour pandemic due to the removal of opportunities during lockdown restrictions, particularly if the new norms of social distancing and staying at home persist across time and become habitual.

2.8.2 COVID-19 - Body Composition and Fitness

To date, research exploring the impact of the COVID-19 pandemic on children's fitness is inconsistent. One study assessed multiple components of fitness and found that whilst there was no significant impact on handgrip strength, the tests for motor skills, standing long jump and the 20m multistage shuttle run were significantly poorer after, compared to before, the lockdown restrictions (Chambonnière et al., 2021).

In Austria, COVID-19 mitigation measures were associated with a decrease in children's CRF and an increase in BMI (Jarnig et al., 2021). Further, decreases in CRF were the same in children who attended sports clubs and those who did not, despite attendees of sports clubs displaying better CRF than those who did not at all time points (Jarnig et al., 2021). There was a higher proportion of children obese or overweight during the pandemic than prior to it. One study in a rural location of Germany, found no differences in children's fitness or BMI pre and post COVID-19 restrictions (Eberhardt et al., 2022). In England, the Childhood Measurement Programme highlighted increases in children's BMI from pre-COVID-19 where 22.6% (2018-2019; Office for National Statistics, 2019) of 4- and 5-year-olds were overweight or obese to 27.7% (2020-2021; Office for National Statistics, 2021). This is in line with data from Wales, specifically the Swansea Bay University Health Board (UHB) where 26% of 4- and 5-year-olds were overweight or obese (2018/19) (Hobson et al., 2021) compared to 34% (2020/21; Crowther et al., 2022). These increases in obesity levels are concerning as there was already a childhood obesity epidemic pre-COVID-19 (Janssen, et al., 2005), and an obese child is more likely to become an obese adult (Simmonds et al., 2016).

2.8.3 COVID-19 and Motor Competence

Evidence for changes in motor competence because of the pandemic are inconsistent. Pombo et al. (2021) found that regardless of sex, motor competence was lower in all related physical assessments, apart from the jumping sideways test, than before lockdown. Another study found that children completed a motor skills obstacle course significantly quicker pre- than post-COVID-19 (Chambonnière et al., 2021). The longer-term impact of COVID-19 on motor skills has also been examined and it has been reported that younger children, and more proficient children pre-COVID-19, did not fully recover from the short-term negative motor competence implications of the COVID-19 lockdown after two years (Carballo-Fazanes et al., 2022).

When looking specifically at special populations, children with intellectual disabilities (ID) showed significantly lower motor competence during the pandemic if they were inactive compared to their active peers who also had ID (Sedaghati et al., 2022). Further, pre-school children displayed a greater number of falls and a shorter single-leg standing time post-COVID-19 (Ito et al., 2021). Motor interventions that were completed with children during the pandemic negated some of the detrimental effects of COVID-19 on motor competence in pre-school children (Yanovich & Bar-shalom, 2022).

2.8.4 Conclusion

Considering the associations between physical activity, sedentary behaviour, fitness and motor competence, and healthy weight, the short-term impact of the pandemic on children was detrimental. The long-term implications are yet to be established but future studies, including those within this body of work, will provide a broader understanding of the implications that the pandemic on children's lives, and their health, and wellbeing as they move into adulthood.

The first three studies in this thesis are all set in the context of children pre-COVID-19; with the first study making some reference to COVID-19 and the changes that might have occurred since the findings in that paper. The remaining two studies have a focus on COVID-19 and the changes in children's physical activity within the home environment, as children spend most of the time at home, and this increased further during the pandemic restrictions. However, all the studies are important to consider in the post-COVID-19 recovery to enable children to increase levels of physical activity, motor competence and fitness moving into the post-pandemic era.

2.9 Summary

Based on the gaps in the literature explored throughout this chapter, the overall aim of this research is to investigate children's physical activity, fitness, and motor competence; and subsequently the effects that the COVID-19 lockdown restrictions had on children's lifestyles. **Study 1** will aim to build on the work of previous Active Healthy Kids Wales (AHK-Wales) Report Cards produced in 2014, 2016 and 2018 to provide a current overview of children's physical activity across Wales pre-COVID-19. Also, to make comparisons between the quality indicator grades that were previously reported. Based on the recognised the gap in the literature for population-level analysis of daily life skills, related to safe activity (swimming) and active forms of transport (cycling), **Study 2** will aim to predict motor fitness, which is protective against all-cause mortality, based on swimming and cycling skill competence. **Study 3** aims to address the paucity of population-level studies on motor competence in children with additional learning needs compared to typically developing children using pan-Wales data. This complements the preliminary work on disabilities by the AHK-Wales network. **Study 4** will focus on issues related to the lived experiences of children and their families during the first lockdown period of the COVID-19 pandemic; recognising the potential impact that not attending school and limited opportunities for physical activity had on children's physical activity, and sedentary behaviour using the socioecological model as a theoretical framework. **Study 5** will be the first study to report medium term changes in children's activity behaviours in the HomeSPACE before, during and immediately after COVID-19 restrictions were put in place using a qualitative approach. This will be a continuation from study 4, exploring the same children and their families, as the lockdown restrictions change over time, using the self-determination theory to aid the understanding of motivation during these changes.

To summarise, this literature review has provided a critical overview of the research to date in physical activity, physical fitness, motor competence and in the context of the COVID-19 pandemic; something that was unforeseen at the start of the programme of doctoral research. However, researchers should be flexible in their thinking and designs. Therefore, the originally planned research was changed to account for the impact of COVID-19. The global pandemic and compulsory lockdown restrictions, particularly the closing of schools, had a significant impact on the direction of this thesis and hindered the progression of further research surrounding the second study in this body of work. While the pandemic impacted on this research, it also provided different and exciting opportunities to explore children's activity in the home environment and provided an opportunity to explore the subject in context of the contemporary, real-world situation.

3 GENERAL METHODOLOGY

The methods described in this chapter are the field-based approaches to data collection common to the studies within this body of work. Detailed methods, sample sizes and statistical analysis specific to each study are presented in the relevant chapters and appendices; whilst a critique of the methods were provided within the literature review.

3.1 ETHICAL APPROVAL

Ethical approval was gained from the Swansea University College of Engineering Research Ethics and Governance Committee for all studies (REC numbers: PG/2014/007; PG/2014/37, PG/2014/39 2020-029). Written informed consent was obtained from parents/guardians and headteachers where applicable, whilst children provided written or verbal assent. Age-appropriate information sheets were produced and read prior to participants taking part in each study (Appendix VII).

3.2 INSTRUMENTS AND PROCEDURES

3.2.1 Swanlinx/Bridgelinx Fitness Fun Day: Field-Based Fitness Measures

Swanlinx was an already established health and fitness assessment and intervention programme, mirroring the Sportslinx programme (Taylor et al., 2004). The Swanlinx project included the EUROFIT fitness test battery (Adam et al, 1988). Bridgelinx was developed to run alongside Swanlinx and to collect data from children in the neighbouring town, Bridgend. The full Standard Operating Procedures (SOP) for running the Fitness Fun Days can be found in Appendix IV.

During a Fitness Fun Day, fitness tests were conducted by trained members of staff from Swansea or Bridgend Active Young People Department (AYPD), Sport Science postgraduate students and trained college students. Quality assurance was conducted prior to these trained assessors overseeing the research. Children were split into appropriately sized groups, on average eight children per group, and moved between fitness testing stations where an appropriate adult would conduct the fitness test. At each of the testing stations, the appropriate page from the SOP was provided as a reminder of the testing protocol.

Anthropometrics: Body Mass, Stature & Sitting Stature (Body Mass Index, Classification of Weight Status and Maturation): All anthropometric measures were taken using standards and techniques from the anthropometric standardisation manual (Norgan, 1988). All measures were taken behind a screen to ensure confidentiality of sensitive data for the participants. Body weight was measured using portable weighing scales [Seca 813, Seca Ltd, Birmingham, UK] and measured to the nearest 0.1kg. To ensure an accurate reading, participants were asked to remove their shoes, coats or jumpers and anything in their pockets. To measure standing stature, the participants were again asked to remove their shoes and stand up tall whilst looking ahead and keeping their head and body still. A stadiometer [Seca 213 portable stadiometer, Seca Ltd, Birmingham, UK], was used to measure the distance between the floor and the top of the participants head to the nearest 0.1cm. Sitting stature was measured using a sitting stature stadiometer [Harpenden Sitting Height Table, Holtain Ltd, Pembrokeshire, UK]. Participants removed their shoes so that their feet could be placed on a platform to support their legs whilst they sat on the stadiometer. They placed their hands on their legs, kept their head level and still and sat as straight and tall as possible whilst inhaling. The distance between the top of the skull and base of the sitting surface was measured to the nearest 0.1cm.

Participants Body Mass Index (BMI) was calculated using the equation (BMI = body mass (kg)/stature^2 (m^2)). BMI z-scores were then calculated and the UK 1990 Growth Reference Curves (Cole et al., 1995) and International Obesity Task Force (IOTF) reference curves (IOTF; Cole & Lobstein, 2012) were used to define participants as:

underweight, healthy weight, or those with overweight or obesity. After calculating both IOTF and UK growth reference curves a decision was made to use the latter, as it is nation specific and has also been previously used as part of the Swanlinx Project (Tyler, 2015; Tyler et al., 2019). A proxy measure of biological maturation was also calculated using sex-specific maturation offset regression equations, using the anthropometric measures to predict age from peak height velocity (Mirwald et al., 2002). Despite calculating biological maturation, it was not directly used within any subsequent analyses as it was found to be highly correlated with decimal age.

20m Shuttle Run Test: The 20m Shuttle Run Test (20mSRT) used a standardised lap scoring protocol (Riccoch, 1990), to measure the participants cardiovascular fitness when continuously running between two lines 20m apart, in time to recorded beeps from a CD. Once participants failed to reach the end line on two consecutive beeps or voluntarily withdrew from the running the number of shuttles completed was recorded. A researcher ran with the participants to support them to continue running to exhaustion and also to promote a consistent running pace.

Handgrip Strength**:** To measure strength, participants held a hand dynamometer [Takei Corp Ltd., Tokyo, Japan] with their arm extended above their head and squeezed the grip with maximum force for five seconds, slowly moving it down to their side. They completed this with both right and left hands and an average in kilograms (kg) was calculated.

Standing Long Jump: Participants completed a standing long/broad jump on a long jump mat measured in centimetres (cm) to evaluate their power. They were encouraged to bend their legs, swing their arms, and jump from standing as far as they could on the mat, landing with two feet. The measure was taken from the back of their feet. They had three opportunities to complete this and the best score out of the three attempts was recorded.

Speed Bounce: Participants were tested using the speed bounce for their speed and coordination. They were asked to jump sideways, over the speed bounce wedge, with their shoes on, as many times as possible in 30 seconds. They were allowed a practice jump of 5 to 10 bounces to spot any problems with technique, as only jumps that were performed correctly were measured i.e., over the wedge and taking off and landing on two feet simultaneously. Participants had two attempts at this, with a break in the middle, and the highest was their final score.

10x5m Shuttle Run: Another method to measure the participants speed was the 10x5m shuttle run, measured to the nearest 0.01second. Participants were asked to sprint back and forth over a 5-metre distance, ten times with both feet fully crossing the line at each marker.

Sit and Reach: To measure the participants flexibility, specifically their lower back and hamstring muscles, participants were asked to sit on the floor with their legs outstretched and feet, without shoes, flat against the sit and reach box. Both knees should be locked and pressed flat to the floor. If participants struggled with this, the researcher could gently push their knees to the floor. With their palms facing downwards and hands side by side the participant reached forward along the measuring line on the box as far as possible and holds for two seconds. Their score to the nearest cm at the end point of their longest finger was recorded.

3.2.2 Child Health and Activity Tool: Online Questionnaire

A tool developed by Swansea University, the Child Health and Activity Tool (CHAT) is an interactive, online questionnaire consisting of a series of questions involving the participant recalling their activities and behaviours on the previous day. The survey can be done in both English and Welsh and is completed within the classroom, under the supervision of the class teacher, following a standardised video shown to all children prior to completing the CHAT. Within this study the questions used from the CHAT were:

1. Can you swim 25m unaided?
2. Can you ride a bike?
3. Do you attend a sports club outside of school?

Many questions within the CHAT have been validated through a study utilising an autographer, parent reports and accelerometers (Everson et al., 2019). A copy of CHAT version 4 is shown in Appendix III.

3.2.3 The Dragon Challenge: Physical Competence Measure

The Dragon Challenge (DC) is used to assess children's motor competence and has shown acceptable reliability and validity in children aged 8 to 14 (Tyler et al., 2018). There are nine tasks assessing children's stability, object control and locomotor skills: Balance Bench, Core Agility, Wobble Spot, Overarm Throw, Basketball Dribble, Catch, Jumping Patterns, T-Agility and Sprint. Tasks are completed in the same order for each participant, although they are under the illusion that the order is random. It is a dynamic assessment, where the participant is also assessed on their fluidity between tasks through the measure of time.

All participants received a demonstration of the full DC and a breakdown of each task. They were then given the opportunity to practice each task, in isolation. They then completed the full DC, under the supervision of at least two researchers, with one leading the child around the DC course and the other, being a trained assessor, scoring the participants in line with the scoring system in the DC Manual (Appendix V). Briefly, for each task there were two process measures and one outcome measure. The time taken to complete the DC was converted into a score. The three measures, process, outcome, and time were all scored out of 18 and summed to give a total score. Based on their total score, participants were then categorised into Platinum, Gold, Silver, or Bronze.

3.2.4 HomeSPACE: Longitudinal Semi-Structured Interviews

Semi-structured, online interviews were conducted for the qualitative element of the HomeSPACE study. Interviews were conducted with families including, but not limited to, at least one parent and one child. Interviews were analysed using thematic analysis combining inductive and deductive processes (Braun & Clarke, 2022). Thematic analysis involves familiarisation by reading and re-reading the transcripts, highlighting important, repetitive, and novel data, and subsequently coding this data. Codes are then group together to form themes and sub-themes which are then substantiated by direct quotes from the transcripts. For a further understanding and a deeper insight into the data, a socioecological model (Sallis & Owen, 2015) and the self-determination theory (Ryan & Deci, 2017) were used as frameworks for analysis.

3.3 PROCESSES

3.3.1 Active Healthy Kids (AHK) Process

The first study in this thesis was part of The AHK Global Alliance (AHKGA) which is a global movement to get children more active and healthier. The AHK-Wales Research Working Group (RWG) was established in 2014 and produced their first Report Card on children's physical activity, adhering to the AHKGA guidelines, benchmarks, and recommendations. Subsequently, report cards were produced in 2016 (Tyler et al., 2016) and 2018 (Edwards et al., 2018) contributing to the global movement. The next report was scheduled for 2020, however, the COVID-19 pandemic had an impact on this, and the Report Card was pushed back to 2021. Early in 2020 the AHK-Wales RWG met virtually to discuss the 2021 cycle and steps to take to ensure continuity with the group. Under the supervision of Project Lead Professor Gareth Stratton, I was named as the Lead Researcher, coordinating the group, sourcing the data, and writing the outputs. The RWG met approximately every quarter (meeting dates can be found in the Report Card in Appendix I), to discuss the progress of the group including, scrutinising the data, and producing a grade for each quality indicator of children's physical activity.

3.4 CONCLUSION

This chapter has provided a general overview of the methods that are common amongst multiple studies within this research. More specific methods are outlined within specific study chapters.

THESIS MAP

Before and after each chapter, I present a thesis map. This is to show the journey of each empirical study within this body of work. The thesis map acts as both an introduction and a conclusion to each phase of the research, highlighting the aim of the following study and the key findings of preceding study.

	Study	Outcomes	
1	Wales 2021 Active Healthy Kids (AHK) Report Card: The Fourth Pandemic of Childhood Inactivity	***Aim***	To summarise the findings of the Active Healthy Kids Wales 2021 Report Card process and to present and interpret the results for physical activity domains for children and young people.
		Key Findings	
2	Associations Between Swimming & Cycling Abilities and Fitness In 9–11-Year-Old Boys and Girls	***Aim***	
		Key Findings	
3	Motor Competence Between Children with and without Additional Learning Needs: A Cross Sectional Population-Level Study	***Aim***	
		Key Findings	
4	A Socioecological Perspective of how Physical Activity and Sedentary Behaviour at Home Changed during the First Lockdown of COVID-19 Restrictions: HomeSPACE Project	***Aim***	
		Key Findings	
5	Qualitative Changes in Children's Physical Activity and Sedentary Behaviours Throughout the COVID-19 Pandemic: The HomeSPACE Project	***Aim***	
		Key Findings	

*The following chapters contain the published version of the studies; therefore, the terms physical activity and PA are used interchangeably.

4 STUDY 1 - WALES 2021 ACTIVE HEALTHY KIDS (AHK) REPORT CARD: THE FOURTH PANDEMIC OF CHILDHOOD INACTIVITY

*This chapter is part of a published manuscript:

Richards, A. B., Mackintosh, K. A., Swindell, N., Ward, M., Marchant, E., James, M., Edwards, L. C., Tyler, R., Blain, D., Wainwright, N., Nicholls, S., Mannello, M., Morgan, K., Evans, T., & Stratton, G. (2022). WALES 2021 Active Healthy Kids (AHK) Report Card: The Fourth Pandemic of Childhood Inactivity. International Journal of Environmental Research and Public Health, 19(13), 8138. https://doi.org/10.3390/ijerph19138138

4.1 INTRODUCTION

Children's physical activity (PA) levels worldwide are poor and have been decreasing over the decades (Kohl et al., 2013) to the detriment of physical (Hills et al., 2011) and mental health (Biddle & Asare, 2011). This is, unfortunately, no different in Wales (United Kingdom; U.K.) (Edwards, et al., 2018). Wales has a population of approximately 3 million people, of which approximately 664,000 are children and young people aged between 0 and 18 years (StatsWales, 2020). Only 51% of the Welsh population who are aged 3–17 years meet the guidelines for PA. These guidelines recommend at least 60 minutes of PA every day of the week (World Health Organisation, 2020). Only 13–17% of children aged 11–16 years partake in the recommended amount of PA (Health Social Care and Sport Committee, 2019), leaving Wales with some of the poorest levels of PA and time spent in sedentary behaviour globally (Aubert et al., 2018; Hanson et al., 2017).

Guidelines suggest that PA should be of moderate to vigorous intensity and that some PA is better than none. The guidelines further recommend that children and young people engage in a variety of types and intensities of PA to develop movement skills, muscular fitness and bone strength, and that sedentary time should be minimised (World Health Organisation, 2020). Poor levels of PA have a subsequent negative effect on physical health, including increased risk of obesity (Ng et al., 2014). In Wales, this is reflected in data from the Public Health Wales Child Measurement Programme (Public Health Wales NHS Trust, 2018), which show year-on-year weight increases with more than one in four children (aged 4–5 years) now living with overweight or obesity in Wales. High levels of obesity are also linked with low levels of fitness (Dumith et al., 2010). Research in Wales indicated that less than half of 3000 9- to 11-year-old children assessed achieved a healthy level of overall health-related fitness (Tyler et al., 2019). Furthermore, research has shown that PA levels during childhood can be tracked into adulthood, with children who are physically active more likely to be physically active as adults (Telama et al., 2014). Thus, there is a growing need to (i) highlight the current PA situation with children and young people across Wales; (ii) identify any inequalities in achieving recommended levels of PA in Wales; and (iii) provide recommendations for improving these to inform the decision making of policy makers, practitioners, and educators in Wales. These needs have been recognised by policy makers who previously produced a report detailing 20 recommendations to improve children and young people's PA in Wales (Health Social Care and Sport Committee, 2019).

There are many inequalities in PA levels, including, but not limited to, age, sex, race and ethnicity and socioeconomic status. Specifically, the current evidence base suggests that boys are more active than girls (Hallal et al., 2012); PA levels decline with increasing age (Farooq et al., 2020); differences exist between ethnic groups, with White European children recording more PA than South Asian children (Eyre et al., 2013; Owen et al., 2009); and lower socioeconomic status is associated with lower PA levels (Drenowatz et al., 2010). Despite these inequalities, Wales has a strong performance history of supporting PA through policies and strategies, with the 2018 Active Healthy Kids (AHK) Wales Report Card awarding a grade of C+ based on the identification of 21 national documents with a direct bearing on children and young people's PA. However, the Report Card did highlight that some of these policies were outdated (Edwards et al., 2018; Ward et al., 2021).

The Active Healthy Kids Global Alliance (AHKGA) is a network of researchers and health professionals aiming to improve children and young people's PA across the world, with an expanding development over time (Aubert et al., 2019). The 2021 Report Card for Wales is the fourth Active Healthy Kids Wales (AHK-Wales) Report Card, following reports in 2014, 2016 and 2018. Wales's fourth Report Card contributes to the AHKGA Global Matrix 4.0, which consists of 57 countries across six continents, after previously producing Report Cards for the Global Matrix 1.0 (Tremblay et al., 2014), 2.0 (Tremblay et al., 2016; Tyler et al., 2016) and 3.0 (Aubert et al., 2022; Edwards et al., 2018). The AHK-Wales Research Working Group (RWG) is co-ordinated by Swansea University and consists of academics and professionals from across Wales in the fields of sport, play, transport, public health, leisure and education. The overall purpose of the AHK-Wales Report Card is to act as an advocacy tool and provide a lens over PA behaviours and influencing factors of children and young people within Wales. A strength of the AHKGA process is that participating countries use a standard method that allows for comparison between countries, and it highlights children and young people's rights to be active and healthy. The purpose of this paper is to summarise the findings of the AHK-Wales 2021 Report Card and to present and interpret the results for PA domains for children and young people.

4.2 MATERIALS AND METHODS

The AHK-Wales RWG consisted of 20 members, including academics, postgraduate researchers, professionals and practitioners with expertise in PA and access to national data sources. The Academic Lead (G.S.) gained funding for and supervised the project, whilst the Lead Researcher (A.B.R.) led on sourcing and synthesising the data, organising the quality indicator (QI) groups and liaising with the AHKGA regarding progress of the Wales RWG. G.S. and A.B.R. were also responsible for producing the Report Card and subsequent impact activity, including that of the website, social media and further advocacy practices. Members of the RWG were allocated to QI groups, each with an associated lead (initials below), to collectively allocate grades to each QI. The method used throughout the process was aligned to guidance from the AHKGA (Tremblay et al., 2014) culminating in the production of eleven PA QI grades. Whilst Physical Literacy was not an AHKGA QI, the RWG deemed the inclusion important, given the association with overall PA (World Health Organisation, 2018) and the ongoing work on this in Wales over recent years (Wainwright et al., 2018, 2020). The eleven PA QIs were assessed and graded using the AHKGA standardised Report Card development process, which has been previously described for the Global Matrix 2.0 (Tremblay et al., 2016) and 3.0 (Aubert et al., 2018) and is based on the Canadian Report Card model (Colley et al., 2012). Briefly, this process involved collating, synthesising and providing expert consensus on the best available data aligned to the AHKGA benchmarks for the Global Matrix 4.0 (Table 1) for each QI. Slight alterations of benchmarks were made between Global Matrix 3.0 and 4.0 based on feedback from stakeholders. The RWG decided to use pre-COVID-19 data to produce the 2021 Report Card due to the time gap between the 2018 Report Card and the 2021 Report Card. However, it should be noted that a further Report Card is currently in production to compare the grades in this Report Card to children and young people's PA post-COVID-19. The eleven QIs included Overall Physical Activity (K.A.M.), Organised Sport and Physical Activity (R.T.), Active Play (M.M.), Active Transportation (N.S.), Sedentary Behaviours (K.M.), Physical Fitness (D.B.), Family and Peers (S.N.), School (E.M.), Community and Environment (M.J.), Government (M.W.) and Physical Literacy (N.W.). The QIs were graded using a standardised grading scheme and rubric (Table 2), provided by AHKGA, ranging from A+ (94–100% of children met the criteria) to F (<20% met the criteria) or Inconclusive (Inc), where data were inadequate or not available. The most recent and highest quality data (at the time of the grading process pre-COVID-19) were used from the following data sources: Health and Attainment of Pupils in a Primary Education Network (HAPPEN), School Health Research Network (SHRN), School Sport Survey, Further Education Sport and Active Lifestyles Survey, Play Sufficiency Child Survey Analysis, The National Survey for Wales, Swanlinx and Bridgelinx Data, Dragon Challenge Data, and Movement Assessment Battery for Children (MABC) Data. Each of these data sources had various sample sizes and age ranges (Table 3) and these were taken into consideration when grading the QIs. Data sources that were nationally representative were prioritised, followed by the best available data for each specific QI. The RWG regularly met virtually using an online platform to discuss and critique data for each of the eleven QIs, resulting in a grade being presented. During the meetings, data were reviewed in terms of representativeness, data collection, age range of participants, sample size and the reporting of any inequalities, including age, sex, race and ethnicity and socioeconomic status.

Table 1: *The Active Healthy Kids Global Alliance benchmarks for each quality indicator. The benchmark for Physical Literacy was created by the Active Healthy Kids-Wales group.*

Indicator	**Benchmark(s)**
Overall Physical Activity	% of children and young people who meet the Global Recommendations on Physical Activity for Health (World Health Organisation, 2020), which recommend that children and young people accumulate at least 60 minutes of moderate-to-vigorous-intensity physical activity per day on average.* OR % of children and young people meeting the guidelines on at least four days a week (when an average cannot be estimated)
Organised Sport and Physical Activity	% of children and young people who participate in organised sport and/or physical activity programs.*
Active Play	% of children and young people who engage in unstructured/unorganised active play at any intensity for more than two hours a day.* % of children and young people who report being outdoors for more than two hours a day.*
Active Transportation	% of children and young people who use active transportation to get to and from places (e.g., school, park, mall, friend's house)*
Sedentary Behaviours	% of children and young people who meet the Canadian Sedentary Behaviour Guidelines (Canadian Society for Exercise Physiology, 2018) (5- to 17-y-olds: no more than two hours of recreational screen time per day). Note: The Guidelines currently provide a time limit recommendation for screen-related pursuits, but not for non-screen-related pursuits.*

Physical Fitness	Average percentile achieved on certain physical fitness indicators based on the normative values published by Tomkinson et al. (2018) *
Family and Peers	% of family members (e.g., parents, guardians) who facilitate physical activity and sport opportunities for their children (e.g., volunteering, coaching, driving, paying for membership fees and equipment).* % of parents who meet the Global Recommendations on Physical Activity for Health [5], which recommend that adults accumulate at least 150 min of moderate-intensity aerobic physical activity throughout the week or do at least 75 min of vigorous-intensity aerobic physical activity throughout the week or an equivalent combination of moderate- and vigorous-intensity physical activity.* % of family members (e.g., parents, guardians) who are physically active with their kids. % of children and young people with friends and peers who encourage and support them to be physically active.* % of children and young people who encourage and support their friends and peers to be physically active.
School	% of schools with active school policies (e.g., daily physical education (PE), daily physical activity, recess, "everyone plays" approach, bike racks at school, traffic calming on school property, outdoor time).* % of schools where the majority (≥80%) of students are taught by a PE specialist.* % of schools where the majority (≥80%) of students are offered the mandated amount of PE (for the given state/territory/region/country).* % of schools that offer physical activity opportunities (excluding PE) to the majority (>80%) of their students.* % of ~~parents who report their~~ children and young people who have access to physical activity opportunities at school in addition to PE classes.* % of schools with students who have regular access to facilities and equipment that support physical activity (e.g., gymnasium, outdoor playgrounds, sporting fields, multipurpose space for physical activity, equipment in good condition).*

Community and Environment	% of children or parents who perceive their community/municipality is doing a good job at promoting physical activity (e.g., variety, location, cost, quality).* % of communities/municipalities that report they have policies promoting physical activity. % of communities/municipalities that report they have infrastructure (e.g., sidewalks, trails, paths, bike lanes) specifically geared toward promoting physical activity. % of children or parents who report having facilities, programs, parks, and playgrounds available to them in their community.* % of children or parents who report living in a safe neighbourhood where they can be physically active.* % of children or parents who report having well-maintained facilities, parks, and playgrounds in their community that are safe to use.
Government	Evidence of leadership and commitment in providing physical activity opportunities for all children and young people. Allocated funds and resources for the implementation of physical activity promotion strategies and initiatives for all children and young people. Demonstrated progress through the key stages of public policy making (i.e., policy agenda, policy formation, policy implementation, policy evaluation and decisions about the future). HEPA PAT v2 and the scoring rubric published by Ward et al. (Ward et al., 2021)*
Physical Literacy	% of children and young people who are physically active, physically competent, motivated, confident, and possess knowledge and understanding within the cognitive domain of physical literacy.*

* were used in our analysis and those with a strikethrough were changed.

***Table 2**: The Active Healthy Kids Global Alliance grading rubric*

Grade	Interpretation
A+	94% - 100%
A	87% - 93%
A-	80% - 86%
B+	74% - 79%
B	67% - 73%
B-	60% - 66%
C+	54% - 59%
C	47% - 53%
C-	40% - 46%
D+	33% - 39%
D	27% - 33%
D-	20% - 26%
F	<20%
Inc	Incomplete – insufficient or inadequate information to assign a grade

***Table 3**:The characteristics of the data sources that were and which quality indicator used these sources.*

Data Source	Sample Size	Age Range	Indicator Used
School Health Research Network Student Health and Wellbeing Survey	110,877	11 – 16 years	Overall Physical Activity, Sedentary Behaviours, Active Play, Active Transportation, School, Physical Literacy
School Health Research Network School Environment Questionnaire	167 Secondary School Senior Leaders	n/a	School
Health and Attainment of Pupils in a Primary Education Network	1,329	8 – 11 years	Overall Physical Activity, Sedentary Behaviours, Active Transportation, School, Community & Environment, Physical Literacy
School Sport Participation Survey	118,893	7 – 16 years	Organised Sport Participation, Family & Peers, School, Physical Literacy
School Sport Provision Survey	869 primary school PE teacher/coordinators 186 secondary school PE teacher/coordinators	n/a	School
Further Education Sport & Active Lifestyles Survey	3,857	16+ years	Organised Sport Participation, Physical Literacy
Play Sufficiency Child Survey Analysis	5,884	4 – 18 years	Active Play, Active Transportation, Family & Peers, Community & Environment

The National Survey for Wales	11,922 1,450 950	16+ years 4-11 years 11-16 years	Active Transportation, Family & Peers, Community & Environment
Swanlinx and Bridgelinx Data	4,778	9 – 12 years	Physical Fitness
Dragon Challenge	4555	9 – 12 years	Physical Literacy
Movement Assessment Battery for Children	92	5 – 7 years	Physical Literacy

4.3 RESULTS

The overall grades for each QI are presented in Table 4. Results are discussed herein on an individual QI basis.

Table 4: *Grades for all versions of the Active Healthy Kids-Wales Report Card*

Indicator	2014	2016	2018	2021
Overall Physical Activity	D -	D -	D +	F
Organised Sport & Physical Activity	C-	C	C+	C
Active Play	D +	C	C-	C +
Active Transportation	C	C	D +	C -
Sedentary Behaviour	D	D -	F	F
Physical Fitness	N/A	N/A	Inc	C -
Family & Peer Influence	D	D +	D	D+
School	N/A	B	Inc	B -
Community & Environment	B	C	Inc	C
Government	B -	B -	C +	C
Physical Literacy	N/A	Inc	Inc	C -

4.3.1 Overall Physical Activity Levels: F

In line with the global PA guidelines (StatsWales, 2020), "the percentage of children and young people who accumulate at least 60 minutes of moderate-to-vigorous PA (MVPA) on all day seven days of the week" was used as the benchmark for this QI. Data from the SHRN and HAPPEN databases were used to provide a grade (Table 4). The SHRN findings indicated that 17% of young people were active for at least 60 minutes on all seven days, although this figure decreased to 14% when only considering MVPA. There were inequalities in these findings, with more boys (18%) reporting engaging in MVPA in comparison to girls (10%). An age gradient was also present, with younger children (11-year-olds) reporting higher levels of MVPA (20%) in comparison to 16-year-olds (10%). A lower percentage (12%) of young people from less affluent families met the PA guidelines, compared to more affluent families (17%); different ethnicities reported similar PA levels (White: 14%; Black Minority Ethnic: 15%). The HAPPEN survey provided insight into the PA levels of 8–11-year-old children, with 22% reporting carrying out sport/exercise, as the structured component of PA, for at least 60 minutes across all seven days. Moreover, there were similar inequalities whereby boys reported more engagement (27%) in sport/exercise than girls (17%). There was, however, little variation with age (21–24%) or socioeconomic status (20–24%). Taken together, the RWG assigned a grade F to this QI. Although this suggests a decrease from the 2018 AHK-Wales Report Card, it is pertinent to note that the benchmark and data used in this Report Card differed from previous report cards, thereby precluding direct cross-comparisons. Indeed, some MVPA data were used as well as considering PA levels across all seven days, rather than "on average" or "on at least four days", commensurate with the AHK Global Matrix 4.0 benchmarks. Nonetheless, the benchmarks align closer to Wales's national PA guidelines.

4.3.2 Organised Sport and Physical Activity: C

The benchmark for grading this indicator was aligned with Sport Wales's concept of children and young people being "hooked on sport", meaning taking part in sport on three or more occasions per week. Data were captured in the Sport Wales School Sport Survey and are consistent with benchmarks used in previous AHK-Wales Report Cards (2014 and 2016). The School Sport Survey and the Further Education Sport and Active Lifestyles Survey showed the following figures for taking part in sport or PA on three or more occasions per week: 44% (7–9 year olds, school years 3 and 4); 51% (9–11 year olds, school years 5 and 6); 49% (11–14 year olds, school years 7–9); 46% (14–16 year olds, school years 10 and 11); 44% (16-year-olds); 46% (17-year-olds). This equates to an average of 47% and thus a C grade. Sub-group analysis (age, sex, ethnicity, disability and socioeconomic status) revealed that inequalities exist. There remains a sex difference in participation levels, with 50% of boys and 46% of girls hooked on sport. Furthermore, socioeconomic inequalities have widened since the previous Report Card, with the gap in participation rates between the least- and most-deprived children increasing by two percentage points. In both primary and secondary school data, the gaps have closed between ethnicities/ethic groups and between those who are impaired/disabled and those who are not since the previous Report Card. Despite this, disparities between ethnic groups and disabilities do exist within further education, with children from a Black/African/Caribbean/Black British ethnic group being more likely to participate in sport/PA three or more times a week (45%) than White (43%) and Asian/Asian British (35%) ethnic groups. Furthermore, there remains a difference between those who are impaired/disabled and those who are not, with 33% of students with an impairment/disability participating three or more times a week in 2018, compared with 45% of those who did not identify an impairment/disability. This gap has unfortunately widened since the last Report Card. The Organised Sport and Physical Activity grade remains unchanged from the 2016 AHK-Wales Report Card, but has decreased from the 2018 AHK-Wales Report Card. It is important to note that because of varying survey cycle dates, different questions and surveys were used for the grading of the 2018 Organised Sport Participation indicator compared to the 2014, 2016 and 2021 Report Cards. Therefore, caution is advised when viewing the changes in grades across Report Cards.

4.3.3 Active Play: C+

For the benchmark "percentage of children and young people who report being outdoors for several hours a day", information from the Play Sufficiency Child Survey 2018–2019 was used. The survey asked children how often they go out to play or hang out with friends. When asked if they played outside most days, 42% of children aged 5–17 years reported that they did and 33% of children reported playing outside a few days each week. For the benchmark "percentage of children and young people who engage in unstructured/unorganised active play for several hours a day", the SHRN Student Health and Wellbeing Survey 2019/20 was used, as playing with friends is included in the definition of exercise within the survey. In this survey, 42% responded "often or more" to the question "how often, during the most recent summer holidays, did you exercise in your free time so much that you got out of breath or sweated?" When taking the Play Sufficiency Child Survey Analysis responses to the question "days spent playing out" into account, the RWG slightly deviated from the recommended >2 hours per day. The RWG determined that responses of "most days" and "a few days" each week were representative of the benchmark "several days" a week. Taking into consideration both benchmarks, the RWG concluded that Active Play within Wales had an overall percentage of 58%, which is commensurate with a C+ grade. This grade is slightly improved from the C grade previously reported in 2018. However, it is important to acknowledge that only participants who indicated the response "most days" each week were included in the data for the 2018 Report Card.

4.3.4 Active Transportation: C

This RWG determined a grade of C for this indicator based on the benchmark, "percentage of children and young people who use active transportation to get to and from places (e.g., school, park, mall, friend's house)". According to three surveys (SHRN Student Health and Wellbeing, HAPPEN and Play Sufficiency Child Survey Analysis), between 42% and 44% of primary school-aged children use active transport to travel to school. In two surveys of children aged 11–16-years, 35% and 33% used active transport to travel to school. In another survey, 73% of children aged 4–18 years used active travel to places where they play. A small sex difference was shown, with a higher proportion of boys using active transport to primary school compared to girls, whereas, at secondary school level, this trend was reversed, with more girls using active transport compared to boys. The proportion of children using active transport was also greater in urban compared to rural primary and secondary schools. The proportion of children using active transport also increased with age, with 45% and 51% of children in Year 6 using active travel to and from school, respectively, compared to 37% and 41% in Year 4. When drawing comparisons across socioeconomic groups, there was a clear gradient, with the most affluent group reporting higher active travel (37%) compared to the most deprived (21%). The Play Sufficiency Child Survey Analysis showed that 73% of children used active transport to travel to places of play. The RWG assigned a C to this category, considering that active transport to school ranged between 33% and 43% and accounting for the first inclusion of a question addressing active transport to a destination other than school. This grade has increased from a D+ in the last AHK-Wales Report Card completed in

2018. It is important to note that the grade increase reflects the inclusion of more data sources as well as the inclusion of data on active transport to destinations other than school. Thus, this grade provides a more complete overview of this indicator, rather than reflecting evidence of an upward trend in the use of active transport.

4.3.5 Sedentary Behaviours: F

There is one benchmark for the Sedentary Behaviours indicator, which is "the percentage of young people who exceed the recommended sedentary time guidelines (i.e., two or more hours)". Two data sources were used to assign a sedentary behaviour grade, namely, the SHRN, which asked young people how much time they spent sitting outside of school hours during free time on weekdays and the HAPPEN survey, which asked children "in the last seven days, how many days did you watch TV/play online games/use the internet etc. for two more hours a day (in total)?" These data showed that 86.4% of young people spent two or more hours sitting during weekdays. Results were found to be higher amongst boys and there was a positive association between sedentary behaviour and age. Data also showed that 32% of children reported watching TV/screens for two hours or more every day of the week, which was also higher in boys than girls, and in older children. There was also a difference in socioeconomic status, where 37% of deprived and 21% of the most affluent children reported two or more hours of screen time daily. A grade F was reported for this indicator, which has not changed since the 2018 Report Card.

4.3.6 Physical Fitness: C

The overall grade for physical fitness was decided upon using the best available data to compare to the Tomkinson et al. (2018) normative values as per the AHKGA benchmark, "average percentile achieved on certain physical fitness indicators based on the normative values published by Tomkinson et al. (2018). Available data for both cardiorespiratory fitness and muscular fitness were used. Based on the best available data from the Swanlinx and Bridgelinx Projects, the RWG assigned a C to this indicator. For cardiorespiratory fitness, data from the multi-stage fitness test for 4310 participants aged 9–12 years were available. Overall, the mean lap achieved was 29.65 laps (SD = 16.76). For comparison with European normative values (Tomkinson et al., 2018), data were classified by age and sex, with children and young people in Wales typically falling within the 40th percentile for cardiorespiratory fitness. Results for muscular fitness also showed children and young people falling into the 40th percentile, using data from the grip strength test for 3387 participants aged 9–12 years comparing with European normative values (Tomkinson et al., 2018), classified by age and sex. Overall, young people in Wales aged 9–12 typically fall within the 40th percentile for both cardiorespiratory and muscular fitness, meaning that the physical fitness indicator was graded a C.

4.3.7 Family and Peers: D+

The RWG allocated the Family and Peers indicator the grade of a D+ based on data from three out of the five AHKGA recommended benchmarks (Table 1). Data from the Play Sufficiency Child Survey Analysis and the National Survey for Wales were used to evaluate these benchmarks. Children reported that 46% of adults were "great and happy with children playing out", with another 43% stating that adults were "OK and alright about children playing out". Data show that 10% of adults volunteered in sport over the past 12 months, whilst 53% of adults met the MVPA guidelines of 150 minutes of PA per week. Based on these results, an average was taken, giving a total of 36%, equating to a grade D+, a slight increase from the 2018 Report Card, which was a D.

4.3.8 School: B

To grade this indicator, data from the HAPPEN Survey, SHRN School Environment Questionnaire, SHRN Health and Wellbeing Survey and School Sport Survey Participation and Provision surveys were synthesised to provide data on the six benchmarks provided for by the AHKGA (Table 1). The data used to produce a grade for the school indicator were as follows: 45% of primary schools offered an afternoon break. When exploring PE specialisations within teaching, 69% of primary schools and 92% of secondary schools had at least one male specialist PE teacher, whilst 69% of primary and 80% of secondary schools had at least one female specialist PE teacher. When exploring how many minutes per week were allocated to PE within the formal curriculum, only 6% of children aged 11–12 years (school year 7) were offered the recommended 120 minutes per week, which decreased with age, with <1% of children aged 15–16 years offered this amount. When exploring extracurricular sport, 84% of primary (7+ years old) and 94% of secondary schools were offered regular access to extracurricular sport, whilst on average, 66% across primary and secondary schools reported participation (68% males; 65% females). Finally, when studying resources, equipment and facilities, it was found that indoor and outdoor space conducive to facilitate PA were provided to 72% of schools, whilst 64% of primary and 58% of secondary staff agreed/strongly agreed that their school has access to sufficient facilities to provide sport. The RWG recognises these benchmarks to be of equal importance and assigned an even weight, allocating an overall average of 60% and a grade of B .

4.3.9 Community and Environment: C

The RWG decided on an overall grade of C for the community and built environment indicator. The main data sources considered for this Report Card included a broader range of data. The National Survey for Wales, HAPPEN survey and Play Sufficiency Child Survey Analysis provided the data for the three benchmarks evaluated within this indicator. Children and parents who perceive that their community/municipality is doing a good job at promoting PA (e.g., variety, location, cost, quality) were evaluated through several questions: 21% report they were satisfied with places to play; 23% were very satisfied with clubs and activities; 21% were very satisfied with places to meet; 48% strongly agree that green space was suitable; 88% of children were happy with their area. These questions averaged out at 40%, equating to a C. Children and parents reporting that they have facilities, programs, parks and playgrounds available to them in their community varied between the National Survey for Wales and HAPPEN survey. A total of 72% of children reported playing out, 24% reported being able to play everywhere they would like, 42% reported great places to play, whilst 88% can walk to a park and 38% can walk to a facility, averaging this benchmark at 53% (C). When exploring the percentage of children or parents who report living in a safe neighbourhood where they can be physically active, 45% reported feeling safe in the Play Wales Survey, whilst 70% reported feeling safe in the HAPPEN survey. An average of 58% (C) was calculated for this benchmark. Overall, those who were more deprived reported feeling less safe in their areas. Additional data sources have been made available since 2018 and it is apparent that the evidence base is growing in this area; however, it is still reliant on self-report data from both children and adults. The grade of C has been assigned to this indicator based on 3/6 of the benchmarks, highlighted in Table 1. For previous Report Cards, the RWG used the percentage of children/parents satisfied with the play facilities available in their local area to assign a grade to this indicator. Data available around these benchmarks were limited.

4.3.10 Government: C

The RWG concluded that the grade would be decreased slightly from a C+ in 2018 to a C (50%) for this current Report Card. This is in part due to the expiry of previous policies specific to PA promotion that were subsequently replaced by an obesity policy that includes PA as one element. This was seen by the group as a retrograde step as it overlooks the wider health impacts of PA. There was also a perceived lack of progress in embedding PA in education policy and actions despite a recent revision of the national curriculum in Wales. Similarly, to the other QIs, there are no purely objective measures that can be used to inform the Report Card. However, after utilising the WHO Europe Health-enhancing PA (HEPA) policy audit tool (PAT)v2 (Bull et al., 2015) to inform the 2018 Report Card, we developed a complementary weighted scoring tool that provided an objective measure aligned to the Report Card [20]. In interpreting this indicator, twenty-six “active” national instruments including national policies, strategies, action plans, legislation and a few other advisory and technical documents that have a direct bearing on children and young people’s PA were identified. Guided by the HEPA PAT tool, the evidence relating to key policy domains that influence PA in children and young people were evaluated. A range of key “elements” were identified from the HEPA PAT tool and refined by the RWG that could individually or collectively impact the effectiveness of the policy instrument. These elements included number and breadth of policies, identified supporting actions, identified accountable organisation(s), identifiable reporting structures, monitoring and evaluation plans and identified funding/resourcing. The HEPA PAT tool was used in assessing this indicator and the information translated into a score by utilising the previously used scoring tool (Ward et al., 2021). Each element was assigned a percentage score weighted to reflect the element’s perceived importance in translating the policy instruments effectively. The final scoring matrix was as follows: number and breadth of relevant policies—10% (5% number and 5% breadth) = 8%, identified supporting actions—20% = 15%, identified accountable organisation—25% = 14%, identifiable reporting structures—15% = 6%, identified funding and resources—20% (5% number of identified national programmes and 15% funding) = 5%, monitoring and evaluation plan—10% = 2%.

4.3.11 Physical Literacy: C

Following the inconclusive grades assigned to physical literacy in 2016 and 2018, a C grade was awarded. The definition of physical literacy utilised in Wales is "the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life" (Edwards et al., 2017; IPLA, 2017). Following the elements of physical literacy in this definition, the concept was divided into four sub-indicators: physical competence, motivation, confidence and PA as a behaviour that is representative of physical literacy. There were no available data for the cognitive (knowledge and understanding) domain; however, there were data from six sources to support a score in physical competence, motivation, confidence and PA. Using the six sources highlighted in Table 3 (Dragon Challenge, Movement ABC, HAPPEN, School Sport Survey, FE Sport and Active Lifestyle Survey, and SHRN), each domain was scored as follows: physical competence, 34%; confidence, 69%; motivation, 65%; PA, 19%. Based on these scores for the sub-categories, the overall score is 47%, giving a grade of C.

4.4 Discussion

The results of the AHK-Wales 2021 Report Card have shown that prior to COVID-19, children and young people's PA levels in Wales decreased. Of concern, recent research during and after the COVID-19 pandemic shows that on average, these negative trends further declined during pandemic restrictions (Hurter et al., 2022; James et al., 2021). Using the best available data, the majority of children in Wales were insufficiently active, did not achieve the recommendation of at least 60 minutes of MVPA every day and spent excess time (>2 hours) in sedentary behaviour (Page et al., 2021). This was the first year the Wales RWG was able to report a grade for all eleven QIs. All but three grades (Active Play, Active Transportation and Family and Peers) either remained the same or decreased from 2018 to 2021. This is of great concern, not least given that recent research has also shown that pandemic and post-pandemic PA levels in Wales have further decreased (Hurter et al., 2022; Richards et al., 2022). Based on this recent research and the results of the Report Card, a further Report Card detailing children and young people's PA grades post-COVID-19 will be released shortly.

Quality indicators of particular concern include Overall Physical Activity and Sedentary Behaviours, both receiving a grade F, the lowest of the Wales indicators and decreasing from previous years. The Physical Literacy and Physical Fitness QIs were given grades for the first time in the AHK-Wales Report Card history. Given the importance of both physical fitness (Eddolls et al., 2018) and physical literacy (Edwards et al., 2018) to overall health and well-being, considerations are needed on how data can be maintained to ensure effective monitoring of these QIs for the next Report Card cycle and beyond. The recent global pandemic has only further highlighted the importance of good physical fitness (Sallis et al., 2021). The School QI was given a grade of B , which has decreased from the B grade assigned in the 2016 Report Card. Data behind this grade suggest that the provision and resources are available; however, time allocated to PE within schools is not sufficient. The importance of the provision of facilities and the duration of both PE lessons and lunchbreaks in facilitating PA and reducing sedentary behaviour has been previously established (Morgan et al., 2016). The results from the School QI are particularly relevant to the new curriculum in Wales coming into effect in 2022. Despite a renewed statutory focus on Health and Wellbeing as one of the six Areas of Learning and Experience, there will not be mandated time requirements for PE provision. Both Community and Environment, and Family and Peers QIs were able to assign grades; however, data were not available for all suggested benchmarks, and hence the grades were assigned based on an appropriate selection of the benchmarks, as shown in Table 1. This should be taken into consideration when evaluating these QIs.

Congruent with all three previous Report Cards (Edwards et al., 2018; Tyler et al., 2016), there were inequalities in children and young people's PA across Wales. These inequalities are at risk of widening, especially following the COVID-19 pandemic, particularly the sex/deprivation gap. Whilst there was a significant increase in both walking and cycling, with 38% and 39% increases, respectively, compared to pre-COVID levels (Department for Transport, 2020), these increases in activity were identified amongst people predominantly at the higher end of the socioeconomic spectrum. However, other studies suggest a reduction in PA amongst more vulnerable and disadvantaged groups (Shur et al., 2020), which would subsequently further widen the health inequalities gap.

4.4.1 Research Gaps

The AHK-Wales Report Card is typically produced every two years, but the COVID-19 pandemic resulted in a three-year gap between this Report Card and the previous one in 2018. Following in-depth discussions, the RWG came to a consensus to focus this Report Card on pre-COVID-19 data. During the production of the 2014, 2016 and 2018 Report Cards, there were significant gaps identified within the data, resulting in INC grades (n = 4 in 2018) for Physical Fitness, Physical Literacy, School and Community and Environment. Previous research has identified both national and international research gaps and no ideal PA surveillance measures (Aubert et al., 2021). It is therefore particularly noteworthy that all indicators were assigned grades in the 2021 Report Card due to increased availability of data. Within the Physical Fitness QI, data from the Swanlinx and Bridgelinx programmes were used to establish levels of fitness in children. However, whilst there was a large sample size (n = 4778), these data are not nationally representative and thus there remains a paucity of national-level data. Despite this, the deprivation levels, measured through the Welsh Index of Deprivation (WIMD), align with and span the socioeconomic status of Wales as a nation. Similarly with the Physical Literacy QI, although substantially more data are available in this area, particularly from the School Sport Survey and the Dragon Challenge, which are both nationally representative sources and provide data for physical competence, confidence, motivation and PA, there were no data available for the knowledge and understanding aspect of physical literacy. Furthermore, there is a continued lack of data that consider the holistic approach to physical literacy. The School QI was primarily graded INC in the 2018 Report Card as a result of the Sport Wales School Sport Survey being conducted every three years instead of every two, producing no updated data since the 2016 Report Card. Finally, the Community and Built Environment QI, which only had sufficient data for three out of the six benchmarks suggested by the AHKGA, was able to be graded, in accord with other countries, following consultation and audit from the AHKGA. Nonetheless, efforts are required to provide data for all benchmarks and enable a more comprehensive overview of the indicator.

Despite there being an improvement in the range of data available for the 2021 Report Card, there are still no large-scale nationally representative studies utilising device-based PA or sedentary time measures, which would be beneficial over solely self-reported information. Furthermore, there remains a scarcity of qualitative evidence to provide detail on the quality of PA provision, or indeed ascertain why PA levels are changing. To address why grades have been awarded, the voices of children could be utilised to apply context. While these data are difficult to obtain on a larger scale, it is important to advocate for what children want and need to be more active. Finally, another issue that should be considered is how closely linked the available data were to the AHKGA proposed benchmarks. Indeed, some data were not as closely aligned to the QIs as others, with some indictors requiring deeper exploration, more synthesis and the use of expert opinion. It is important to note that this Report Card has also taken a more robust approach from more experienced RWG members who have been involved in the process for four iterations.

4.4.2 Recommendations to Improve the Grades

This is the fourth AHK-Wales Report Card to be published and the first to include a grade for all QIs. As the RWG has developed and become more established, the lasting impact, reach and significance of the Report Card increase with importance. The results can be used to inform the decision making of policy makers, practitioners and educators. Indeed, there are several key recommendations that will be advocated for based on these results. Specifically, the Active Play QI suggests prioritising the views of children and young people, making the most of community assets and protecting play time, whereas the Physical Fitness QI suggests that health enhancing PA should be encouraged from a range of contexts. Moreover, based on the Community and Environment QI, the inclusion of more data sources with children's voices—as data sources are currently predominantly adult-based—should be prioritised, along with the development of objective measures of access, including, but not limited to, network distances. However, it is pertinent to note that such objective measures should be used in conjunction with self-report so that subjective accessibility is also monitored. Finally, the key recommendation from the Government QI is that PA should not be conflated with "obesity"; whilst there is a relationship, the health impacts of PA extend far beyond obesity. Health-enhancing PA is influenced by most policy areas, and therefore, any strategic approach must ensure active engagement with all relevant sectors, including education, communities, environment, play, transport, health and sport.

A primary concern following these grades is the evident decline in children and young people's PA levels in Wales. It is therefore imperative to seek to positively impact children's PA levels between the Report Card cycles. Data from the 2018 AHK-Wales Report Card were used in the National Assembly for Wales Health, Social Care and Sport Committee Report on PA of children and young people in March 2019 (Health Social Care and Sport Committee, 2019). Since the last Report Card, The Welsh Institute of Physical Activity, Health and Sport (WIPAHS) has been inaugurated. WIPAHS brings together academia, facilitators, policy makers and the public to develop and answer questions on the nation's well-being and health, whilst translating this research into practice. It is anticipated that WIPAHS will play a key role in sharing data and research to further inform the AHK-Wales RWG.

4.4.3 Future Directions

The dissemination of the Report Card will continue with the launch of the Report Card at the AHKGA meeting in conjunction with the International Society for PA and Health (ISPAH) in October 2022; this will provide opportunities to learn from other countries that have followed the same process. This will be supported by an independent website (www.activehealthykidswales.net accessed on 24 June 2022). These are the foundations for continued work with the advocacy and impact group, who will resume enhancing communications with key stakeholders to improve the PA of children and young people in Wales.

4.5 CONCLUSIONS

Worryingly, in comparison to the AHK-Wales 2018 Report Card, eight out of the eleven QIs remained the same or decreased in the 2021 Report Card, with the largest decrease being in the Overall Physical Activity QI, which changed from a D+ to an F. The AHK-Wales 2021 Report Card emphasises the hard work of academics and professionals in Wales in developing, implementing and analysing new datasets since 2018, which has allowed more data to be used for the 2021 Report Card. This has allowed a more comprehensive understanding, and in some instances, has helped provide further context. However, it is pertinent to acknowledge that the current AHKGA benchmarks are open to interpretation, and some measures utilised were not fully aligned with Global Matrix 4.0 benchmarks. It is therefore recommended that national surveillance strategies are implemented to provide a more holistic and informative overview of children and young people’s PA.

THESIS MAP

	Study		Outcomes
1	Wales 2021 Active Healthy Kids (AHK) Report Card: The Fourth Pandemic of Childhood Inactivity	***Aim***	To summarise the findings of the Active Healthy Kids Wales 2021 Report Card process and to present and interpret the results for physical activity domains for children and young people.
		Key Findings	Grades ranged from F for overall physical activity and sedentary behaviour indicators, through to a B- for the school indicator. All but three grades remained the same or decreased from the 2018 version of the Report Card and it was the first time that Wales did not have any inconclusive grades.
2	Associations Between Swimming & Cycling Abilities and Fitness In 9–11-Year-Old Boys and Girls	***Aim***	To examine the associations between fitness and swimming and cycling proficiency in primary school boys and girls.
		Key Findings	
3	Motor Competence Between Children with and without Additional Learning Needs: A Cross Sectional Population-Level Study	***Aim***	
		Key Findings	
4	A Socioecological Perspective of how Physical Activity and Sedentary Behaviour at Home Changed during the First Lockdown of COVID-19 Restrictions: HomeSPACE Project	***Aim***	
		Key Findings	
5	Qualitative Changes in Children's Physical Activity and Sedentary Behaviours Throughout the COVID-19 Pandemic: The HomeSPACE Project	***Aim***	
		Key Findings	

5 Study 2 - Associations Between Swimming & Cycling Abilities And Fitness In 9-11-Year-Old Boys And Girls

*This chapter is part of a published manuscript:

Richards, A. B., Klos, L., Swindell, N., Griffiths, L. J., De Martelaer, K., Edwards, L. C., Brophy, S., & Stratton, G. (2021). Associations between swimming & cycling abilities and fitness in 9–11-year-old boys and girls. *Journal of Sports Sciences*, 40(6), 658–666. https://doi.org/10.1080/02640414.2021.2013616

5.1 Introduction

Swimming and cycling are foundational movement competencies (Hulteen et al., 2018) that provide a gateway to a plethora of health promoting physical activity opportunities. The term "foundational movement skills" has been developed to incorporate both traditional fundamental movement skills, that are necessary for participation in physical activity, together with additional supporting skills that, developed correctly, will increase opportunities for participation (Hulteen et al., 2018). Moreover, children's ability to swim or cycle are important to reduce the risk of drowning (Asher et al., 1995) and improve road safety (Corden et al., 2005). Both swimming and cycling are highly accessible activities to children, through national curriculum policy, which helps with achieving physical activity recommendations and promoting fitness. Longitudinal studies on children between 6 and 13years of age, within Europe, emphasise the potential long-term impact that developing motor competence has on physical activities (Fransen et al., 2014; Lima et al., 2019). Developing motor competence improves the way that someone can control and move their body. Therefore, children who are unable to swim and cycle may be lacking in foundational movement skills which would aid in promoting an active lifestyle and fitness across the lifespan (Stodden et al., 2009).

Studies have demonstrated decreases in both children's and adult's fitness levels through time; this includes both muscular (Müllerová et al., 2015) and cardiorespiratory fitness (Vaara et al., 2020). Cardiorespiratory fitness is arguably the most important component of fitness, as early research found strong associations between poor cardiorespiratory fitness and all-cause mortality (Blair, 1989). With children's cardiorespiratory fitness declining in high- and middle-income countries (Tomkinson et al., 2019), communities and schools have placed interventions to combat this; finding that appropriate school-based physical activity programmes, which include aerobic activities such as skipping, dancing and running, are effective in increasing cardiorespiratory fitness in children (Pozuelo-Carrascosa et al., 2018). These school-based physical activity programmes can be run as extra-curricular sports clubs and being a member of a sports club has also shown positive associations with fitness levels in children (Larsen et al., 2017). Children from more affluent families are more likely to attend extra-curricular or community sports clubs than their more deprived peers (Basterfield et al., 2015). Socioeconomic status is also associated with swimming ability, where more deprived children are less likely to be able to swim 25m than their more affluent peers (Sport England, 2019). A study by Henrique et al. (2016) found that organised sport participation in early childhood significantly increased the likelihood of continuation throughout childhood. Providing both structured and context-specific unstructured opportunities for children to learn motor skills, play a critical role in both the quality and quantity of physical activity individuals engage in across the lifespan (Brian et al., 2020).

The positive relationship between physical activity and motor competence in children has received attention (Stodden et al., 2008), finding that associations increase in strength as children age, yet fewer studies have examined relationships between foundational movement skills such as swimming and cycling and fitness. While there is some evidence that fundamental movement skills are related to fitness in children (Jaakkola et al., 2019a), cycling or swimming competence is largely missing from the extant literature. This is surprising given the high value placed on the importance of children learning to swim and cycle. Associations have been found between health outcomes such as bone health in swimming (Gómez-Bruton et al., 2013) and obesity in cycling (Ming Wen & Rissel, 2008), however, there is a lack of evidence on associations between these factors and fitness levels in children, particularly where both swimming and cycling are considered.

The purpose of this study was therefore to examine the associations between fitness and swimming and cycling proficiency in primary school boys and girls. We hypothesised that a) being able to swim and cycle would be positively associated with fitness and b) that there would be gender interactions between boys' and girls' fitness and swimming and cycling abilities.

5.2 METHODS

5.2.1 Participants and Settings

Thirty-three, primary schools took part in the Swanlinx and Bridgelinx programmes (Sheldrick et al., 2018; Tyler et al., 2019) to assess multiple components of fitness, health, wellbeing and lifestyle behaviours in a local further or higher education setting. All children in school years 5 and 6 were invited to take part in the study and written consent was sought from parents, headteachers and assent from children. The inclusivity of the programmes meant that children with registered disabilities took part in the project, but their data was not used. Between 2013 and 2019, consent was obtained, and data collected for 2258 children (50.7% boys; aged 10.52±0.6years; BMI 19.14±3.79).

5.2.1.1 Instruments and Procedures

Fitness Fun Days

Children attended a "fitness fun day" in an indoor sports hall where they completed a battery of six fitness assessments selected from the EuroFit battery (Adam, 1988). The fitness fun days have previously been described (Taylor et al., 2004) and the measures have shown acceptable test/re-test reliability (Boddy, Stratton & Hackett, 2010). All fitness assessments were conducted by trained assessors.

Skill-Related Components of Fitness

Children completed the following assessments to measure skill-related components of fitness: standing long jump (power), the 10x5m shuttle run (speed) and the speed bounce test (speed and coordination). Power was measured using a standing long jump mat and distance jumped was measured in cm; children had three trials of this assessment and their best jump was recorded. The 10x5m shuttle run was measured in seconds and therefore lower scores indicate a higher performance. Children took part in speed bounce twice and their best effort was recorded as their final score.

Health-Related Components of Fitness

The health-related components of fitness included measures of strength, cardiorespiratory fitness, flexibility, and BMI. Strength was measured in kilograms (kg) using a handgrip dynamometer [Takei Corp Ltd., Tokyo, Japan] to provide an indication of overall muscular strength. The standard EuroFit protocol for using the handgrip dynamometer was adhered to. Cardiorespiratory fitness was measured using the 20mSRT, where children's performance was assessed by number of shuttles that they completed before failing to meet the requirements of the test. Flexibility was measured using the sit and reach protocol. Anthropometric measures were taken including standing height, sitting height and body mass. A portable height stadiometer [Seca 213 portable stadiometer, Seca Ltd, Birmingham, Uk], a sitting height stadiometer [Harpenden Sitting Height Table, Holtain Ltd, Pembrokeshire, UK] and electronic weighing scales [Seca 813, Seca Ltd, Birmingham, UK] were used. BMI was calculated (BMI=body mass (kg)/height2(m)) and BMI z-scores were obtained from the UK 1990 growth reference curves (Cole et al., 1995), using the 2nd centile to categorise as underweight, 85th as overweight and 95th as obese.

CHAT Survey (Child Health & Activity Tool)

Children also completed a self-report online survey as a routine measure during their school day. They completed the CHAT survey (Todd et al., 2016) that has acceptable validity (Everson et al., 2019) under supervision of their teachers who used a standardised information sheet and video to explain the aims of the study, confidentiality and withdrawal information. The survey is child-friendly and captures a wide range of lifestyle behaviours. The data used in this study included whether the children could i) ride a bike, ii) swim 25 m and iii) whether they were a member of a sports club.

Confounding Variables

Demographic characteristics such as date of birth, gender and postcode were collected from the school. Date of birth was used to calculate the children's decimal age. Home postcodes were used to calculate deprivation scores using the Welsh Index of Multiple Deprivation (WIMD). The WIMD uses eight domains, weighted in the following order: income, employment, health, education, access to services, housing, community safety and physical environment; to rank the areas within Wales from 1 being the highest deprivation area to 1909 being the least deprived.

5.2.1.2 Design and Analysis

Of the 2258 participants, 7 were found to be ≥12years of age and were excluded due to our target age being 9–11years of age, a further 1 was removed due to not having any fitness data recorded. There were a small number of outliers detected (18) and removed from the analysis. Seventeen consecutive participants were identified with a standing long jump score of more than 3 standard deviations away from the mean, whilst one participant's height was above a realistic range. A further 114 participants were removed as they were missing at least one of the dependent variables, decimal age, BMI, WIMD or had not completed the CHAT survey. Therefore, the final sample included 2,118 participants.

Statistical Analysis

Given that the data was collected across 33 schools, it is likely children from the same school share some characteristics. Intraclass correlations (ICC) indicated that schools accounted for between 5.2% and 23.9% of the variance in the dependant variables. Therefore, to account for the nested structure of the data, a multivariate, multilevel model with a random intercept was fitted to investigate whether being able to swim and cycle predicted the various components of fitness. MLwiN (version 3.05) was used for the analysis. At level 1 multiple responses (the fitness scores) from individuals were treated as repeated measures nested within that respondent. Three models were fitted sequentially. First, the "null model" containing only the individual and school-level structure was fitted (model 1). The main variables of interest, swimming, and cycling together with covariates decimal age, gender, BMI z-scores, deprivation and sports club attendance were then added (model 2). Finally, to test the moderating effect of gender, two-way interactions (gender-by-swim and gender-by-cycle) were added to the model (model 3). The −2loglikelihood values were compared using Chi-squared to ensure a step-by-step increase in variance captured for each model. The alpha level for significance was set at $p < 0.05$ for all analyses. The regression coefficient and their standard error were used to evaluate the significance of the relationship generating a p-value within MLwiN using the compare models' window. Significance values were derived using the Wald statistic (2007).

5.3 RESULTS

Descriptive data are included in Table 5. To summarise the children had a mean age of 10.51±0.6years. Almost 60% of children were of a healthy weight, the remaining 23.49%, 15.44% and 1.32% being obese, overweight, and underweight respectively. A fifth of children reported that they were unable to swim (20.10%) whereas less than one in ten were unable to ride a bike (7.80%). Over 85% of children reported being a member of a sports club. Table 6 shows means and standard deviations for each fitness variable, split by gender, swim and cycle proficiency and sports club attendance. As shown in Table 6 boys outperformed girls in all fitness components except flexibility where girls outperformed boys.

Table 5: *Characteristics of participants who were included in the analysis for this study.*

Variable	All		Boys		Girls	
	Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**
Gender			1077	50.80	1041	49.20
Age (Years)						
<10	505	23.84	254	23.58	251	24.11
≥10 & <11.0	1040	49.10	517	48.00	523	50.24
≥11.0 & <12	573	27.05	306	28.41	267	25.65
BMI Category						
Underweight	28	1.32	15	1.39	13	1.25
Normal weight	1266	59.77	638	59.24	628	60.33
Overweight	326	15.39	152	14.11	174	16.71
Obese	498	23.51	272	25.26	226	21.71
WIMD						
10% most deprived	310	14.64	166	15.41	144	13.83
10-20% most deprived	301	14.21	144	13.37	157	15.08
20-30% most deprived	171	7.40	94	8.73	77	7.40
30-50% most deprived	453	22.00	224	20.80	229	22.00
50% least deprived	883	41.69	449	41.69	434	41.69
Swim						
Yes	1693	79.90	874	81.20	819	78.70
No	425	20.10	203	18.80	222	21.30
Cycle						
Yes	1952	92.2	989	91.80	963	92.50
No	166	7.8	88	8.20	78	7.50
Sports Club						
Yes	1804	85.20	921	85.50	883	84.80
No	314	14.80	156	14.50	158	15.20

Table 6: *Fitness test results for each variable including means (M) and standard deviations (SD) split by gender, swim and cycle ability and sports club attendance.*

	Fitness Tests											
	10x5m ***Speed***		**Speed Bounce** ***Speed & Coordination***		**Grip Average** ***Strength***		**Sit & Reach** ***Flexibility***		**MSFT** ***Cardiorespiratory***		**Standing Jump** ***Power***	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
All	20.20	2.65	40.65	12.11	16.83	3.83	17.92	7.47	28.48	15.99	133.79	23.77
Girls	20.62	2.64	39.18	11.82	16.33	3.79	20.49	7.28	23.56	12.35	127.70	22.19
Boys	19.80	2.60	42.06	12.23	17.32	3.81	15.42	6.79	33.20	17.59	139.68	23.77
Swim (Yes)	20.05	2.58	41.66	12.04	17.12	3.80	18.30	7.47	29.72	16.29	135.91	23.23
Swim (No)	20.82	2.86	36.61	11.56	15.68	3.77	16.36	7.29	23.43	13.61	125.33	23.69
Cycle (Yes)	20.09	2.60	41.32	11.96	16.98	3.84	18.13	7.49	29.28	16.11	135.08	23.46
Cycle (No)	21.53	2.87	32.65	11.10	15.05	3.26	15.27	6.75	18.91	10.60	118.59	22.18
Sports Club (Yes)	20.17	2.61	40.99	11.99	16.94	3.87	18.16	7.51	29.09	16.05	134.06	23.48
Sports Club (No)	20.42	2.89	38.75	12.63	16.20	3.60	16.50	7.08	24.95	15.19	132.26	25.35

Each regression model (1 through 3) increased the variance accounted for (−2logliklihood values) resulting in model 3 providing the main results (Table 7). The step-by-step increase in variance from models of the multivariate multilevel analysis can be seen from the −2loglikelihood values and Chi-squared significance levels in Table 8. It shows how the final model (model 3) was built and how each model significantly improved on the previous one, by adding extra variables; this can be seen by the significant chances in the −2 Log Likelihood ($p<0.001$).

5.3.1 Swimming

After controlling for school level differences, and adjusting for decimal age, BMI, gender, deprivation, and sports club attendance, swimming was a significant predictor of all six fitness variables ($p<0.05$) (Table 7). Children who could swim significantly outperformed their non-swimming counterparts in all measures of fitness. Moreover, there was a significant gender x swimming interaction for cardiorespiratory fitness (β=4.846, p =<0.001). Boys who could swim completed over 7 more shuttles (140 m) on the MSFT than those who could not. This difference was less marked in girls, as those who could swim completed 2.3 (46 m) more shuttles than those who could not. Girls in the could not swim group, on average, achieved higher grip strength scores than boys in the same group.

5.3.2 Cycling

Children who could ride a bike performed significantly better ($p<0.05$) than those who could not in all fitness tests (Table 7). A significant gender x cycling interaction was evident for grip strength (β=1.699, p=0.02), cardiorespiratory fitness (β=5.513, p=0.015) and power (β=6.554, p=.049). Interestingly, girls who could not cycle had a superior grip strength than boys who could not cycle. However, boys who could cycle had 2.52 kg stronger grip strength than boys who could not cycle whereas girls who could cycle were only 0.83 kg stronger than girls who could not cycle, meaning that boys who could cycle then outperformed girls who could cycle in this component of fitness. The other significant gender x cycling interactions occurred in the MSFT and standing long jump, where girls in both cycle and non-cycle groups were outperformed comparatively by boys. The difference between boys who could and could not cycle exceeds the difference in girls for cardiorespiratory fitness and power. Boys who could cycle could jump 15.38 cm further than boys who could not, whilst the girl's difference was half this, at 8.83 cm. In the MSFT, the difference was almost double, again, where boys would achieve 9.69 shuttles more if they could cycle and girls 4.18 shuttles.

The strength of the predictions of fitness varied but it was noticeable that the only fitness test where swimming was a stronger predictor than cycling was the 10x5m shuttle run, measuring speed. Children who could swim were 0.92 seconds faster than children who could not; whereas children who could cycle were 0.81 seconds faster than those that could not. In all other fitness tests, being able to cycle had a greater impact on performance than being able to swim.

Table 7: *Results table for model 3 of the multivariate multilevel analysis including Beta values, standard error and p vales.*

	10x5m Run			Speed Bounce			Grip Strength			Sit & Reach			MSFT			Standing Long Jump		
	beta	**SE**	**95% CI**	**beta**	**SE**	**95% CI**	**beta**	**SE**	**95% CI**	**beta**	**SE**	**95% CI**	**beta**	**SE**	**95% CI**	**beta**	**SE**	**95% CI**
Intercept	22.735***	0.39	21.98 – 23.49	30.828***	1.50	27.88 – 33.77	14.716***	0.45	13.83 - 15.60	14.87***	0.93	13.04 – 16.70	14.918***	1.89	11.22 – 18.62	112.942***	2.88	107.29 – 118.59
Age	-0.376***	0.09	-0.54 - -0.21	3.293***	0.41	2.50 – 4.09	1.825***	0.12	1.58 - 2.07	-0.424	0.25	-0.92 - 0.07	3.045***	0.51	2.05 – 4.04	5.794***	0.75	4.32 – 7.27
British Growth Reference (BMI)	0.014***	0.00	0.01 – 0.02	-0.092***	0.01	-0.12 - -0.08	0.035***	0.00	0.03 - 0.04	-0.001	0.01	-0.01 – 0.01	-0.177***	0.01	-0.20 - -0.16	-0.196***	0.01	-0.22 - -0.17
Gender (ref: F)	-0.648	0.38	-1.38 – 0.09	0.804	1.81	-2.75 – 4.36	-0.481	0.56	-1.57 - 0.61	-2.876*	1.15	-5.12 - -0.63	1.143	2.28	-3.33 – 5.61	6.356	3.35	-0.22 – 12.93
Deprivation (WIMD)	0.00	0.00	0.00 – 0.00	0.001	0.00	0.00 – 0.00	0.00**	0.00	0.00 – 0.00	0.00	0.00	- 0.00 – 0.00	0.002**	0.00	0.00 – 0.00	0.001	0.00	-0.00 – 0.00
Sports Club (ref: no)	-0.444**	0.14	-0.72 - -0.17	1.24	0.68	-0.09 – 2.57	0.402	0.21	-0.01 - 0.81	0.95*	0.43	0.12 – 1.78	2.534**	0.85	0.87 – 4.20	1.334	1.26	-1.13 – 3.80
Swim (ref: no)	-0.916***	0.18	-1.27 - -0.57	3.706***	0.86	2.03 – 5.38	0.737**	0.26	0.22 – 1.25	2.202***	0.54	1.15 – 3.26	2.306*	1.08	0.19 – 4.42	6.952***	1.59	3.84 – 10.06
Cycle (ref: no)	-0.813**	0.27	-1.35 - -0.28	4.885***	1.31	2.31 – 7.46	0.833*	0.40	0.05 – 1.62	3.075***	0.83	1.45 – 4.70	4.175*	1.66	0.92 – 7.43	8.828***	2.44	4.05 – 13.60
Gender x Swim (ref: no x F)	0.319	0.25	-0.17 – 0.81	-0.538	1.20	-2.90 - 1.82	-0.28	0.37	-1.01 – 0.45	-0.464	0.76	-1.95 – 1.02	4.846***	1.51	1.88 – 7.81	-0.547	2.23	-4.92 – 3.83
Gender X Cycle (ref: no x F)	-0.553	0.37	-1.29 – 0.18	2.753	1.80	-0.78 – 6.28	1.699**	0.55	0.62 – 2.78	-1.877	1.14	-4.11 – 0.36	5.513*	2.26	1.08 – 9.95	6.554*	3.33	0.02 – 13.09

*p<.05, **p<.01, ***p<.001

Table 8: *The variables included in each model of the multivariate multilevel analysis, -2 Loglikelihood data and p values.*

Variables	**Model 1**	**Model 2**	**Model 3**
Intercept	X	X	X
Decimal Age		X	X
BMI British Growth Reference		X	X
Gender		X	X
Deprivation (WIMD)		X	X
Sports Club		X	X
Swim		X	X
Cycle		X	X
Gender X Swim			X
Gender X Cycle			X
-2 Log Likelihood	86044.904	82774.61	82732.628
Chi^2 (p-value)		<0.001	<0.001

5.4 DISCUSSION

The purpose of this study was to explore relationships between fitness and swimming and cycling proficiency in primary school boys and girls. We hypothesised that (i) being able to swim and cycle would be positively associated with fitness and (ii) there would be gender interactions between boys' and girls' fitness and swimming and cycling abilities.

Being able to swim and cycle were significant predictors of all components of fitness, after controlling for decimal age, BMI, gender, deprivation and sports club attendance. Cycling was a stronger predictor of fitness than swimming for all components of fitness except for the 10x5m shuttle. In addition, gender interactions showed that both cycling and swimming were stronger predictors of cardiorespiratory fitness in boys than girls. Gender and cycling proficiency interactions were evident for strength and power. For cardiorespiratory fitness gender interactions showed that both cycling and swimming were stronger predictors of fitness performance in boys than girls.

The significant predictions outlined above suggest that these movement competencies should be developed as part of the life course to increase fitness and subsequent health. Research has shown that being fit as a child has many benefits, physically, mentally and socially (Bangsbo et al., 2016) together with longitudinal benefits of increased fitness and health into adulthood (Ruiz et al., 2009). In our analysis, the ability to cycle was a stronger predictor of fitness than the ability to swim. Studies have shown positive relationships between cycling and cardiorespiratory fitness in children and subsequent inverse associations with all-cause mortality in adults (Oja et al., 2011). It has previously been implied that children's physical activity behaviours transfer into adulthood (Boreham & Riddoch, 2001). Therefore, encouraging cycling at a young age could contribute to higher fitness levels and quality of life during both childhood and into adulthood.

Across all components of fitness, cycling had larger positive predictions than swimming, apart from the 10x5m shuttle, where the opposite trend was observed. Participation rates, school involvement and accessibility may be influencing factors, with one study showing that only 7% of children reported their school offering cycle lessons/tests (Sustrans, 2015). In Wales, almost 55% of primary school PE coordinators strongly disagreed that their school has sufficient access to bicycles to deliver training, also reporting that swimming was a more widely offered activity during school hours than cycling (Sport Wales, 2018). Despite this emphasis on swimming, in Wales, cycling is more popular outside of school (Sport Wales, 2018). Moreover, the availability of swimming infrastructure including supervision, is less obvious than having space to cycle on the road or in nature. This implies that children who can cycle may have higher fitness levels across all components of fitness than children who can swim because of higher participation rates and possibilities, increasing their physical activity and subsequently fitness (Stodden et al., 2008).

The number of sports clubs attended was taken into consideration in this study, but swimming and cycling are both common leisure-time activities contributing to levels of physical activity (Hulteen et al., 2017). Consequently, the children may have reported no sports club attendance, but may have still participated in swimming and cycling activities in unorganised settings with family and friends. These settings could include cycling to school as it has been found that 5% of children living in a similar area to those in this study cycle to school (Sustrans, 2015). This would have increased their physical activity levels and therefore fallen in line with previous research highlighting the positive association between physical activity and fitness in children (Hall et al., 2018). Therefore, measuring and controlling for physical activity levels would have further strengthened our study.

Our finding that swimming and cycling were significant predictors of all components of fitness could suggest that these skills encompass the fundamental movement skills (FMS) that have previously been associated with fitness (Jaakkola et al., 2019). Recent developments in research surrounding children’s cycling abilities have highlighted that cycling interventions should include activities to improve balance and coordination (Kavanagh et al., 2020). Both balance and coordination are evaluated regularly in common FMS assessments, although usually encompassed in the stability realm. Therefore, if a child can cycle, they are likely to have higher levels of motor competence, particularly balance and coordination.

Although, not the primary aim, we found significant gender interactions for both swimming and cycling with cardiorespiratory fitness. There were no other significant interactions for swimming and gender, whilst cycling and gender interactions were significant for the handgrip test and standing long jump. In these significant interactions, boy's fitness was higher than girls when comparing the "cannot swim/cycle groups" to the "can swim/cycle groups". These gender interactions demonstrate a stronger association between swimming and/or cycling for boys rather than girls. Previous research indicates that girls cycle less frequently than boys (Sport Wales, 2018); resulting in a lower volume of activity that may be insufficient to promote their fitness. Baquet's seminal work (Baquet et al., 2003) demonstrated that activity had to be vigorous to increase fitness in prepubertal children. Thus, the findings may imply that cycling may promote short duration vigorous intensity activity aligned with children's pattern of activity in general and thus for boys at least stimulate an increase in fitness. These gender interactions imply that being able to swim and/or cycle promotes boy's fitness more so than girls. Moreover, if boys swim and cycle more often than girls throughout childhood and adolescence then the gender gap in fitness that has previously been reported (Tyler et al., 2019) will grow.

Collectively, previous studies comparing boys and girl's fitness levels show that boy's fitness is higher than girls, with the exemption of flexibility and balance (Marta et al., 2012). However, our study found that for some components of fitness girl's results were higher than boys. Girls in the "could not swim" and "no cycle" groups achieved, higher grip strength scores than boys in the same respective group. This suggests that previous research that has identified boys as being stronger than girls (Omar et al., 2018) may have only used children with high levels of motor competence or did not account for foundational movement skills, which are rarely measured (Hulteen et al., 2018). Although our study did include the movement skills of cycling and swimming, the data did not include quality of the skill, frequency, intensity or time, which is considered a limitation of the study.

Having the ability to swim and cycle are strongly associated with children's fitness levels, particularly their cardiorespiratory fitness. Cardiorespiratory fitness has been strongly associated with health outcomes. Therefore, swimming and cycling, and their associated skills such as balance and coordination should be developed and encouraged from a young age. These activities will not only improve fitness levels but also expand the range of activities and leisure time opportunities that children can participate in due to the development of specific movement skills, balance and coordination. Schools should continue to offer swimming lessons and incorporate cycling based programmes into their physical education curriculum to remove any common barriers; including affluence (Sport England, 2019) and parents swimming ability (Irwin et al., 2009). Given the health benefits of sport in general, and specifically swimming and cycling, designing learning environments that offer a rich and safe landscape of outdoor and indoor opportunities is important. This will serve to promote lifelong participation in the plethora of water related activities and for cycling as active transport and recreational or competitive sport practice.

To our knowledge, this is the first study to have examined swimming and cycling proficiency and their association with children's fitness. The main strengths of this study include a large sample size, across two contrasting geographical locations, Swansea and Bridgend, in South Wales, while controlling for other variables such as deprivation, age, BMI and sports club attendance. Furthermore, this study also measured and analysed multiple fitness measures to allow for a deeper understanding of the associations of swimming and cycling on fitness. In addition, a multilevel analysis approach was used to consider the variation between schools. Nevertheless, the following limitations are acknowledged. Although the study uses data over a 5-year period, it is cross sectional and so does not have the strengths that a longitudinal study has and is therefore not possible to establish a cause and effect of the associations that have been established. Self-reported sports club attendance and proficiency for swimming and cycling was reported using a dichotomous scale (yes/no) and did not consider the degree of proficiency or the frequency and intensity of participation. More detailed assessment of cycling and swimming competence using the national cycling standards or British Swimming (formally Amateur Swimming Association, ASA) achievement metrics such as aquatic skills or distance achieved would allow for further interpretation of these findings; although existing assessment methods for measuring children's swimming competence are limited (Chan et al., 2020) and do not cover the wider activity of aquatic competence. Device based measures of activity during cycling or swimming would also permit greater insight into the patterns, frequency, intensity and duration of cycling and swimming. Future studies should therefore focus on including more detailed swimming and cycling skills, frequency of participation as well as other physical activity, sport, dance and play behaviours that are related to fitness.

5.5 Conclusion

In conclusion, swimming and cycling abilities are associated with all components of fitness and may have several implications in the field of motor development, fitness and physical activity. The ability to swim and cycle can be considered as important "milestones" in the journey of motor development and our results suggest these abilities are positively associated with fitness levels. Children should therefore be encouraged to participate in cycling and swimming regularly, executing more complex motor/aquatic skills at more advanced levels in appropriate learning situations to facilitate transfer of learning (Guignard et al., 2020). Moreover, barriers to participation should be reduced to allow maximum exposure, allowing for optimal development of motor skill, fitness and health. Being proficient in swimming or cycling is associated with fitness regardless of whether a sports club is attended or not. Therefore, physical activity promotion should not only focus on sufficient levels of physical activity, but also on supporting the development of foundational movement skills.

THESIS MAP

	Study		Outcomes
1	Wales 2021 Active Healthy Kids (AHK) Report Card: The Fourth Pandemic of Childhood Inactivity	***Aim***	To summarise the findings of the Active Healthy Kids Wales 2021 Report Card process and to present and interpret the results for physical activity domains for children and young people.
		Key Findings	Grades ranged from F for overall physical activity and sedentary behaviour indicators, through to a B- for the school indicator. All but three grades remained the same or decreased from the 2018 version of the Report Card and it was the first time that Wales did not have any inconclusive grades.
2	Associations Between Swimming & Cycling Abilities and Fitness In 9–11-Year-Old Boys and Girls	***Aim***	To examine the associations between fitness and swimming and cycling proficiency in primary school boys and girls.
		Key Findings	All components of physical fitness were associated with swimming and cycling abilities when accounting for age, BMI, deprivation, gender, and sports club attendance. There were also gender interactions visible with cardiorespiratory fitness, grip strength and power.
3	Motor Competence Between Children with and without Additional Learning Needs: A Cross Sectional Population-Level Study	***Aim***	To explore motor competence in children with and without additional learning needs at a population-level.
		Key Findings	
4	A Socioecological Perspective of how Physical Activity and Sedentary Behaviour at Home Changed during the First Lockdown of COVID-19 Restrictions: HomeSPACE Project	***Aim***	
		Key Findings	
5	Qualitative Changes in Children's Physical Activity and Sedentary Behaviours Throughout the COVID-19 Pandemic: The HomeSPACE Project	***Aim***	
		Key Findings	

6 STUDY 3 - MOTOR COMPETENCE BETWEEN CHILDREN WITH AND WITHOUT ADDITIONAL LEARNING NEEDS: A CROSS SECTIONAL POPULATION-LEVEL STUDY

6.1 INTRODUCTION

In children, the physiological and psychosocial benefits of achieving sufficient levels of physical activity have been well documented (World Health Organization, 2018). However, in Wales, United Kingdom (UK), only 14% to 22% of children achieve the recommended levels of physical activity (Richards et al. 2022). This is of particular concern given the positive association between physical activity and motor competence (Stodden et al., 2008), defined as 'a person's ability to execute a wide range of motor acts in a proficient manner, including coordination of fine and gross motor skills that are necessary to manage everyday tasks, such as walking, running, jumping, catching, throwing, kicking, and rolling' (Morano et al. 2020, p. 1). Motor competence is an important marker of children's health and development, with research showing children with high motor competence accrue benefits on physical fitness, healthy weight-status, bone density, executive functioning, and academic attainment, together with overall physical activity (Duncan et al. 2022; López-Bueno et al. 2021; Robinson et al. 2015; Barnett et al. 2022; Stodden et al. 2008). Moreover, there are long-term impacts that promoting motor competence has on future physical activity opportunities (Lima et al., 2019; Stodden et al., 2008), as children who are more proficient in their motor competence are associated with having a higher quality of life as an adult (Robinson et al., 2015). It is therefore important to develop motor competence in children to promote immediate health and well-being that can track into adulthood (Loprinzi et al., 2015).

Given the importance of motor competence for children's health, well-being and development, it is surprising that few studies have reported national levels of directly measured motor competence (Opper et al., 2022). Surveillance approaches are essential to track trends, identify inequalities, and for developing effective approaches to enhance children's motor competence. As a result, recent research has focussed on the development of motor competence assessments that can be implemented at scale (Hulteen et al., 2020). Common assessment methods include tests which assess discrete skills in isolation, such as the Test of Gross Motor Development (TGMD-3; Ulrich, 2017) and Movement-ABC (M-ABC; Henderson, Sugden, and Barnett, 2007). More recently, dynamic assessments have been validated, such as the Dragon Challenge (Tyler et al. 2018), the Canadian Agility and Movement Skill Assessment of Physical Literacy (CAMSA; Longmuir et al. 2017), and the Athletic Skills Track (Hoeboer et al. 2017). The Dragon Challenge and CAMSA assess a range of combined and complex movement skills (Whitehead, 2010) through a continuous dynamic obstacle course, and aim to provide a more authentic assessment environment to emulate the multi-skill and sports activities that are developmentally appropriate for older children and adolescents. Furthermore, these circuit-based measures enable the assessment of large groups of children in a short time, making them more feasible for collecting population-level data on motor competence (Bardid et al., 2019; Hulteen et al., 2020).

Several studies have examined biological and demographic correlates of motor competence in children and adolescents. Age has been strongly positively correlated with motor competence (Barnett et al. 2010; Spessato et al. 2013), whilst body mass index (BMI) has been negatively correlated with motor competence (Hondt et al., 2009; Morano et al., 2011). Sex has shown inconsistent results (Barnett et al. 2016), with some studies showing no differences (Barnett et al. 2012; Barnett et al. 2013), but others indicating that being a girl is correlated with stability skills (Olesen et al., 2014; Venetsanou & Kambas, 2011) and being a boy correlated with object control and locomotor skills (Robinson, 2011; Spessato et al., 2013). Ethnicity and socioeconomic status (SES) research in this area remains in its infancy. Yet, significant differences in motor competence have been reported between SES (Woodard and Yun, 2001; Habib, Westcott, and Valvano, 1999) in total, fine and gross motor competence (Morley et al., 2015) and in stability, but not object control (D'Hondt et al. 2009). Early research found no significant differences between ethnicities in motor competence (Kenzie et al. 2002), although more contemporary research has shown that children identifying with a South Asian ethnicity had poorer locomotor skills than children from a white or black ethnic background (Adeyemi-Walker et al. 2018; Eyre, Walker, and Duncan, 2018).

Another demographic group that may need targeted support for motor competence interventions concerns children with additional learning needs (ALN). In Wales, ALN is used as an umbrella term within the education system to describe any child who has a learning difficulty or disability that requires additional learning provision (Welsh Government, 2022b). The term ALN recently replaced the label ‘special educational needs and disability’ (SEND) and aims to reflect a more holistic approach to supporting children with difficulties. According to the 2022 school census in Wales, 15.8% of the child population had ALN (Welsh Government, 2022a), which is in line with global figures of 15% of the world’s population experiencing some form of disability (World Health Organization and World Bank. 2011). The Welsh Census (Welsh Government, 2022a) highlights that the most reported type of additional learning needs are ‘speech, language and communication difficulties’ at 4.8%, followed closely by ‘behavioural, emotional and social difficulties’ at 4.6%, ‘general learning difficulties’ at 2.9%, ‘moderate learning difficulties’ at 2.6% and ‘Autistic Spectrum Disorder’ (ASD) at 2.1%. To our knowledge, no studies have compared motor competence in children with additional learning needs (ALN) with typically developing children at a population-level, using an objective, dynamic measure.

To date, research exploring motor competence and disabilities has generally focussed on clinical populations, such as children with ASD (Pan, Tsai, and Chu 2009), Attention Deficit Hyperactivity Disorder (ADHD; Villa 2018), Down Syndrome (Volman et al., 2007) and CHARGE syndrome (Perreault et al. 2021), concluding children living with these health conditions have poorer fundamental movement skills than typically developing children. Indeed, a recent systematic review highlighted research on intellectual disabilities (ID) and fundamental movement skills within the child and adolescent population (Maïano, Hue, and April, 2019) and concluded that although children with ID showed deficits in their fundamental movement skills, there is a dearth of research on ALN and motor competence at a population-level. Research to date is limited as studies on clinical populations have a low number of participants (Downs et al., 2020) and none have used dynamic assessment measures that are relevant for investigating motor competencies that are developmentally appropriate for older children. An example of this includes a study where most children with ASD (82%) showed significant motor delays using the M-ABC assessment, however, this study only included used 51 children, of which only five were girls (Liu et al., 2019). Similarly, a systemic review investigating the impact of medication on ADHD children and their motor skills also cited its limitations as small sample sizes and a lack of female participants (Kaiser et al., 2015). One population-level study did focus on the coordination element of motor competence, between children with and without ADHD (Opper et al. 2022), finding significant differences over time. Children with ADHD had lower coordination performance than children without ADHD and these differences persisted over the 11-year period. Nevertheless, population-level data comparing levels of motor competence among children with and without ALN is required to provide a deeper understanding of motor behaviours and abilities within this large proportion of the population.

Despite almost a sixth of children in Wales having an ALN, there remains a paucity of research within this large population. Studies investigating motor competence in children with ALN, in comparison to typically developing children, are urgently needed given the relationship between physical activity, motor competence, health and well-being (Stodden et al., 2008). The aim of this study therefore was to explore motor competence in children with and without ALN at a population-level.

6.2 METHODS

6.2.1 Study Design and Participants

This study was of cross-sectional design conducted between November 2014 and November 2016. In total, 4,555 children from 65 schools across all regions of Wales participated in the Dragon Challenge surveillance project to assess children's motor competence. Children were invited to take part in the study and written consent was gained from parents, headteachers and assent from children. Ethics approval was granted by the lead authors institution (PG/2014/39).

6.2.2 Measures

6.2.2.1 The Dragon Challenge

The Dragon Challenge is a valid, reliable, and dynamic measure of motor competence in children aged 10 to 14 years. The development of the Dragon Challenge took nearly five years and included a full and inclusive group of stakeholders and a representative group of children that included 20% with ALN (Tyler et al, 2018). The Dragon Challenge has been validated at a population-level including children with various ethnic backgrounds, socioeconomic status and those with and without ALN (Tyler et al, 2018). All measures were conducted in accordance with Tyler et al. (2018), and the Dragon Challenge manual (Appendix V). Briefly, the Dragon Challenge comprises of nine tasks including three stability tasks (balance bench, core agility, wobble spot), three object control tasks (overarm throw, basketball dribble, underarm throw and catch) and three locomotor tasks (T-run, jumping pattern and a sprint finish). Children watched a demonstration of the full Dragon Challenge and practiced each task in isolation, before having a single attempt at the full Dragon Challenge. The Dragon Challenge is a hybrid-based assessment of motor competence that uses equally weighted process (quality of technique), product (successfully achieve task goal) and time scores (time taken to complete circuit) to provide an overall score out of 56. This score is then given a category ranging from Bronze through to Platinum. All assessments were conducted in-situ by trained assessors who received standardised training (at least five hours) to implement the Dragon Challenge assessment. Assessors also had no prior knowledge of the children's movement capabilities or physical activity levels. The Dragon Challenge has previously shown good inter- and intra-rater reliability among assessors (Tyler et al., 2018).

6.2.2.2 Confounding Variables

Demographic characteristics, such as date of birth, sex, ethnicity, free school meal status (as a proxy measure of SES) and ALN were obtained from school demographic records. Date of birth was used to calculate the children's decimal age, whilst ethnicities were categorised into ‘White’, ‘Asian’, ‘Black’, ‘Mixed’, and ‘Other’. There was no consistent sub-categorisation of ALN between the schools; some using categories such as ‘school action,’ ‘school action +,’ ‘statemented,’ and ‘no provision,’ whilst others simply used ‘yes’ or ‘no’. As such, this variable was collapsed into a dichotomous (yes or no) response.

6.2.3 Statistical Analysis

Of the 4,555 participants, a total of 3,489 participants (11.4 ± 0.6 years; 49.4% boys) from 55 schools were eligible for analyses. Data were excluded for participants missing school-level data (n=175), demographic data (n=750) or where there were errors, outliers or missing data in the scores that were recorded (n=123). Children whose recorded time was greater than four minutes (n=18; 0.4%) were also removed from the analyses. Those participants whose data was excluded were similar to those used in the final analysis. Children were able to score zero, one, two, three or four on each Dragon Challenge task. Each of the nine task scores were subsequently collapsed into two categories, ‘proficient’ which encompassed scoring a 4 and ‘not proficient’, which included scoring a 0, 1, 2 or 3, these were the dependent variables within the study.

Given that the data was collected across multiple schools, it was possible that children from the same school share similar motor competence profiles. Between component variance showed that schools accounted for between 4% and 23% of the variance in the dependent variables. Therefore, to account for the nested structure of the data, in conjunction with the proportional odds assumption not being met, a multi-nominal multi-level model, using Markov Chain Monte Carlo (MCMC) estimations, with a random intercept, was fitted to investigate whether there were significant associations in motor competence between children of different ages, ethnicities, SES and those with and without ALN. MCMC was due to the estimates being less biased and it being valid to apply to new models (Green et al., 2015). Six models were fitted sequentially using, MLwiN (version 3.05; Charlton et al. 2020). First, a single-level “null model” was fitted (model 1) followed by another “null model” but this time with the individual and school-level structure fitted (model 2). The main variable of interest, ALN, together with covariates (decimal age, ethnicity, free school meal status and sex) were then added (model 3), including a random intercept at the school level to account for the school-level variance. Models were also explored for ALN and decimal age interactions (model 4), ALN and free school meal interactions (model 5) and ALN and sex interactions (model 6). The Deviance Information Criteria (DIC) values were compared to ensure that the most appropriate model was used for analysis (Li, Yu, and Zeng, 2021). Model three has been reported as the final model as the interaction effects did not result in a significant improvement in DIC. The alpha level for significance was set at $p<0.05$ for all analyses and the Wald statistic was used within MLwiN to calculate significance. The regression coefficient was used to calculate odds ratios, using the exponentiate function in Microsoft Excel. Coefficients, standard error, and credible intervals at 2.5% and 97.5% for all models were also reported.

6.3 RESULTS

Descriptive data are included in Table 9. To summarise, the children had a mean age of 11.4 ± 0.6 years. Almost 94% of the children were of white ethnic origin, the remaining 0.8%, 2.7%, 1.6% and 1.1% being Black, Asian, Mixed, and other ethnicities. A fifth of children were classed as having ALN, whilst less than one in six were entitled to free school meals.

Table 10 shows means and standard deviations for tasks split by sex, ethnicity, ALN and free school meal status. Using mean scores, girls scored higher than boys in balance bench, core agility, wobble spot and jumping patterns. More affluent children scored higher than children entitled to free school meals in all tasks, apart from the overarm throw where the opposite was true, and the basketball dribble in which there were no differences between the groups. In all tasks, typically developing children performed better than their peers with ALN.

The DIC value for each regression model (1 through 3) decreased (Table 11). Therefore, the best fitting model, model 3 provided the main results in the form of odds ratios (OR) and significance values (Table 12). Results hereon in are discussed on a task-by-task basis.

6.3.1 Balance Bench

For the balance bench task, when accounting for age, ethnicity, free school meal status and sex, typically developing children were 35% more likely to be proficient in the balance bench than their peers with ALN (OR=1.35; $p \leq 0.01$). Older children were significantly less likely to be proficient than younger children (OR=0.92, $p<0.05$); whilst Asian children were significantly less likely to be proficient than while children (OR=0.65; $p<0.05$). Girls were 19% more likely to be proficient than boys (OR=1.19; $p \leq 0.01$).

6.3.2 Core Stability

Similar to the balance bench task, when controlling for age, ethnicity, free school meal status and sex, children who did not have ALN were 65% more likely to be proficient in the core stability task (OR=1.65; $p<0.001$) than their peers who had ALN. Older children were significantly more likely to be proficient than their younger peers (OR=1.20, $p<0.001$). Asian children were significantly less likely to be proficient than white children (OR=0.43; $p \leq 0.01$); whilst children not entitled to free school meals were significantly more likely to be proficient than less affluent children (OR=1.40, $p \leq 0.01$). Girls were significantly more likely to be proficient than boys (OR=1.64; $p<0.001$).

6.3.3 Wobble Spot

After accounting for age, ethnicity, sex, and free school meal status, typically developing children were 91% more likely to be proficient than children with ALN (OR=1.91; $p<0.001$). There were no significant sex or SES associations. For each year a child aged, they were 29% more likely to be proficient than younger children (OR=1.29; $p<0.001$).

Asian children were significantly less likely to be proficient than white children (OR=0.63, $p<0.05$).

6.3.4 Overarm Throw

When controlling for age, ethnicity, sex and free school meal status, typically developing children were 29% more likely to be proficient than children with ALN (OR=1.29; $p\leq0.01$).The overarm throw task showed that older children were significantly more likely to be proficient than their younger peers (OR=1.27; $p<0.001$), whilst boys were also more likely to be proficient than girls (OR=0.31; $p<0.001$).

6.3.5 Basketball Dribble

Children with no additional needs were 49% more likely to be proficient than children with ALN (OR=1.49; $p<0.001$), after controlling for age, ethnicity, sex and free school meal status. The basketball dribble was performed more proficiently in older children than their younger peers (OR=1.35; $p<0.001$). Asian children were less likely to be proficient than white children (OR=0.50; $p<0.001$) and girls were less likely to be proficient than boys (OR=0.38; $p<0.001$).

6.3.6 Underarm Throw and Catch

The model controlled for age, ethnicity, sex and free school meal status and results revealed that typically developing children were more likely to be proficient than their peers with ALN (OR=1.25; $p\leq0.01$). Older children were more likely to be proficient than younger children (OR=1.16; $p<0.001$), along with girls being less proficient than boys (OR=0.43; $p<0.001$).

6.3.7 T-Run

Typically developing children were 34% more likely to be proficient than children with ALN (OR=1.34; p≤0.01) when controlling for age, ethnicity, sex and free school meal status, whilst girls were less likely to be proficient than boys (OR=0.84; p<0.05). Older children were more likely to be proficient than younger children (OR=1.42; p<0.001). Black children were 4.3 times more likely to be proficient than white children (OR=4.38; p<0.001), whilst children categorised as 'other' ethnicity were less likely to be proficient than white children (OR=0.25; p≤0.01). This was one of only four tasks where significant associations between SES were evident; children entitled to free school meals were 43% less likely to be proficient than their more affluent peers (OR=1.43; p≤0.01).

6.3.8 Jumping Patterns

When accounting for age, ethnicity, sex and free school meal status, typically developing children were 58% more likely to be proficient than children with ALN (OR=1.58; p<0.001), while Asian children were less likely to be proficient in jumping patters than white children (OR=0.38; p<0.001). Older children were significantly more likely to be proficient than younger children (OR=1.07, p<0.05); whilst children who weren't entitled to free school meals were more were more likely to be proficient than children who were (OR=1.19, p<0.05).

6.3.9 Sprint Finish

Typically developing children were more likely to be proficient than children with ALN (OR=1.47; p<0.001), after controlling for age, ethnicity, sex and free school meal status, whilst girls were less likely to be proficient than boys (OR=0.65; p<0.001). Older children were more likely to be proficient than younger children (OR=1.17, p<0.001); whilst Asian children were less likely to be proficient than white children (OR=0.44; p<0.001). More affluent children were 40% more likely to be proficient than children eligible for free school meals (OR=1.40; p≤0.001).

Although, not the primary aim, we also looked at the interaction effects with age, sex and SES. However, the inclusion of interaction effects did not significantly improve the model suggesting that the effects of having ALN on motor competence are not significantly different across boys and girls, SES and ages.

6.4 DISCUSSION

The purpose of this study was to ascertain whether there were population-level associations in motor competence, between typically developing children and children with ALN, using a dynamic assessment tool. We hypothesised that children with ALN would be less proficient in motor competence tasks than their typically developing peers.

When controlling for age, sex, ethnicity, and SES, typically developing children were more likely to be proficient in all Dragon Challenge tasks than children with ALN. Specifically, for balance and stability tasks it could be postulated that such differences are evident due to the range of contexts where balance and stability skills can be developed, such as organised sporting opportunities and through habitual activity, unlike object control skills (Drenowatz, 2021). Indeed, recent evidence suggests children with additional needs achieve less habitual physical activity such as running and jogging than typically developing children (Sport Wales, 2022), which may, at least in part, reduce their proficiency in these skills.

Children with ALN were less proficient in object control skills than their typically developing peers; this is in accord with previous research which found that children with intellectual disability (ID) have poorer object control skills than their typically developing peers (Westendorp et al., 2011). The object control skills incorporated within the Dragon Challenge, can all be developed through exposure to organised sporting opportunities, such as basketball, cricket, or rounders. Congruent with previous research which suggested that the popularity of ball games for children and adolescents may play a part in the motor competence of object control skills (Barnett et al. 2009), the basketball dribble was, on average, a high-scoring task. Recent data from the Active Lives Children Survey reinforce this, where team sports, the majority being ball games, were the most prevalent type of activity for 11-16-year-olds and the second most prevalent, only behind active play and informal activity, for 7-11-year-olds (Sport England, 2022). Having established that object control skills are developed through organised sporting opportunities and skilled instruction (Drenowatz, 2021; Lubans et al., 2010), it has been identified that children with ID, and presumably ALN, participate significantly less in organised sport than typically developing children (Westendorp et al., 2011). This is also evident in Wales, where only 34.5% of children with any learning difficulty participate in sporting activities three times per week, compared to 41% of children with no learning difficulty (Sport Wales, 2022). Of interest, this same survey highlighted that for children with ALN, basketball was identified as the second most popular sport by demand, after swimming.

The last category of skills were the locomotor skills, consisting of a T-run, jumping patterns and sprint finish. Typically developing children were significantly more likely to be proficient in these tasks than children with ALN. In this section of skills there was the overall average lowest score (T-run, 2.00) and the overall average highest score (sprint finish, 3.42). However, again, children with ALN were less proficient at these locomotor tasks, consistent with previous research in children with ID (Westendorp et al., 2011) and learning disabilities (Woodard and Surburg, 2001).

Although the focus of this paper was on motor competence in children with and without ALN, there were also other between-group analyses that provide informative insights. The present study found that object-control skills were better in boys than girls, which is in accord with Barnett et al. (2016) meta-analysis. Whilst boys outperformed girls in object control skills, the opposite was the case in stability skills, a finding which has previously produced equivocal results, with some studies consistent with this study (Sigmundsson & Rostoft, 2003) and others showing no differences (Butz et al., 2015). Locomotor skills showed mixed results with two tasks showing boys to be more proficient and one where girls were more proficient which is consistent with other work (Barnett et al. 2016). Despite being a cross-sectional study, children’s age also affected performance where older children were more proficient than the younger children in eight out of nine tasks, concordant with Barnett et al. (2016). Socioeconomic status and ethnic groups also performed differently. The present study revealed that more affluent children were significantly more likely to be proficient at four of the tasks than their peers who receive free school meals similar to the findings of (McPhillips & Jordan-Black, 2007). In two-thirds of the tasks children who identified as having Asian ethnicity were less likely to be proficient than white children, in agreement with other studies (Adeyemi-Walker et al., 2018; Eyre et al., 2018).

A key message consistent across all tasks for children in any group, is the level of exposure that they have to certain activities, and this is based on opportunities provided. In Wales, only 9.6% of primary schools strongly agreed that staff members have enough support to engage with pupils with ALN when delivering physical education and sport (Sport Wales, 2022); this figure doubles to 20.8% in secondary schools, however, early exposure to appropriate movement and physical education is imperative for children to develop adequate levels of motor competence which can lead to lifelong health-promoting physical activity (Fisher et al., 2005b). The exposure to activity theme continues, where it is almost expected that boys will be more proficient in object control skills and girls in stability skills as in secondary schools in Wales, 21.2% of basketball sessions are male only, compared to only 7.7% that are female only. Conversely, gymnastics sessions with 5.2% and 11.0% male and female only, respectively.

Despite the lack of available data on children with ALN and motor competence, there are several intervention studies that have focussed on children with a range of disabilities. One systematic review summarised 14 motor skill interventions on fundamental movement skills in children with varying levels of ID (Maïano, Hue, and April 2019), which all used a range of methods from Wii Fit training (Abdel Rahman, 2010) to strength and balance activities (Borji et al., 2018) and adapted play training (Malekpour et al., 2012). Despite significant improvements in balance or stability skills and in overall fundamental movement skills, these sample sizes were small. Interventions should be placed with larger ALN groups to assess any motor competence improvements with representative cohorts.

To our knowledge, this is the first study to provide a population-level analysis of children with ALN using a dynamic assessment of motor competence. The main strengths of this study include a large nationally representative sample size, across all four regions of Wales, whilst collecting demographic data, such as free school meals and age. Furthermore, this study used a multi-level analysis approach to account for the variation between schools and calculated odds ratios to indicate the practical implications of the results. Nevertheless, the following limitations are acknowledged. Odds ratios cannot be compared between studies and therefore they cannot be synthesised within a meta-analysis (Norton et al., 2018). However, the Beta coefficients would allow meta-analyses to use the data. Socioeconomic status was measured through free school meal status which is a crude measure compared to indices of multiple deprivation used in other studies (Richards et al. 2022; Swindell et al. 2021). Although motor competence is correlated with other variables in this study, physical activity, fitness, and motor competencies such as swimming and cycling were not directly measured and could have an impact on motor competence scores in the Dragon Challenge. Another limitation includes that it is not evident as to what level of ALN the child has, as there was no consistent sub-categorisation within the data, therefore, the data was collapsed into a dichotomous variable. Having an insight into the type and severity of ALN, could provide a greater depth of understanding within this study. However, this approach provides a population measure of health and also aligns with current policy on managing learning needs in school, where they are grouped in a single ALN category.

Considering the strengths and limitations, further studies should focus on providing nationwide, longitudinal insight into children’s motor competence. Such research would need a representative sample including children from multiple levels of deprivation, various ethnicities, and a reasonable proportion of children with ALN. Given the proportion of children who encompass the broad range of the ALN population, more focus should be given to this group and intervention studies, should not only focus on a clinical population but also this broad ALN category to further reduce inequalities. Additional studies should also consider the role of process and product scores on children of varying abilities and how these scores could impact on any differences highlighted.

This research suggests that children with ALN require additional support and investment in improving motor competence, which should be made at an early age and in an inclusive setting, such as the school environment. Despite being a cross-sectional study, children’s scores increased with age suggesting that any investments that are being made in children’s motor competence across time are effective, but not consistent among children with differing abilities, SES and between boys and girls. Research and application in this area is gaining momentum as a recent expert statement from the UK and Ireland, emphasized these differences and provided recommendations for reducing these inequalities (Duncan et al., 2022).

In conclusion, children's motor competence at a population-level is yet to be included in children's health and well-being data, therefore this study not only provides a basis but highlights that typically developing children are significantly more proficient than children with ALN. Policy makers should consider, and indeed develop, specific recommendations to provide the foundation for ensuring that inequalities in children's motor competence are minimised and investments made in addressing this gradient.

Table 9: *Participant characteristics*

Variable	All		Boys		Girls	
	Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**
Gender			1722	49.4	1767	50.6
Age						
8 years	5	0.1	3	0.2	2	0.1
9 years	65	1.9	40	2.3	25	1.4
10 years	705	20.2	363	21.1	342	19.4
11 years	2342	67.1	1136	66.0	1206	68.3
≥12 years	372	10.7	180	10.5	192	10.9
Ethnicity						
White	3273	93.8	1615	93.8	1658	93.8
Black	27	0.8	12	0.7	15	0.8
Asian	94	2.7	41	2.4	53	3.0
Mixed	55	1.6	30	1.7	25	1.4
Other	40	1.1	24	1.4	16	0.9
ALN						
No	2784	79.8	1296	75.3	1488	84.2
Yes	705	20.2	426	24.7	279	15.8
Free School Meals						
No	2943	84.4	1442	83.7	1501	84.9
Yes	546	15.6	280	16.3	266	15.1

Table 10:*The mean (M), standard deviation (SD) and percentage proficient (%) for each task, split by sex, ethnicity, Free School Meal (FSM) status and Additional Learning Needs (ALN) status.*

	Balance Bench			**Core Agility**			**Wobble Spot**			**Overarm Throw**			**Basketball Dribble**			**Underarm Throw & Catch**			**T-Run**			**Jumping Patterns**			**Sprint Finish**		
	M	SD	%	M	SD	%	M	SD	%	M	SD	%	M	SD	%	M	SD	%	M	SD	%	M	SD	%	M	SD	%
All	2.22	1.55	38.7	2.34	1.38	24.8	2.09	1.92	47.9	2.28	1.42	30.5	2.64	1.54	46.4	1.70	1.70	31.4	2.00	1.55	21.6	2.73	1.51	49.4	3.42	0.88	62.6
Boys	2.14	1.55	36.4	2.18	1.39	20.3	2.08	1.92	47.1	2.67	1.32	41.9	2.91	1.46	57.1	2.05	1.72	40.0	2.03	1.56	23.2	2.66	1.55	48.7	3.50	0.83	67.2
Girls	2.29	1.54	40.9	2.50	1.35	29.1	2.10	1.93	48.7	1.90	1.40	19.4	2.38	1.58	36.0	1.35	1.61	23.1	1.96	1.55	20.0	2.80	1.46	50.1	3.35	0.91	58.1
White	2.23	1.55	39.2	2.35	1.38	25.5	2.11	1.92	48.4	2.29	1.41	30.9	2.65	1.54	46.6	1.70	1.70	31.4	2.00	1.56	21.9	2.75	1.50	50.4	3.44	0.86	63.4
Black	2.63	1.45	44.4	2.37	1.12	14.8	2.11	1.93	48.1	2.26	1.40	25.9	2.59	1.65	51.9	1.26	1.63	22.2	2.48	1.63	37.0	2.70	1.49	44.4	3.41	1.15	70.4
Asian	1.84	1.53	29.8	2.04	1.32	12.8	1.52	1.89	35.1	2.05	1.34	21.3	2.27	1.63	35.1	1.61	1.72	30.9	1.79	1.42	10.6	1.96	1.49	23.4	2.93	1.08	38.3
Mixed	2.05	1.52	30.9	2.47	1.20	18.2	1.82	1.98	43.6	2.13	1.52	30.9	2.80	1.60	54.5	1.95	1.70	36.4	2.24	1.54	25.5	2.91	1.32	47.3	3.33	0.86	52.7
Other	1.88	1.49	27.5	2.10	1.26	15	1.90	1.95	42.5	2.13	1.44	25.0	2.65	1.44	42.5	1.70	1.71	32.5	1.58	1.39	7.5	2.58	1.50	42.5	3.33	1.05	60.0
FSM (N)	2.23	1.55	39.2	2.39	1.37	26.1	2.12	1.92	48.5	2.28	1.42	30.6	2.64	1.54	46.0	1.71	1.69	31.5	2.04	1.55	22.6	2.77	1.50	50.6	3.45	0.86	64.3
FSM (Y)	2.12	1.54	36.1	2.08	1.39	17.8	1.94	1.93	44.7	2.30	1.41	30.0	2.64	1.56	48.7	1.61	1.74	31.3	1.75	1.55	16.1	2.55	1.55	43.2	3.26	0.96	53.5
ALN (N)	2.27	1.54	40.0	2.43	1.36	26.9	2.19	1.92	50.5	2.31	1.41	30.6	2.70	1.51	47.1	1.71	1.70	31.8	2.02	1.55	22.1	2.82	1.47	51.9	3.47	0.84	64.5
ALN (Y)	2.02	1.58	33.5	2.01	1.39	16.3	1.69	1.89	37.4	2.20	1.44	29.9	2.42	1.64	43.7	1.65	1.69	29.9	1.89	1.55	19.9	2.37	1.60	39.6	3.23	1.00	55.2

Table 11: *The Deviance Information Criteria (DIC) for each model built.*

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Balance Bench	4658.836	4632.459	4619.820	4620.687	4617.389	4619.981
Core Agility	3910.001	3775.699	3715.943	3709.362	3714.668	3708.826
Wobble Spot	4832.631	4728.511	4678.374	4681.959	4681.005	4681.185
Overarm Throw	4293.612	4226.323	4011.409	4011.785	4015.564	4012.960
Basketball Dribble	4821.041	4721.006	4517.451	4517.538	4520.416	4518.480
Underarm Throw & Catch	4346.470	4311.087	4193.697	4191.132	4195.619	4194.462
T-Run	3644.146	3394.667	3375.390	3374.976	3373.000	3375.917
Jumping Patterns	4838.390	4625.221	4599.997	4600.737	4603.652	4601.199
Sprint Finish	4614.999	4384.170	4326.726	4329.427	4326.539	4329.327

Table 12: *Model 3 odds ratios with significance levels indicated as follows: $p \leq 0.05$=ns, $p \leq 0.05$=a, $p < 0.01$=b, $p \leq 0.001$=c. Note: Reference is not proficient, reference ethnicity is white, reference free school meal is yes, reference ALN is yes, reference sex is boy.*

	Balance Bench	Core Agility	Wobble Spot	Overarm Throw	Basketball Dribble	Underarm Throw & Catch	T-Run	Jumping Patterns	Sprint Finish
Decimal Age	0.92[a]	1.20[c]	1.29[c]	1.27[c]	1.35[c]	1.16[c]	1.42[c]	1.07[a]	1.17[c]
Ethnicity_Asian	0.65[a]	0.43[b]	0.63[b]	0.68	0.50[c]	0.87	0.64	0.38[c]	0.44[c]
Ethnicity_Black	1.27	0.45	1.42	0.79	0.82	0.50	4.38[c]	1.09	2.00
Ethnicity_Mixed	0.66	0.63	0.76	1.01	1.20	1.13	1.31	0.94	0.69
Ethnicity_Other	0.63	0.63	0.81	0.61	0.62	0.91	0.25[b]	0.92	0.94
Free School Meal	1.11	1.40[b]	1.03	1.05	0.86	1.02	1.43[b]	1.19[a]	1.40[b]
ALN	1.35[c]	1.65[c]	1.91[c]	1.29[b]	1.49[c]	1.25[b]	1.34[b]	1.58[c]	1.47[c]
Sex	1.19[b]	1.64[c]	1.03	0.31[c]	0.38[c]	0.43[c]	0.84[a]	1.07	0.65[c]

THESIS MAP

	Study		Outcomes
1	Wales 2021 Active Healthy Kids (AHK) Report Card: The Fourth Pandemic of Childhood Inactivity	***Aim***	To summarise the findings of the Active Healthy Kids Wales 2021 Report Card process and to present and interpret the results for physical activity domains for children and young people.
		Key Findings	Grades ranged from F for overall physical activity and sedentary behaviour indicators, through to a B- for the school indicator. All but three grades remained the same or decreased from the 2018 version of the Report Card and it was the first time that Wales did not have any inconclusive grades.
2	Associations Between Swimming & Cycling Abilities and Fitness In 9–11-Year-Old Boys and Girls	***Aim***	To examine the associations between fitness and swimming and cycling proficiency in primary school boys and girls.
		Key Findings	All components of physical fitness were associated with swimming and cycling abilities when accounting for age, body mass index (BMI), deprivation, gender, and sports club attendance. There were also gender interactions visible with cardiorespiratory fitness, grip strength and power.
3	Motor Competence Between Children with and without Additional Learning Needs: A Cross Sectional Population-Level Study	***Aim***	To explore motor competence in children with and without additional learning needs at a population-level.
		Key Findings	Children with additional learning needs were less proficient in their motor competence than their typically developing peers across all tasks of the Dragon Challenge assessment.
4	A Socioecological Perspective of how Physical Activity and Sedentary Behaviour at Home Changed during the First Lockdown of COVID-19 Restrictions: HomeSPACE Project	***Aim***	To improve understanding of the impact of COVID-19 lockdowns on children's physical activity and sedentary behaviour at home using the socioecological model as a theoretical framework.
		Key Findings	
5	Qualitative Changes in Children's Physical Activity and Sedentary Behaviours Throughout the COVID-19 Pandemic: The HomeSPACE Project	***Aim***	
		Key Findings	

7 STUDY 4 - A SOCIOECOLOGICAL PERSPECTIVE OF HOW PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR AT HOME CHANGED DURING THE FIRST LOCKDOWN OF COVID-19 RESTRICTIONS: THE HOMESPACE PROJECT

*This chapter is part of a published manuscript:

Richards, A. B., Minou, M., Sheldrick, M. P., Swindell, N., Griffiths, L. J., Hudson, J., & Stratton, G. (2022). A Socioecological Perspective of How Physical Activity and Sedentary Behaviour at Home Changed during the First Lockdown of COVID-19 Restrictions: The HomeSPACE Project. *International Journal of Environmental Research and Public Health*, 19(9), 5070. https://doi.org/10.3390/ijerph19095070

7.1 INTRODUCTION

Children spend most of their time at home and indoors (Matz et al., 2014), which is a concern as children are more sedentary when indoors (Biddle et al., 2009). In the year 2020, children were forced to spend a considerable amount of time in their home environment due to the COVID-19 global pandemic. Many countries employed a stay-at-home directive to reduce transmission of the virus and, as a result, many businesses moved to a working-from-home model, with the hospitality sector, non-essential shops, schools and other education settings being forced to close. School closures meant that children were home-schooled with remote, online learning provided by teachers, and this removed opportunities for PA including face-to-face physical education (PE), active transport to and from school, together with break and lunchtime activity.

According to the World Health Organisation (WHO), failing to regularly achieve PA recommendations and spending an increasing amount of time in SB is the fourth leading risk factor of mortality, only behind obesity, hypertension and tobacco use

(World Health Organisation, 2010). Children's PA has been widely explored and the physiological and psychological benefits to children's health have been well established (T. Brown et al., 2019; Habib & Saha, 2010), yet most children today still choose to spend their leisure time engaging in more sedentary activities as ways to spend their leisure time, compared to their parents (Balci & Ahi, 2017). Moreover, it is estimated that only 17.5% of children in the UK meet the recommended level of 60 min of moderate to vigorous physical activity (MVPA) per day (World Health Organisation, 2020; Sport England, 2019).

Recent research has explored children's PA during the COVID-19 pandemic with worrying speculations that short-term decreases in PA levels and increases in SB may become permanent (Dunton et al., 2020). When schools were reopened, objectively measured PA levels had decreased and SB remained high (ten Velde et al., 2021). Research with adults has also shown decreases in daily steps taken when a full lockdown was in place, whereas similar decreases in daily steps were not observed in areas where there was a partial lockdown (Pépin et al., 2020). These downward trends in PA are present, despite research identifying the importance of PA in reducing the risk of severe COVID-19 disease (Sallis et al., 2021).

Qualitative studies have begun to explore the reasons for decreases in PA, finding that an increase in screen time (Schmidt et al., 2020) and the cancellation of organised (Dunton et al., 2020) activities were two factors which negatively impacted children's PA levels during COVID-19 lockdown restrictions. One study found that the main barrier to maintaining PA levels during the COVID-19 pandemic was not having access to an outdoor space or PA equipment (Perez et al., 2021). Whilst outdoor spaces were of particular importance, during the COVID-19 pandemic, children's home space was also a key factor as findings show that children's PA at home either increased or stayed the same during the pandemic (McCormack et al., 2020); despite this, it did not compensate for the out of home reduction in PA.

Children's PA at home was explored pre-pandemic with one study finding that almost 50% of children's overall MVPA and sedentary time was accrued in the home (Tandon et al., 2014), indicating that PA and SB are largely influenced by the home environment. Further research has found that an open-plan living area was positively associated with total PA and MVPA, whilst sitting breaks were positively associated with garden size, suggesting that those with bigger gardens had more opportunities to break up SB (Sheldrick et al., 2019). Research has concluded that the physical home environment can provide both barriers and facilitators to children's PA and SB (Maitland et al., 2014). Despite the importance of the physical home environment, it was also highlighted that the home space is socially impacted by the people living in it, hence it is a dynamic ecological setting (Maitland et al., 2014).

In this dynamic home context, both PA and SB can be influenced by multiple factors at different levels. This provides an opportunity to use the socioecological model to enhance understanding of children's PA and SB, acknowledging that interactions between people and their environment are key factors (Sallis et al., 2006). This model proposes five levels: individual characteristics (e.g., sex, age, and motivations), interpersonal factors (e.g., family, friends), organisational factors (e.g., schools), community factors (e.g., social norms) and policy-level factors (e.g., policy and law).

The primary aim of this study was to improve understanding of the impact of COVID-19 lockdowns on children's PA and SB at home using the socioecological model as a theoretical framework. A secondary aim was to make recommendations to improve children's PA at home and their subsequent health, in the event of spending prolonged periods of time in the home environment. As such, qualitative research was carried out to identify barriers and facilitators of children's PA and SB at home during the first lockdown of the COVID-19 pandemic, in the UK, between March 2020 and June 2020.

7.2 Materials and Methods

7.2.1 Study Design and Participants

The HomeSPACE study was a cross-sectional observational study investigating the influence of the home environment on children's PA levels and sedentary time

(Sheldrick et al., 2019). The HomeSPACE COVID-19 project is a longitudinal study investigating how homes have changed during COVID-19 and the impact on children's PA and SB. Appendix VIII contains an overview of the phases involved during the HomeSPACE project. During the second phase of the HomeSPACE COVID-19 project, families were invited to take part in a semi-structured, online video interview to explore PA and SB changes within the home resulting from COVID-19 lockdown restrictions between March 2020 and June 2020. Participants were recruited to the qualitative element of the HomeSPACE study by categorising all 103 families into tertiles generated from the Welsh Index of Multiple Deprivation (WIMD). Participants were split into socioeconomic status (SES) tertiles based on the WIMD as follows: low- (1–636), medium- (637–1272) and high-SES (1273–1909) groups. Within each SES group, variables measured in the quantitative element of the study (MVPA, sitting time, house size and garden size) were stratified into three groups: high; medium, and low. The "stratified" function in R© (4.0, R Core Team, Vienna, Austria) was then used to allow for random sampling to select an equal number of participants from each stratum. Forty-one participants were subsequently contacted via email and telephone. Twenty families agreed to participate including 20 parents (90% female) and 23 children (39% girls) (aged 12 years ± 1.25). Thirteen families were from high, three from medium and four from low SES; this split was uneven due to the final sample of volunteer participants.

7.2.2 Data Collection

Following institutional Research Ethics Committee approval (REC: MS_2020-029a), participants were contacted to organise online interviews with families to include one parent and at least one child aged 9-14 years. Interviews were organised at a time suitable for the family, between June 2020 and August 2020, and were all conducted by the same researcher who was trained in qualitative research methodology. For parents and children to express themselves freely and without subjective bias, they were interviewed separately. The interviews were recorded via Zoom© with the participant's written consent. During the interviews, participants were asked to express their feelings and opinions on the effects of the COVID-19 restrictions on the children’s PA and SB within the home environment. A semi-structured interview guide (Appendix VI) was created and used to ensure that similar questioning routes were pursued with each participant, with flexibility to respond to lines of discussion raised by each participant. Question topics included most frequent activities, social elements including siblings, space within the home including the garden, routines and differences on weekend and weekdays. These questions were pilot tested with a convenience sample of similarly aged children to ensure understanding and fluidity prior to the interviews taking place.

7.2.3 Data Analysis

Once data collection was completed, interviews were transcribed using the automated transcriber on Zoom© (5.1.0, Zoom Video Communications, San Jose, CA, USA) and then checked and cleaned. Data were analysed using Braun and Clarke, (2022) thematic analysis process combining both inductive (data-driven) and deductive (actively searching for perceived factors affecting PA and SB at home) techniques. The process started with familiarisation, which involved reading and re-reading the transcripts and highlighting data of importance, including that which were repetitive across numerous interviews, related to previous research and suggested a novel finding. These significant data were then coded using NVivo 12© (NVivo12, QSR International, Melbourne, Australia). After reviewing the codes and grouping-related codes together, initial themes and sub-themes were generated in a hierarchical manner. Final theme names were conceived and substantiated by data obtained from the transcripts. Data were then deductively analysed in line with the socioecological model to map the themes in line with the model’s five levels: individual, interpersonal, organisational, environmental and policy. To ensure credibility, Lincoln & Guba, (1985) criteria were considered, keeping in mind Gergen, (2014) evaluation that these are only useful under certain conditions and should be study specific. The researchers engaged in prolonged engagement to immerse themselves in the research to understand multiple factors that were being investigated. Discussions with the research team, termed peer debriefing (Lincoln & Guba, 1985), together with self-reflection and progressive subjectivity were key in challenging thoughts and reviewing results.

7.3 RESULTS

The results were organised following the socioecological model, which showed the multiple factors involved in children's PA and SB at home during the COVID-19 pandemic. There were factors identified that could be both barriers and facilitators at each level of the socioecological model: individual, interpersonal, organisational, community and public policy.

7.3.1 Individual Level

7.3.1.1 Gender

Boys and girls showed differences in their PA and SB at home during the lockdown, with girls choosing more sedentary activities, as highlighted by one parent.

> *"I'm a teacher in secondary school and I find it really annoying and even seeing my son like they'll go to the beach now and they'll all take a ball…and then make up games…whereas the girls don't" (Mother, High SES)*

7.3.1.2 Competence

Children's physical competence in relation to PA was also a factor that influenced their PA levels at home during the lockdown, with children who were more physically competent remaining more physically activity during the lockdown.

> *"Yeah, I suppose, sport is his passion as much as anything. And that's what he does excel at in he's very good and he gets a lot of enjoyment...so that's kind of a bit motivator for him." (Mother, High SES)*

7.3.1.3 Attitudes, Motivation and Enjoyment

Although many children reported that enjoying PA made them want to be physically active, others stated that they were motivated to be physically active for several different reasons, including keeping fit and healthy, mental health and wellbeing benefits and because their family were physically active. One child spoke about setting goals to maintain their motivation to be physically active during lockdown. These positive attitudes and motivations towards PA facilitated greater levels of PA than those children who reported negative attitudes or a lack of enjoyment of PA.

> *"Wanting to like exercise and stuff it makes me happier in general." (Girl, Aged 12, High SES)*

> *"Well, it's mostly just things I like to do so. I quite like to run around in the park and play with my dad and brother. And then if it's anything to do with like I like going to like public pools and splashing about there. I like going to the beach as well just jumping in the sea." (Boy, Aged 12, High SES)*

> *"I just love doing sports and it keeps me active all the time." (Boy, Aged 12, Low SES)*

> *"Well, I've set myself a goal in running and so that that keeps me active. Yeah, I like setting myself goals so that helps to motivate." (Boy, Aged 15, Medium SES)*

7.3.2 Interpersonal Level

7.3.2.1 Siblings

Children discussed that they spent more time with their siblings, and this helped them to be more physically active during the COVID-19 lockdown restrictions.

> *"With brother and sister like they always find to do things or just even like jumping with each other." (Mother, Low SES)*

> *"Yeah, I would probably mess around the house with my brother for a bit and play some sports in the back garden sometimes." (Boy, Aged 13, Medium SES)*

> *"Yeah, we played a lot more [with my siblings] because one of them was in uni [university] but has now moved back so we played with him more." (Boy, Aged 13, High SES)*

7.3.2.2 Parental Support

Parental support was a key theme that was generated in this study. Having parents who were supportive of PA promotion was one factor that helped in preventing children from spending too much time pursuing SB.

> *"So, she had to go and measure how far she can run or something. So, my husband and I went to the park to do that." (Mother, Low SES)*

> *"So anytime we could get him off the games and out into the garden or at least you know outside we would do." (Mother, High SES)*

> *"And sometimes I'd complain to my mom that I was bored, and she would tell me to go for a run." (Boy, Aged 13, Low SES)*

> *"Our mom and dad tried to get us out all time." (Boy, Aged 13, High SES)*

7.3.2.3 Pets

Families with dogs had more motivation to be physically active, illustrating the link between family environment and intrapersonal factors. Both adults and children had a reason to get out of the house and take their dog for a walk, therefore decreasing their sedentary time.

> *"Well, my neighbours got a new puppy, so I'd go out and play a lot." (Girl, Aged 12, High SES)*

> *"Yeah, exactly and he did play an awful lot with the dog, poor dog is exhausted you know he was in the garden. He's had enough now it's all that kind of thing that they do constantly. I'd say…the dog's been a big source of company and exercise for him as well." (Mother, High SES)*

> *"I've got a Yorkshire Terrier and she loves him, completely adores him so it'd be something that…you know she'll take him you know for walks. That was something that motivates her." (Mother, Low SES)*

> *"And so, we were using more leaving the house as sort of the reason for physical activity. We…had the dog that we had to walk him. So that was a good excuse to get out and get some exercise." (Mother, High SES)*

7.3.2.4 Friends and Peer Influence

During the lockdown, friends and peer influence seemingly had a greater impact on SB, due to the opportunities to play with friends remotely that online gaming provides. Due to restrictions, children were prevented from socialising in person, so many turned to online gaming to stay connected with their peers. However, this increased their screen time and therefore their SB.

"Yeah, like, mainly because I think one of the reasons was because I couldn't see my friends in the day, I play Xbox with them." (Boy, Aged 13, High SES)

"I felt like I was missing out because I wasn't playing [online] with them. I felt like I was missing out and stuff, so I got more like I wanted to stay home." (Boy, Aged 13, High SES)

"I think he spends more time on screen because his friends are on screen as well." (Father, High SES)

7.3.2.5 Community Coaches

An additional interpersonal factor is the influence of community coaches on the children's PA and SB. If the child attended a community sports club, some coaches tried to continue with their coaching virtually during lockdown. This increased the children's opportunities to be physically active.

"Well, our coach had the idea and whoever did the most of one type of skill would get a prize or something. And things like different types of tricks. And so, we had like a week or so to do it. And then we put in our scores and then whoever did a certain amount would be put in their name would be put in a hat. And then he would pick out a random name they would get the prize." (Boy, Aged 12, High SES)

7.3.2.6 Family Routine

A primary theme from the interviews was family routine and how this changed through the pandemic restrictions. Those families who maintained behaviours seemed to remain more physically active than those whose behaviours changed as a result of the restrictions.

“No, my mom woke me at the same time I would normally [to try and keep a routine]…go outside and play out there” (Girl, Aged 12, High SES)

“Yes, more structure to the day, like times mattered [pre-pandemic] whereas in lockdown it was just like another day...I’m on my phone more” (Girl, Aged 13, High SES)

“Once we got into a routine, he did it [physical activity] without too much moaning.” (Father, High SES)

“At the start of lockdown, we tried to get them into some kind of routine…we started with Joe Wicks, I tried to get them up to do that every day.” (Mother, High SES)

7.3.3 Organisational Level

7.3.3.1 Schools

A key organisational-level theme was the role of schools during lockdown. Schools had differing approaches to providing home schooling. Some schools provided live online home-schooling lessons and they monitored the children’s progress whilst others set work for the children to complete remotely and submit. Despite PE being a compulsory part of the curriculum, some schools did not provide PE lessons, whilst others provided opportunities for PA as a replacement, including YouTube videos for the children to work out to, or yoga. Overall, home schooling increased children’s screen time and SB as seen through the quotes below.

Home Schooling and Screen Time

“All of her education was done through the laptop and the school were pretty good actually maintaining a regular school day.” (Father, High SES)

"When I was doing my work, I would mostly be on the screen." (Boy, Aged 13, High SES)

"And so, I suppose [screen time] has probably gone up but I think his generally screen use has just gone up anyway because he's doing a lot of learning online." (Mother, High SES)

"I think it's [screen time] gone higher since the lockdown because it's been a lot of online training with school and she's been there since the time that schools open at eight o'clock…until about possibly three, four in the afternoon you know, she's, they've been doing, sending a lot of homework. So, she's been on the screen, more than before. And it's because of this, the lockdown." (Mother, Low SES)

Physical Education (PE)

Discussion of PE reinforced the differing approaches taken by schools to providing PE for the children during the home-schooling period. There appeared to be limited direction on being physically active from schools. For some students, it was not included in their timetable:

"They tend to have a timetable which is one kind of subject a day and it was like one was humanities, one was science, one was maths, English and then I think like arts and crafts type thing. So no, no physical activity included." (Mother, High SES)

For other children, the PE work was theoretical but not practical.

"I'm not aware of him having, I think he had some kind of theoretical stuff to do. But I was never aware of any practical stuff." (Mother, High SES)

"Yeah, she had P.E homework, but it wasn't anything to do with physical activity and was just quizzes." (Mother, Medium SES)

Some of the children were asked to carry out activities either using online videos or alternative equipment which would not normally be available at school.

> *"Yes, they did. XXXX had whenever she should have had PE there was an hours worth of things in there, yoga and some exercises to home. XXXX also had a similar thing he had things to do you know that list of different YouTube videos to watch that they work out to." (Father, High SES)*

> *"I think it was there was more theory involved, but there was also, I know there was a couple of things. She was told to do. And she said she didn't have the equipment so she'd kind of substitute did it for the trampoline or cycling or something that she skateboarding. She was still doing some form of physical exercise." (Mother, High SES)*

7.3.3.2 Clubs and Societies

Being part of a club or society often provided opportunities for the children to be physically active. This is linked to the interpersonal factor of community coaches. It is not just the coaches that had an impact here, the clubs themselves gave children the opportunity to stay connected with their team and/or group of peers involved in these clubs/societies who also took part in the virtual challenges.

> *"We had to walk to Scotland or something that the team had to go to Scotland…everybody had to do so many miles or kilometres and but of course XXXX only did what he was supposed to do he didn't do very much more." (Mother, Low SES)*

7.3.4 Community Level

7.3.4.1 Physical Environment

Parents and children commented on the effect of their physical environment. This included both the home environment and the local environment, particularly when the restriction was posed that the public in Wales could not travel more than 5 miles from their home unless in extenuating circumstances. Families commented on how, before the 5-mile restriction, they were able to drive to safe outdoor spaces including parks and beaches for the children to be physically active; but once the 5-mile rule was introduced, this became illegal. However, this restriction gave families the opportunity to explore their local areas more and find areas that they were unfamiliar with.

> *"So, we go on lots of family walks, I would go walking with them or XXXX would take him walking and when the five-mile restriction was in we couldn't go anywhere. It was lots of walks from the house" (Mother, Medium SES)*

> *"There was no traffic, we were able to walk along the road it was so lush, so so lovely. And she actually blossomed during that time, because no peer pressure, can do whatever she wanted it was really lovely. So, when you know in terms of making a difference. Yeah, we'd always make sure that we would do something nice on the weekend that we'd go for a big walk." (Mother, High SES)*

7.3.4.2 Access to Facilities

Access to facilities was another community theme. Parents and children commented on the lack of community facilities available due to the lockdown restrictions. The leisure facilities children would normally use to be physically active were unavailable and this decreased their opportunities to be physically active.

"The only problem was when it was raining, we couldn't go to like places like the LC2 or Limitless which made us sit more." (Boy, Aged 12, High SES)

7.3.4.3 Weather

The first lockdown started in March 2020 as the spring and summer months were approaching and it was made clear that the children were more physically active during the warmer and drier weather.

"Definitely the weather, I won't go out if it's like raining or anything. I, even if it's sometimes too cold. I don't wanna go out because I can't deal with it." (Girl, Aged 12, High SES)

"If it's sunny outside then we are normally always outside." (Girl, Aged 12, Medium SES)

7.3.4.4 Outside Space

Together with the home environment and access to PA equipment within the home, the outside space at home influenced home-based PA during the lockdown. The size and scope of garden space within the individual's home played a part, suggesting that those with a bigger or flatter garden spent more time outside and being physically active in the garden than those with smaller or less accessible garden spaces.

"And there's not really space outside in my garden to do any like sports, because it's quite a small garden." (Girl, Aged 13, Low SES)

"Well, I've definitely been going for runs around where I live and maybe going on more walks as a family. And playing in the back garden more than I was before." (Girl, Aged 13, High SES)

7.3.4.5 Social Norms

Another theme within the community level were social norms, within which there are two factors that were identified: time constraints and home-based equipment. There was a social norm around the time that children should allocate to learning, sleeping and leisure time, with learning, when at school, taking up most of a child's day. Schools being closed meant that children had more freedom with their day, albeit they should have been taking part in home schooling; however, only a small proportion of a child's day was spent home schooling.

> *"Yeah [I've had more time]. I wouldn't really be messing around the house with my brother as much as I wouldn't have time like that." (Boy, Aged 13, Medium SES)*

> *"Yeah, the actual time together as a family. Is a lot more limited. So the older ones have been moaning that we've done more in terms of going out for walks than we did before, just because we've got time in an evening, whereas normally you wouldn't have it." (Mother, High SES)*

> *"And during the week [pre-lockdown] he would never have the computer on he would never have time to go on the computer." (Mother, High SES)*

> *"We also go on the trampoline a lot more because I wasn't doing work all day." (Boy, Aged 13, High SES)*

7.3.4.6 Availability of and Access to Equipment

Many children highlighted that having PA equipment accessible at home helped them with being physically active during the lockdown. Media equipment accessibility was also noted as a facilitator to SB. Children and parents commented that having electronic equipment such as game consoles, phones and laptops increased the children's SB. On the other hand, having bikes, basketball hoops, swings and scooters increased the children's PA. Many families had to buy new electronic equipment during lockdown to fulfil the requirements of home schooling, increasing interest in screens and SB, potentially leading to a decrease in PA. Ultimately, parents had the financial power of what to buy, making a clear interaction with the interpersonal level of the model.

PA Equipment

> *"Paddling pool was up, she'd go out on her own. And play on that and jump on the trampoline." (Mother, High SES)*

> *"Yeah, and he has a trampoline, so he went on the trampoline. And also, he has a push up bar and pull up bar and he also likes a little bit of ball play as well." (Mother, Low SES)*

> *"And in the lounge where I know it's a random place to have it but we got them out at the start of COVID, they were pushed to one side in the conservatory till then there's a sit up hubs crunchy thing and a stepper of sorts. And again, you walk in and quite happily finding watching TV whilst on the stepper" (Father, High SES)*

> *"Only really that we had more of the exercise equipment out" (Father, High SES)*

Media Equipment

> *"XXXX had a laptop bought for because we didn't have enough equipment to use" (Mother, High SES)*

> *"New TV we bought when we were in lockdown because they both wanted to watch their own TV programmes and there was a bit… fighting so at the beginning of lockdown we bought a telly." (Mother, Low SES)*

“I mean we signed up to things like Netflix” (Mother, High SES)

“We had to buy a new laptop because XXXX was at a stage where she was using my laptop.” (Mother, High SES)

7.3.5 Policy Level

The overarching theme was lockdown restrictions at a policy and legal level. The restrictions in place to curb the spread of COVID-19 meant that many children were unable to achieve their usual levels of PA due to missing activities such as active transport to school, PE lessons, attending sports clubs and non-organised play or PA with their friends.

“Before COVID restrictions. I was doing clubs in I went to Ju Jit Su and I was looking for an acting club to do but I can’t do them now because it’s very full contact” (Girl, Aged 11, High SES)

“She does do Guides so she’s involved in Girl Guiding…but obviously that switch to Zoom at the moment. So again, it’s not as physically active as it normally would be.” (Mother, High SES)

7.4 DISCUSSION

The aim of this study was to improve understanding of the impact of COVID-19 restrictions on children’s PA and SB at home, using the socioecological model as a theoretical framework. The results show that individual-level factors (gender, competence, attitudes and motivation), interpersonal-level factors (siblings, parents, pets, friends and coaches), organisational-level factors (school, clubs and societies), community-level factors (home and local environment, access to facilities, social norms, time constraints and home equipment) and policy-level factors (lockdown restrictions) influenced children’s PA and SB at home during the first lockdown of the

COVID-19 pandemic. This model can be used to promote PA within the home by focusing on the facilitators explored within the results.

The views of the parents and children suggest that there was a decrease in overall PA and an increase in SB during the lockdown restrictions, which has previously been reported within a Canadian population (McCormack et al., 2020) . McCormack et al., (2020) found that over three quarters (75.9%) of children increased their general use of screen-based devices and that over half (52.7%) decreased time playing at the park; however, PA at home either increased (48.8%) or remained unchanged (32.9%). This suggests that PA at home increased due to lack of opportunities to partake in PA elsewhere. Despite this, one study from Ireland found no changes in adolescent girls' reported PA during the lockdown restrictions (O'Kane et al., 2021). Studies using objective measures in multiple countries and age groups, including 4–6-year-olds in Spain (Alonso-Martínez et al., 2021), 7–12-year-olds in Holland (ten Velde et al., 2021) and in the USA (Burkart et al., 2022) all found decreases in PA and increases in SB throughout the lockdown restrictions. One reason for these declines in PA, particularly MVPA, included pandemic-related social isolation (López-Bueno et al., 2021). This was also true for this study, as many children reported being isolated meant that they spent more time interacting virtually with their friends in sedentary pursuits including online gaming, and less time engaging in PA as a result. The restrictions meant that the social elements that encouraged many of the children to partake in PA such as being part of a team, were no longer a part of being physically active.

Consistent with previous work (Maitland et al., 2014), the findings indicate that the home is a dynamic environment and that multiple factors at all levels of the socioecological model influenced family PA and SB during the first lockdown of the COVID-19 pandemic. The home physical environment can present barriers to, and facilitators of, PA and SB; however, as previously suggested, it is the family living within the home that changes the dynamic of the environment. This was particularly evident within this study as families were brought together through working from home, returning from universities and home schooling. Changes in the condition of who was living at home and spending more time at home were both a barrier and facilitator to PA. Previous research found that having a sibling who participates in PA is positively associated with higher levels of PA than being an only child (Daw et al., 2015). In this study, siblings were spending more time together seemingly increasing their PA through unstructured play, which also has many benefits for a child's physical, emotional and social wellbeing (Lee et al., 2020). A systematic review (Blazo & Smith, 2018) concluded that although researchers suggest that family is the most important aspect to consider when exploring PA behaviours and attitudes (Brustad, 2010), much of the research has been investigative of parental behaviours as opposed to siblings. Other researchers have explored the sex composition of parent–child and sibling dyads and also the birth order of siblings, with mixed findings including girls with brothers participating in more PA than girls with sisters (Bagley et al., 2006). Older siblings have been identified as role models for younger siblings, meaning that if the older sibling is physically active, the younger sibling will follow suit (Ebihara et al., 1981). Together with the influence of siblings on PA and SB, parents also have an important role to play. This study found that those children with parents who were supportive of PA and provided greater PA opportunities engaged in more PA. In support of this, one COVID-19-based study found that children of parents who were more anxious about COVID-19 visited the park less often and were more likely to spend ≥2 h/day taking part in screen-based activities such as gaming, compared with children of less anxious parents (McCormack et al., 2020).

The results highlighted the importance of the availability and accessibility of space and equipment. These are two key factors that have been previously reported to promote or inhibit PA during the COVID-19 restrictions (Perez et al., 2021). Spending time outdoors can have multiple health benefits (Eigenschenk et al., 2019); however, it was noted that during the lockdown, some families had limited access to outdoor spaces such as gardens whilst others enjoyed exploring their local areas within the 5-mile boundary of the restrictions. In many areas playgrounds were closed, whilst the closure of sports centres and community halls further decreased the availability and accessibility of PA promoting facilities. The accessibility and availability of PA-promoting, or indeed SB-promoting equipment, were widely discussed with both children and parents talking about new equipment that was bought to meet the needs of their new lifestyle. Many families bought new media equipment or subscriptions including laptops, televisions, gaming consoles and streaming services, inevitably increasing the opportunities for SB. Physical activity equipment was also purchased including bikes, roller skates and weights in an attempt to increase PA opportunities at home. Although our data cannot conclude the purchasing of new equipment has widened inequalities as it was not explored in a systematic way and the sample of SES was skewed due to volunteer convenience, future research could explore this in more detail. Together with the availability of this equipment, its accessibility was also a factor that was discussed. Within the physical home space, families moved equipment out of cupboards or unused rooms to make it visible and therefore more accessible, thus increasing PA at home.

Despite the limited structure to the children's days, those families that reported keeping a structure and routine to the day seemingly maintained a higher level of PA. Parents reported that every day felt the same and it was difficult to discern weekdays from weekends and school holidays. This presents challenges for maintaining children's PA and decreasing their SB as previous research has found that on average children engage in less PA and more SB on weekends compared to school days (Rowlands et al., 2008). Similarly, research has found that children who are not enrolled in holiday camps or activities gain more weight over the school holidays than those who are enrolled (Tanskey et al., 2018). A similar scenario was apparent during lockdown, where there was a lack a structure and routine; this could have potentially posed similar health risks, although this was not measured during this study.

All the barriers and facilitators to PA and SB at home that have been previously discussed are complex and cannot be understood or addressed if levels of the model are studied in isolation. Exploring the interactions and reciprocal causation between the levels allows for a deeper understanding and various levels to be targeted to intervene more effectively. A dynamic systems approach may be needed that accounts for the dynamic changes in the factors that lead to a greater understanding of how to support PA and SB management in children within their home environment. Figure 1 shows the multiple factors at each level and the interactions between these. For example, one interaction includes motivation, attitudes and enjoyment at the individual level; however, various factors at the interpersonal level, including siblings, pets and parents, all seemingly have an impact on a child's motivation, attitudes and enjoyment of PA and SB. It is also important to take into consideration interactions within levels together with between levels. An example of an interaction within levels is that between the individual factors of gender and competence, as it has been previously reported that boys are more competent than girls in the majority of fundamental movement skills (Valentini et al., 2016). Considering and exploring interactions within the model allow for a more holistic interpretation of the results and subsequently more effective interventions.

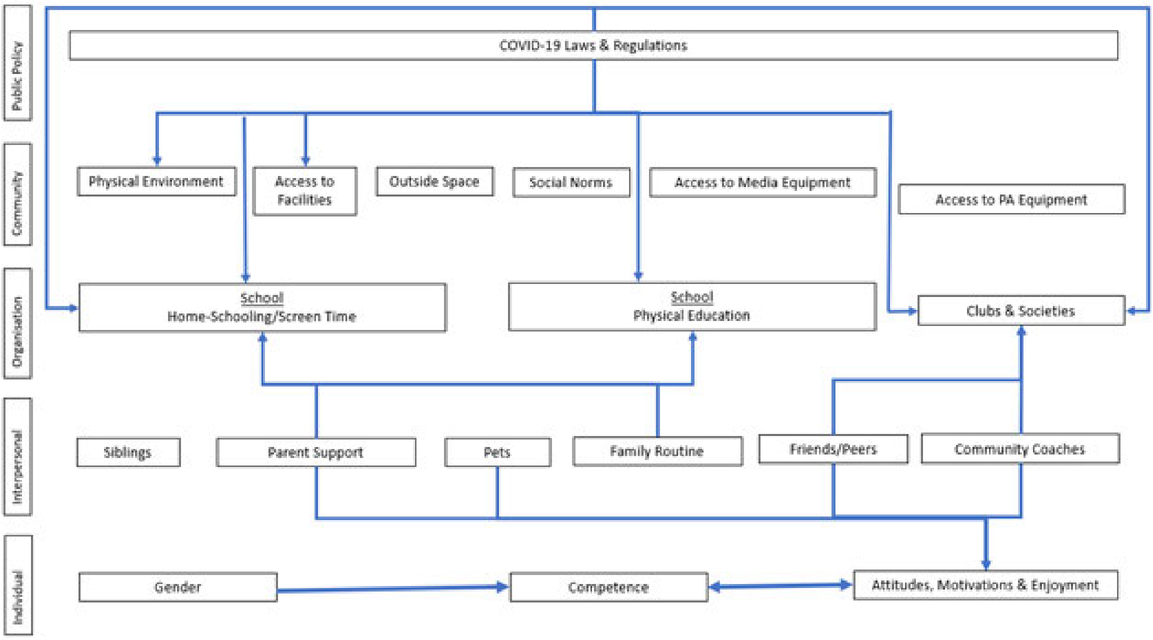


Figure 4: *The multiple interactions between and within levels of the socioecological model*

When interpreting the findings from this study, several strengths and limitations should be considered. To the authors' knowledge, this is the first qualitative analysis of children's PA and SB at home during the first lockdown of the COVID-19 pandemic in the UK, where both parents and children shared their thoughts and experiences of children's PA and SB during lockdown and exclusively in the HomeSPACE. The semi-structured interviews allowed for detailed discussions with participants to delve deeper into their behaviours and attitudes to PA and SB during the first lockdown. The nature of the sequential interviews also allowed the researchers to develop the questions as the interviews progressed. However, this study was not without its limitations, including the sample of participants recruited. Of the twenty parents interviewed, only two of these were fathers. Similarly, although sampling aimed to achieve an equal split of families across SES levels, due to the volunteer uptake, there were more families from high socioeconomic backgrounds; this overrepresentation of high-SES families is common in research due to the difficulty in recruiting lower-SES participants (Hales et al., 2013; Sirard et al., 2010). Despite the over-representation of high-SES families within this study, the findings may be generalisable to areas which share similar geographical and home environment characteristics. This study also only focused on PA and SB during the first lockdown, where factors such as good weather, novelty of a new living situation and uncertainty about the future need to be considered. Future research should seek to evaluate reasons for changes in PA and SB at home over the subsequent COVID-19 restrictions that were put in place including the easing of restrictions. A focus should be placed on inequalities in children's PA and SB, seeking to recruit a larger sample from lower-SES families, to identify any disparities in behaviour. The potential long-term effects of not being in school and having a routine or structure to a day are yet to be explored; future research should focus on the changes that were made in the first lockdown and whether they were sustained over time.

7.5 CONCLUSIONS

An interaction of factors together with the dynamic nature of the home environment presented both barriers and facilitators to children's PA and SB at home during the first lockdown of the COVID-19 pandemic. Use of the socioecological model allowed us to clearly identify the level of influence of different perceived barriers and facilitators. Furthermore, the interaction between these levels provided an integrated view of the parent's and child's perceived changes to PA and SB at home during the lockdown. The policy level factor of COVID-19 laws and restrictions provided the basis for this study as, without these regulations, children would have been continuing as normal. It was this factor that forced changes to be made to daily life and therefore PA and SB at home. Other levels of the model included multiple factors which seemingly influenced PA and SB at home during the first lockdown of the COVID-19 pandemic, including routine, availability and accessibility of suitable facilities, space and equipment, family members and the children's attitudes towards PA and SB.

The results of this study provide key information to increase children's PA at home. The findings can further inform interventions that seek to promote children's PA at home. Moreover, home-based interventions should be developed in the event of future lockdowns. It is essential that the changes reported in this study do not become permanent and that children re-engage in PA opportunities when permitted.

THESIS MAP

	Study		Outcomes
1	Wales 2021 Active Healthy Kids (AHK) Report Card: The Fourth Pandemic of Childhood Inactivity	***Aim***	To summarise the findings of the Active Healthy Kids Wales 2021 Report Card process and to present and interpret the results for physical activity domains for children and young people.
		Key Findings	Grades ranged from F for overall physical activity and sedentary behaviour indicators, through to a B- for the school indicator. All but three grades remained the same or decreased from the 2018 version of the Report Card and it was the first time that Wales did not have any inconclusive grades.
2	Associations Between Swimming & Cycling Abilities and Fitness In 9–11-Year-Old Boys and Girls	***Aim***	To examine the associations between fitness and swimming and cycling proficiency in primary school boys and girls.
		Key Findings	All components of physical fitness were associated with swimming and cycling abilities when accounting for age, body mass index (BMI), deprivation, gender, and sports club attendance. There were also gender interactions visible with cardiorespiratory fitness, grip strength and power.
3	Motor Competence Between Children with and without Additional Learning Needs: A Cross Sectional Population-Level Study	***Aim***	To explore motor competence in children with and without additional learning needs at a population-level.
		Key Findings	Children with additional learning needs were less proficient in their motor competence than their typically developing peers across all tasks of the Dragon Challenge assessment.
4	A Socioecological Perspective of how Physical Activity and Sedentary Behaviour at Home Changed during the First Lockdown of COVID-19 Restrictions: HomeSPACE Project	***Aim***	To improve understanding of the impact of COVID-19 lockdowns on children's physical activity and sedentary behaviour at home using the socioecological model as a theoretical framework.
		Key Findings	An interaction of factors together with the dynamic nature of the home environment presented both barriers and facilitators to children's physical activity and sedentary behaviour at home during the first lockdown of the COVID-19 pandemic.
5	Qualitative Changes in Children's Physical Activity and Sedentary Behaviours Throughout the COVID-19 Pandemic: The HomeSPACE Project	***Aim***	To track changes in experiences of children's physical activity and sedentary behaviour across time related changes in COVID-19 pandemic restrictions in the context of the self-determination theory.
		Key Findings	

8 Study 5 - Qualitative Changes in Children's Physical Activity and Sedentary Behaviours Throughout the COVID-19 Pandemic: The HomeSPACE Project

*This chapter is part of a published manuscript:

Richards, A. B., Sheldrick, M. P., Swindell, N., Barker, H. G., Hudson, J., & Stratton, G. (2023). Qualitative changes in children's physical activity and sedentary behaviours throughout the COVID-19 pandemic: The HomeSPACE project. *PLOS ONE*, 18(1), e0280653. https://doi.org/10.1371/journal.pone.0280653

8.1 Introduction

The COVID-19 pandemic provided a natural intervention (Craig et al., 2017) on children's physical activity (PA) and sedentary behaviour (SB). COVID-19 restrictions constrained children's movement resulting in them spending a considerable amount of time in the home environment. Health-related research has demonstrated the importance of PA in reducing the risk of severe COVID-19 disease (Sallis et al., 2021); despite this, children's PA levels within the United Kingdom remain at low levels (Sport England, 2019). Therefore, it is important to understand how factors during the varying levels of restrictions influenced PA and SB and how these factors may impact on physical and sedentary behaviours in the future.

PA has been well established as a powerful contributor to improving children's physical and mental health (Davies et al., 2019) and plays a significant role in addressing specific physical and mental health issues including obesity (Brown et al., 2019) and depression (Brown et al., 2013). Despite this, only 17.5% of children in the UK meet the national recommendation of 60 minutes of moderate to vigorous PA per day (Sport England, 2019). Subsequent reports found PA decreased further during the COVID-19 pandemic. These reports found sports activity declined and in contrast, recreational screen time increased (Paterson et al., 2021; Richards et al., 2022; Schmidt et al., 2020), with an overall decline in children's PA (Yomoda & Kurita, 2021). Of even greater concern is short-term decreases in PA levels and increases in SB may become permanent (Dunton et al., 2020), supported by evidence that objectively measured PA levels decreased, and SB remained high in children, even when schools were reopened (ten Velde et al., 2021). Due to the COVID-19 restrictions, children spent nearly all their time within the home environment. Our previous research with the HomeSPACE project has clearly identified the barriers and facilitators in children's home environments that influence children's PA and SB (Richards et al., 2022) but has not explored how changing environments impacted these.

The Self-Determination Theory (SDT) can be used as an interpretive framework to understand factors that predict PA or SB (Ryan & Deci, 2017) with extensive application in this context (Brustad, 2010) and more recently, with health-related behaviours during the COVID-19 pandemic (Porat et al., 2020; Šakan et al., 2020). SDT is a control-based theory (Biddle et al, 2007) comprising of six mini-theories. The Basic Psychological Needs Theory (BPNT) is one of these and argues that optimal functioning is predicted by autonomy, relatedness, and competence. These three psychological needs assist in the understanding of the motivation and engagement of individuals. SDT identifies that social and contextual factors play a part in determining an individual's level of motivation to be active. COVID-19 restrictions on activity became a key contextual factor influencing motivation during lockdown. To further develop the theoretical background, differences between an autonomy supportive environment and a controlling environment have been highlighted (Sarrazin et al., 2021); and COVID-19 restrictions posed a controlling environment by restricting choice for individuals' opportunities to be physically active.

Our initial qualitative HomeSPACE study explored children's PA and SB during the first national lockdown of the COVID-19 pandemic and identified several barriers and facilitators to PA within multiple levels of the socioecological model (Richards et al., 2022). The identified barriers and facilitators included gender, siblings, home-schooling, access to equipment/facilities and COVID19 laws and regulations. This initial study reported compelling evidence that COVID-19 was significantly impacting on children's health promoting activity, warranting further longitudinal exploration. Moreover, insufficient attention has been paid to changes in children's PA and SB across various stages of the lockdown restrictions in the UK. The aim of this study was therefore to track changes in experiences of children's PA and SB across time related changes in COVID-19 pandemic restrictions in the context of the SDT.

8.2 METHODS

8.2.1 Study design & participants

The HomeSPACE project was a cross-sectional longitudinal observational study exploring the influence of the home environment on children's PA levels and SB (Sheldrick et al., 2019). The HomeSPACE COVID-19 project is a longitudinal study investigating changes within home environments through the COVID-19 pandemic and the impact of this on children's PA and SB. Appendix VIII contains an overview of the phases involved during the HomeSPACE project. During the second, third and fourth phases of the HomeSPACE COVID-19 project, semi-structured, online interviews took place with families, over a maximum twelve-week period during each phase, to investigate changes in PA and SB within the home because of the fluctuating COVID-19 lockdown restrictions between March 2020 and December 2021.

Recruitment methods have been previously described (Richards, Minou, et al., 2022), including the incentive of receiving a £20 voucher to participate in the research. Briefly, the 103 families who participated in the wider HomeSPACE COVID-19 project were categorised into low (1–636), medium (637– 1273) and high (1273–1909) tertiles from their score in the Welsh Index of Multiple Deprivation (WIMD) as previously described (Richards, Minou, et al., 2022). The quantitative element of the HomeSPACE project measured sitting time, house size, moderate to vigorous PA (MVPA) and garden size; these were stratified within each SES into low, medium, and high. The programme R© was used for random sampling to select an equal number of participants from each stratum using the “stratified” function. These selected participants were then contacted via telephone and email. Twenty families agreed to participate in the first interviews; there was some attrition into the second phase of interviews where 14 of the original families took part and the third round of interviews where nine of the original families took part. Attrition occurred due to natural drop-out and families being unwilling to remain involved for the duration of the project. For the purposes of this study, only the nine families who took part in all three phases of interviews are used for analysis. The nine families consisted of 11 children (36% girls, 64% boys; aged 13.38 years ± 1.14), one father and eight mothers. There was an uneven split between SES groups due to the final sample of volunteer participants, with six families from high SES backgrounds, one from a medium SES and two from low SES backgrounds.

8.2.2 Data collection

The study received approval from the institutional Research Ethics Committee (REC: MS_2020-029a) and following this, online Zoom© semi-structured interviews conducted by trained qualitative researchers were organised with participants at a suitable time for the family and upon gaining the parents” written consent and child’s assent. Parents and children were interviewed separately, allowing for both sets of participants the opportunity to speak freely. Questions were centred around gaining the participants’ thoughts and feelings on the children’s PA and SB within the home and how this was impacted by the COVID-19 restrictions and subsequent easing of restrictions. Questioning followed similar routes using the interview guide (Appendix VI), but there was flexibility to react to issues raised by each participant. Question topics included changes in opportunities to be physically active during the lockdown and upon the easing of restrictions and the thought processes behind engaging with these opportunities both within and outside of the home.

8.2.3 Data analysis

The data analysis process for the first phase of interviews has been previously reported (Richards et al., 2022) and similar analysis methods were used for the subsequent interviews. The first phase of interviews was analysed before the second and third interviews were conducted. Interviews were transcribed using the automated transcriber on Zoom© and then checked and cleaned. The thematic analysis process outlined by Braun and Clarke (Braun & Clarke, 2022) was used to analyse the data, utilising a combination of inductive techniques that were driven by the data followed by deductive techniques where factors affecting PA and SB at home were actively searched for. The transcripts were read and re-read (familiarisation) and data of importance was highlighted, including data that suggested novel findings, was repeated across families and that which was related to previous research. Any significant data were then coded using NVivo 12© and reviewed by grouping linked codes together and generating initial and sub-themes in a hierarchical manner. Initial development of themes led the authors to identify concepts of the BPNT, as part of SDT; therefore, the data was mapped in line with this theory to explore the children's autonomy, competence, and relatedness in the context of their motivation for PA and SB at home across various levels of COVID-19 restrictions. Data obtained from the transcripts authenticated the final theme names that were developed.

Longitudinal qualitative research techniques were explored (Tuthill et al., 2020), including Cross-sectional Profiling (Smith, 2003), Case Histories (Thomson, 2007), Pattern-Orientated Longitudinal Analysis (Kneck & Audulv, 2019) and Framework Analysis (Lewis, 2007). Of these, the research team decided to use Framework Analysis to analyse the subsequent interviews as it can be used to find patterns across participants, time points and themes (Braun & Clarke, 2022). To meet the requirements for the Framework Analysis method, all interviews were analysed by both phase and by family to give two different viewpoints; matrices were created using the Framework Matrix function in NVivo 12©. The restriction timeline was labelled by four categories: lockdown one (March 2020 –June 2020), easing of restrictions (July 2020 –October 2020), lockdown two (November 2020 –March 2021) and new normal (April 2021 –December 2021).

The researchers followed the strategies to support the quality of analysis proposed by Campbell et al., (2021) by firstly engaging in process of reflexivity, followed by discussions between the research group to ensure trustworthiness and credibility. Whilst lengthy engagement with the interview recordings allowed for the researchers to become fully immersed in the topic and gain a deeper understanding of the factors being explored.

8.3 RESULTS

Following analysis of the data, four themes were generated, a through d. The changes in schooling provision theme were further split into three sub themes.

a. Changes in Schooling Provision
    a. Physical Education (PE) Opportunities
    b. Break and Lunchtime Arrangements
    c. Changes in Routines of Lesson Structure and The School Day
b. Opening and Closing of Clubs and Societies
c. Fluctuations in Attitudes and Motivations
d. Equipment Availability and Accessibility

Results are discussed on a theme-by-theme basis and as outlined in the methods, in chronological order consisting of lockdown one, easing of restrictions, lockdown two and new normal.

8.3.1 Changes in schooling provision

Children spend a considerable amount of time in school; a setting that provides many opportunities to be physically active. During the first lockdown these opportunities were removed by home-schooling, which had few, if any, break or lunchtime PA opportunities, no active travel to school or moving between classrooms. Children also encountered mixed experiences of PE provision with some schools providing limited PE opportunities online, some providing theory lessons, whereas some schools did not offer any PE curriculum.

8.3.1.1 Physical education opportunities

PE provides an opportunity to promote PA within the school day. During the first lockdown PE was taken away from children, as the closure of schools meant children were being home schooled. There was a mix of opportunities within PE available for the children to complete in the home environment. Some children were given theory only lessons, whilst others were given videos to watch as a replacement for PE; this was largely unmonitored and not compulsory.

> *"I think he had some kind of theoretical stuff to do. But I was never aware of any practical stuff." (Mother, High SES)*

> *"Yes, they did. XXXX had whenever she should have had PE there was an hour's worth of things in there, yoga and some exercises. . .XXX also had a similar thing he had things to do you know that list of different YouTube videos to watch that they work out to." (Father, High SES)*

When restrictions were easing and children were returning to school, there were, again, mixed experiences of returning to PE. Schools had restrictions in place, which reduced the PE opportunities available, whilst some schools continued with a theory only approach. One positive change, in most schools, was that changing rooms were out of bounds to prevent the spread of COVID-19, meaning that children wore their PE clothing to school on days with PE. Children preferred this as it was more comfortable than uniforms, they did not have to change in front of their peers, and it gave them more time in PE lessons to be active as there wasn't a delay from getting changed.

> *"No, I didn't [have PE]. I would go into class and just do writing about PE." (Boy, Aged 14, Medium SES)*

"They're [PE lessons] much better now like we do football. We don't do rugby because of contact, but we are allowed to do football and cricket and stuff like that…No we don't [wear our uniform to school] just because the changing rooms, they don't want a lot of people inside so we just come in in our kit and we go straight out…it's a lot more comfortable than school clothes so I do find it much better…it gives you a lot more time like 10/15 minutes more." (Boy, Aged 14, Medium SES)

During the second lockdown, schools seemingly provided more at home PE opportunities; increasing children's physical activity opportunities at home.

"So mainly just sending like videos and you decided then what you wanted to do like yoga or Joe Wicks or stuff like that." (Girl, Aged 13, High SES)

"We got PE homework in the second lockdown. He didn't particularly like doing it because it was filming, he doesn't like filming himself, so he'd do the activities like "keepy uppies" in the garden…but he didn't really like sending it in…because [he] didn't want to be on film." (Mother, High SES)

The new normal has provided an opportunity for a re-think of PE in some schools with some continuing to ask children to wear their PE clothing to school on PE days, saving time, infection risk and increasing body-confidence within PE by not having to change in front of peers. Some schools give their children more autonomy to choose their activity and the groups that they participate in, this seemingly has a positive impact on children's experiences within PE.

"Um, lots of stuff we've been doing dodgeball, volleyball, football, netball...we go in our uniform now." (Girl, Aged 14, High SES)

"Well, since the virus we've had to wear our PE kits into school and that I'm thankful for and I'm glad that we haven't had to go back to changing in school. And the PE lessons have gotten a lot more diverse with having a mixed group,

girls, boys and two different PE things we do. But yeah, that's…what I prefer to do rather than what happened in Year 7. Before it was based on athletic skill, but now it's more girls, boys and mixed but you get to choose which one you prefer to go in. They have competitive girls and competitive boys so it's sort of would you rather be more competitive with people who are the same gender with you, or would you rather just be in a sort of more level group of people who are just you know it's mixed, so you have both genders." (Girl, Aged 13, High SES)

"When we came back there was no PE activities it was just writing. But now we are able to play football and rugby full contact and everything...we are allowed to use the changing rooms now." (Boy, Aged 14, Medium SES)

8.3.1.2 Break and lunchtime arrangements

Before the pandemic, break and lunchtimes at school provided an opportunity for unstructured or structured PA for children. This opportunity was removed when children were faced with home-schooling and some children started to spend all day in front of the screen without a suitable break; this minimised their PA within the home.

"So, it [PA] was a lot less than normal…when they're at school, they play rugby at lunch times and all this kind of stuff [but he can't do that at home]" (Mother, High SES)

During the easing of restrictions and returning to school, there were still many break and lunchtime restrictions in place that the children had to follow. Children reported less time, less PA opportunities and physical structures such as metal barriers and cages that inhibited their movement on the playground.

"We'd have a corner of the school, and we just have to stay there at all times. That's really it...I'd mainly just be sitting down. We don't really have that much

room to play sports or anything so…just be talking to people." (Boy, Aged 14, Medium SES)

"Yeah, I think that initially when they went back…they were in cages when they went out in breaktime and lunch time." (Mother, High SES)

During the second lockdown the poorer weather led to even fewer breaks outside at home for the children. Generally, however, schools had learnt from the first lockdown and provided more of a structured school day for the children at home, giving them opportunities for breaks.

"They went on Zoom from like half eight till three when school finished." (Mother, High SES)

In the new normal, break and lunchtimes had returned to normal, albeit a little shorter to compensate for the lost lesson time incurred during lockdowns.

"They do their training during lunch breaks." (Mother, Medium SES)

"They love it now I think the, all the boys and girls in their year group just all play football together all the time now and in lunchtimes and breaktimes and it's so nice that they're just completely back to normal now so yeah he's really enjoying school, which is, which is good." (Mother, High SES)

8.3.1.3 Changes in routines of lesson structure and the school day

Changes that took place from March 2020 and December 2021 in the routine of lesson structure and the school day both increased and decreased time available to participate in PA. During the first lockdown, children reported having more time to be physically active at home as the schoolwork set was flexible and they weren't too tired during the day. The flexibility allowed them to use outdoor areas, such as the garden, or exploring the local area when the weather was fine.

“It’s all the schoolwork was on was on Google classroom. So it’s all laptop based. So they’re on the screens then for three hours a day.” (Mother, High SES)

However, upon easing of restrictions, aspects of PA such as movement between classes, break and lunchtimes were reduced. With the children returning to school, they were tired when they got home from a long day of structured lessons, so did not want to be physically active within the home and just wanted to use their time at home to relax, largely on screens.

“Not really. It was you stay in the same class. You only get out for break and lunch, and it was like you, the teachers come to you, instead of you go to the teachers normally.” (Boy, Aged 13, High SES)

During the second lockdown the school day seemed to be less flexible as live lessons became the norm and therefore there was more structure to the school day. This was considered a positive change for many; however, it reduced the flexibility of being able to go for a walk when the weather allowed or when a parent had a break from work.

“Because of the like more strict day of school and everything [I] didn’t have as much time [for PA], I would say as the first lockdown.” (Boy, Aged 13, Low SES)

Within the new normal the school day seems to have returned to pre-COVID-19 structure, with extra use of screens for work, potentially increasing sedentary behaviours. Many children reported feeling more tired being back at school full-time, giving them less energy for participating in PA after school. They also noted PA during the school day was restricted due to a tight timetable.

"It's more back to normal now, although most of the work we do now is on the screen at school, so it's still quite a bit [of screen time]." (Girl, Aged 13, High SES)

"She was less active during lockdown, and just probably lost motivation and stuff like that. . .she's been far more active since September at school…I think it [going back to school] rejuvenated her especially being suddenly being able to do this stuff" (Father, High SES)

"Sometimes I just feel completely exhausted after school and I just want to have a sit down mostly." (Boy, Aged 10, High SES)

8.3.2 Clubs & societies

Pre-COVID-19, many children attended clubs and societies both in and out of school, which increased their opportunities for PA outside of the home. This opportunity was removed during the first lockdown when all clubs and societies were either forced to stop or moved online. Some clubs continued engaging the children through online challenges whereas others ceased activity. These changes meant children spent more of their leisure time within the home being unable to attend community clubs, potentially increasing both their PA and SB at home.

"His rugby coach sent him like an exercise thing to do every day." (Mother, High SES)

When the restrictions were easing, clubs had a varying timeline of reopening based on the level of risk. Some clubs were able to safely open their doors to the children quickly after the lifting of restrictions, increasing PA opportunities for some. Other clubs that posed a greater risk of infection could not open until later in the pandemic.

"Yeah, they were quite good with the cricket but cricket's outside and there's not an awful lot of contact and whatever contact there is it's easily wiped with

a hand sanitiser for the balls. So yeah, he did have some sports last year." (Mother, Medium SES)

"He went back to cycling, walking, doing everything, everywhere. The only thing that he missed out on was sport didn't get back to normal. So he did miss out on all his football and his rugby you know…you still weren't allowed teams to get together in teams or groups, so he didn't have that to go back to." (Mother, High SES)

"It was a bit strange [going back to clubs] because hadn't done them for such a long time, but it was definitely a good thing to do, because I needed the exercise and it felt good to just get out and do something." (Boy, Aged 13, High SES)

When the second lockdown was imposed, clubs underwent a similar process to the first lockdown where they either closed fully or moved online, once again restricting children's activities. The new normal has seen a cautious approach to re-starting clubs, both extra-curricular within schools and community clubs. Some schools were hesitant to start extra-curricular activities due to risk of infection and increased health and safety concerns, whilst others were keen to re-establish these as soon as was possible. Children had mixed views of re-joining their clubs; some were keen to go back and get started, others had enjoyed screentime and other sedentary pursuits during the restrictions and were reluctant to return. Some parents also reported an additional economic impact, whereby the cost of attending clubs had increased which further reduced opportunities for children to be physically active.

"I mean I'm paying £300 a term for them both to swim once a week, which is ridiculous, but XXXX's lessons are £15 for 45 minutes because they can only have half the children in the pool that they could before so everyone's got to pay double because they're still going to cover their overhead and everything" (Mother, High SES)

"The only one, he done before the pandemic was water polo and he refused to go back to it, which was a shame, because I think he did enjoy it when it was when he was doing it…She was happy to go back to all her clubs…she's keen to do pretty much, do everything which is…great yeah." (Father, High SES)

"Yeah, everything's back to normal, the football and the rugby after school all the other sports they're doing as well yeah. I can't even think of anything that's not normal about it now so yeah." (Mother, High SES)

"There haven't been as many after school activities as they were looking back a couple of years, I think the secondary schools have been better at restarting after school activities than the primary [schools]. Our primary's being very cautious, and they really aren't doing any sort of after school clubs." (Mother, High SES)

8.3.3 Fluctuations in attitudes and motivations

The children's attitudes and motivations changed throughout the COVID-19 pandemic due to them growing older but also the restrictions being imposed on them. In the first lockdown, many children maintained a positive attitude and motivation towards PA, partly due to the novelty of the lockdown and the good weather that was being experienced, meaning they could be physically active in outdoor spaces at home. Some children did lose motivation for PA and preferred the newfound freedom of being allowed to spend more time on screens.

"I just love doing sports and it keeps me active all the time." (Boy, Aged 12, Low SES)

"Now I have to encourage her to go out a bit more." (Mother, High SES)

"I really started doing it [bike riding] more in lockdown because I realized how important it is to maintain physical activity and all that." (Girl, Aged 12, High SES)

On the easing of restrictions, those children who previously attended organised physical activity sessions, mostly regained any motivation that was lost and re-joined any activities that were allowed to be resumed. Children who did not previously attend any clubs or societies used the opportunity of more time on screens to persuade parents into letting them continue these elevated levels of screentime. This increased screentime may be due to those children who attend a club or society could be more competent at physical activity, therefore promoting their motivation.

"I'm definitely a lot more happy because sports will go back to normal now such as school and I'll be able to go out with no mask and stuff like that and act quite normal." (Boy, Aged 14, Medium SES)

"XXXXX seemed to retreat into himself quite a lot and I think his friends did too, which was, which was sad, and it took us as a pair/as his parents and his friends' parents quite a while to build their confidence back up again." (Mother, High SES)

"It made me a bit lazier. After coming back from like six hours of school didn't really do much afterwards so yeah." (Boy, Aged 13, Low SES)

The second lockdown was seemingly more challenging as the weather was poor and the days were short, meaning few opportunities to be physically active outside. At this point even some of the more competent children's motivation to be physically active started to decrease and the lack of relatedness with their peers and autonomy to be physically active had negative implications on their PA levels and attitudes towards being physically active.

"It made me not want to go out and about…I didn't really want to do anything—I just wanted just to lie down." (Girl, Aged 13, High SES)

"More in the second [lockdown] locked away in his in his room, it was hard to...get them out to, 'come on we'll do something come and walk the dogs with us,' or anything, it was hard, but we did eventually sort of get him out and about it took a long time. It was really, really difficult…he just wouldn't, didn't want to come out. . .It was difficult as well, because we couldn't go very far, and it was, like there's nothing around here but we manage, we did eventually find some routes that we could walk on that were within the distance and they were nice, nice walks." (Mother, Low SES)

As the new normal was imposed, this resulted in a mix of attitudes and motivations towards being physically active, some of this was attributed to COVID-19 but also due to an increasing age of the children. Some children showed a lack of motivation to be physically active and failed to return to PA clubs, preferring screen-based sedentary leisure time within the home. Others were rejuvenated with the newfound freedoms and their levels of PA returned to, or exceeded, that pre-pandemic.

"Yeah, she's really missed them [clubs] she has she loves a bit of competition, so that's been good." (Mother, High SES)

"Um I was nervous, I expect, like everybody" (Girl, Aged 13, High SES)

"I do more like after like being locked down, maybe think about like physical health and everything, so I just started being more active." (Boy, Aged 13, Low SES)

"Umm, I think they've appreciated recently that they've been good that they've had these opportunities and they've opened up and they seem keen to take them other than XXXX wanting to give up rugby I've not detected the level of reluctance, I might have expected, I mean we've lost [in the rugby team] quite a lot of kids haven't wanted to come back." (Mother, High SES)

8.3.4 Equipment availability and accessibility

Notably across the pandemic, participants discussed changes in equipment, with initial equipment bought impacting on PA and SB, including bikes, trampolines, laptops, and TVs.

> *"Paddling pool was up; she'd go out on her own. And play on that and jump on the trampoline." (Mother, High SES)*

> *"XXXX had a laptop bought for. . .because we didn't have enough equipment to use" (Mother, High SES)*

> *"New TV we bought when we were in lockdown because they both wanted to watch their own TV programmes and there was a bit…fighting so at the beginning of lockdown we bought a telly." (Mother, Low SES)*

> *"Well, we like to go on a trampoline a lot. Like sometimes my cousins came over and like we went on the trampoline and played games and was quite fun." (Boy, Aged 13, High SES)*

Much of the PA promoting equipment was stored after initial use within the first lockdown. Some was re-used in the second lockdown, but on the whole once opportunities to be physically active outside of the home returned, the PA equipment bought to meet PA needs within the home was obsolete. In contrast, the sedentary-based equipment was consistently used and not similarly discarded.

> *"I was doing some weights 'cause we bought a few weights to use like at home for like a gym, so we did stuff like that, watched a couple videos then did that." (Boy, Aged 13, Low SES)*

> *"I think she is on it [laptop] more than she was before the pandemic because a lot more homework is online and then because like before the pandemic she didn't have a laptop whereas she had to get one during so it's there it's*

accessible for her so she's it's just much easier for…to go on then, and obviously we've got the extra computers that we didn't have before." (Mother, High SES)

We got the trampoline over lockdown which isn't really being used at the moment." (Father, High SES)

"[They are] in a cupboard, we bought him weights and the bar thing that you do pull ups on the door and that kind of stuff and he just does it all at the gym now he doesn't bother when he's at home." (Mother, High SES)

8.4 Discussion

The aim of this study was to track changes in the experiences of children's PA and SB across changes in COVID-19 pandemic restrictions in the context of the SDT. The results show that changes in schooling provision, clubs and societies opening and closing, attitudes and motivations and the availability and accessibility of PA- and SB-inducing equipment all contributed to the shifting levels of PA and SB throughout the pandemic. The changes within these factors were primary influencers of the children's PA and SB. This study had a particular focus on PA and SB within the home environment, however, as might be expected, when restrictions were eased, the home environment became less important, as children's opportunities to be physically active outside of the home increased.

As suggested in the results, the basic human needs according to the SDT, of autonomy, competence, and relatedness, were largely not met during lockdowns and only partly in the easing of restrictions, contributing to a lack of motivation to be physically active, and therefore a decrease in PA behaviours, partly sustained in the new normal. The controlling environment posed by the COVID-19 restrictions left little choice regarding an individual's opportunities to be physically active. The children therefore experienced a deficit of autonomy in their decision making to be physically active. In line with previous research, a lack of autonomy can hinder levels of PA (Dore et al., 2020). In research conducted into the first phase of the lockdown (Richards et al., 2022) competence was found to be a motivating factor, those children who were more competent in PA, were more likely to continue being physically active throughout the lockdown. This pattern continued throughout the remaining phases of the pandemic, with a lack of competence seemingly associated with a lack of motivation to be physically active. This has recently been identified in a systematic review of qualitative studies which highlighted that children with lower perceived competence, withdraw from PA to prevent experiencing negative emotional consequences (White et al., 2021). There was a clear absence of relatedness during the pandemic with children expressing they missed their friends and when permitted, they returned to PA pursuits to be with their friends once again. Social interaction whilst participating in PA was the most frequent response by children and adolescents at the interpersonal level in a systematic review focusing on influences to participation in PA from the socioecological model perspective (Hu et al., 2021).

Evidence suggests children are more sedentary when they are indoors (Biddle et al., 2009), and more active when they are outdoors (Sallis et al., 2000), which is concerning as children spend most of their time at home and indoors (Matz et al., 2014) and even more so when the COVID-19 pandemic restrictions were imposed. Research has found that the physical home environment can provide both barriers and facilitators to PA and SB; whilst the home should be considered a dynamic ecological setting as it is socially impacted (Maitland et al., 2014). Across the lockdown restrictions changes were made to the physical and social environments within the home space. Children were bought both PA- and SB-inducing equipment in the first lockdown to meet the needs of the new lifestyle. However, during the easing of restrictions and subsequently the new normal, the PA-inducing equipment mostly became redundant and was stored out of sight. This trend was not the same for SB-inducing equipment as this seemed to remain accessible within the home. This is a concerning finding for children's health as previous studies have found that amongst children and adolescents, having a TV in their bedroom was associated with less PA (Rosenberg et al., 2010), higher likelihood of being overweight (Adachi-Mejia et al., 2007) and poor school performance (Borzekowski & Robinson, 2005). In pre-school children it has been found that the availability of sporting equipment at home did not differ by child weight status (Trost et al., 2003). However, a study with adults showed that participants with a higher BMI reported less PA equipment in the home, and that more moderate-vigorous PA was associated with the presence of more PA equipment in the home (de Bourdeaudhuij et al., 2003). A systematic review exploring attributes in the physical environment in relation to children's PA found mixed results, with four out of six studies showing no associations between home equipment and observed, self-reported and objectively measured PA (Davison & Lawson, 2006; Dunton et al., 2003; Sallis et al., 1993; Trost et al., 1997, 1999). However, in one study, self-reported PA was positively and significantly associated with the number of pieces of exercise equipment in the home amongst adolescent girls and boys (Fein et al., 2004).

Schools provide numerous opportunities for children to be physically active and parents alluded to this in the interviews; where changes in schooling provision, including PE opportunities, break and lunchtime arrangements and changes in the routines of lesson structure and the school day, all contributed to the fluctuations in PA and SB during the pandemic. With few to no opportunities through school, PA within the home environment increased but this did not compensate for the overall decrease in PA during the restrictions. PE is important for children to provide opportunities to participate in MVPA, with some studies reporting that 34% of PE lessons are spent in MVPA (Fairclough & Stratton, 2006), contributing to the children's achievement of the PA recommendations (World Health Organisation, 2020). PE lessons are also important for students to acquire knowledge, skills, and motivation to be active outside school and later in life. During the first lockdown children were either not given PE for home-schooling or given limited PE including videos to watch, such as the "Joe Wicks" sessions. Upon the easing of restrictions, children reported either not taking part in physical PE lessons, but PE theory lessons took precedence. If children did have practical PE lessons, no contact sport was allowed, some schools required face masks to be worn, and children wore their PE kit to school. Wearing PE kit to school was a major discussion point during the interviews as children much preferred to do this, as it gave them more time in PE lessons and removed the barrier of embarrassment of changing in front of their peers. This was consistent with previous research which identified PE changing rooms as a problematic space for pupils (O'Donovan, Stanford & Kirk, 2015). This space can be a hub for bullying, if pupils are perceived as ‘different’ (Bramham, 2003), and this is further acknowledged by care-experienced children who may have been subject to neglect or abuse (Quarmby et al., 2019).

Some schools improved on their PE provision during the second lockdown providing more structured sessions, but some parents still prioritised academic subjects and did not want to create an additional challenge with their child in encouraging them to take part in the PE provided by the school, whilst at home. The new normal has seen varying school rules for PE; overall, PE has returned to pre-COVID-19 standards, if not with some changes either due to lessons learnt over COVID-19 or the new health and wellbeing curriculum which has been partly implemented in some schools already but being rolled out nationwide across Wales in September 2023 (Welsh Government, 2020). Some schools have changed the way they conduct PE lessons so that the children have more autonomy in their PE, choosing between competitive groups, mixed gender groups and PA opportunities. Consistent with previous research, giving children autonomy in their learning, has a positive influence on the learning process (Dam, 2011). Some schools continue to ask their pupils to wear their PE kit to school, which is a positive change for many, particularly girls (Phillips et al., 2019), whilst others have returned to changing at school, which is not so highly received. Contact sports are permitted, and the use of face masks has been removed. This return to normal for school PA opportunities has further decreased PA within the home due to an increase in time spent away from the home environment.

Schools provide opportunities through active transport, unstructured play, and extra-curricular clubs. These opportunities were all taken away from the children in the first lockdown when schools were forced to close, leaving children with a lack of autonomy. Upon easing of restrictions, children’s PA opportunities at school were limited with children reporting break and lunchtimes being shorter and spent in small areas, described by some as cages, presumably to aid with social distancing. MVPA and very high PA is higher at break and lunchtime for boys than for girls (Ridgers et al., 2011) and the PA accumulated during breaktimes may contribute between 5% and 40% towards the daily PA recommendations (Ridgers et al., 2005). During both lockdowns there was no scheduled time for break or lunch activities and during the easing of restrictions children reported that their PA decreased during break and lunchtime due to limited time and space. Positively, during the new normal phase, break and lunchtime seems to have returned to pre COVID-19 structure and this has once again become an opportune time for children to accumulate some of their daily PA.

The final changes that were made at a school level which had an impact on the children's PA and SB were the changes in lesson structure and daily routine. During the first lockdown, parents were given the task of trying to keep their child in a routine, as the schoolwork was set for the children to complete throughout the day, but not at specific times. This absence of routine lead to an increase in screen-time and therefore SB at home (Cachón-Zagalaz et al., 2021). However, this flexibility was removed during the second lockdown when many schools moved to provide live virtual lessons. Some parents commented that this more structured day kept the children in a better routine, whilst others did not find this helpful, as they preferred the flexibility of getting out for a walk when the sun was shining, or when they were having a break from meetings whilst working from home. During the easing of restrictions, the structure of the school day changed to minimise the spread of the virus, children were required to stay in one classroom, and it was the teachers who moved between classes for lessons, rather than the children. Moving between classes is an unstructured form of PA for the children, and associations have been found between larger school sites and increased PA (Cradock et al., 2007). The large sites mean accumulating PA during the school day just from moving between classrooms, but this was removed during the easing of restrictions. The new normal has meant a return to pre-COVID days where children are once again moving around the school between lessons, accruing PA as they go.

According to the Sport Wales School Sport Survey, pre-COVID-19, 65.1% of children aged 7 to 16 years attended a community sport club at least once per week, whilst 49.9% attended at least one extra-curricular sports club per week (Sport Wales, 2018). Children spoke about the social aspects of going to these clubs and the relatedness that they feel to their friends who also attend the clubs; echoed by previous findings (Hu et al., 2021). Clubs and societies were initially forced to close, with some providing virtual opportunities. There were mixed returns during the easing of restrictions, some clubs opened with ease and others which struggled do so with rule changes. The second lockdown forced the clubs to close again with children losing opportunities for PA once again. These fluctuations in opening and closing of clubs have led to changes within the new normal, including financial impacts. Previous research found that 'financial situation' as a barrier to PA reduced during the pandemic (Marashi et al., 2021) but had previously been reported as a significant barrier to children's participation in PA (Riazi et al., 2017), particularly to single parents (Somerset & Hoare, 2018). Some parents, including both single parents and parents from nuclear families, said that during the new normal, prices had increased to a level where they could now, unfortunately, only provide limited opportunities for their children, this was particularly prominent with swimming clubs. This is a concern, as more than two thirds of families in this study were of a high SES and they were struggling to afford swimming, so lower SES families may be more impacted by this and it is known that children learning to swim is of paramount importance for fitness (Richards et al., 2022), health and safety (Asher et al., 1995). Some children, generally the more physically competent ones, could not wait to return to their clubs to feel a sense of relatedness. In contrast, others were not motivated to return and found alternative leisure pursuits during the lockdowns, mainly involving SB within the home environment.

Not being motivated to return to active leisure pursuits when the opportunity arose was observed in the fluctuations in attitudes and motivations to be physically active throughout the pandemic. Parents commented on the changes in their children's attitudes throughout the lockdown; some attributed this to their age, which is consistent with previous findings that children's PA reduces with age (Sallis et al., 2000). Parents discussed that the changes in their children's motivation and attitudes may have been down to increasing age, but also due to the COVID-19 restrictions. During the first lockdown, motivation and attitudes towards PA were generally positive as it was a novel time for the children and parents alike. Outdoor PA pursuits such as walking and cycling were popular as the weather was dry and warm, which has been previously positively associated with PA (Levin et al., 1999). After the first lockdown, the easing of restrictions occurred during the summer months, again with limited rainfall, this meant that the children's PA seemingly increased from the lockdown as there was more freedom in a less controlling environment, leading to more autonomy; this is supported by the finding that children's PA levels significantly increased upon return to school (Hurter et al., 2022). The second lockdown posed new PA considerations for families, as the weather was poor, and the daylight hours were shorter further reducing opportunities for PA outdoors. This had a negative impact on children's motivation to be physically active. The children reported being "tired" and "bored" of lockdown and in some cases, this had a negative impact on wellbeing and mental health, which were poorer throughout the COVID-19 pandemic (Bignardi et al., 2020). During the new normal phase there were varying attitudes towards returning to pre-COVID-19 PA levels. Some children became even more physically active due to missing out during the restrictions or having a greater understanding of the importance of physical health; these were generally the more physically competent children. Other children gained motivation due to social aspects and relatedness; they wanted to be physically active with their friends again (Nally et al., 2022). Some children continued with more sedentary pursuits, often involving screentime, potentially due to a lack of motivation stemming from the restrictions. This was also documented in a study measuring PA pre, during and post-lockdown restrictions, where there was a decrease in PA and an increase in SB (ten Velde et al., 2021).

8.5 STRENGTHS & LIMITATIONS & FUTURE RESEARCH

When considering the outcomes from this research, several strengths and limitations should be acknowledged. To the authors' knowledge, this is the first longitudinal qualitative analysis of children's PA and SB during the COVID-19 pandemic, where both parents and children shared their experiences. The longitudinal nature of the study allowed the researcher to follow up on specific details of prior interviews to delve deeper into the participants comments' and generate case studies of families' experiences. This may also have built additional levels of trust between the participants and the researcher, reassuring them to share more information. It allowed for a timeline of changes in PA and SB to be created for each family to gain a more thorough understanding of the perceived changes in children's PA and SB across various timepoints of the pandemic, allowing comparisons to be made between different lockdowns and easing of restrictions.

However, this study was not without its limitations, including the attrition of participants. As outlined in the methods, there were 20 families interviewed in the first phase, 14 in the second and nine in the third, which included two sibling dyads. This is a 55% drop out rate from the first to the last phase of interviews. Despite this dropout, both boys and girls, mothers, and fathers and at least one family from high, middle, and low SES were interviewed in the final phase. Reported rates of attrition within longitudinal studies range from 30% to 70% (Gustavson et al., 2012), therefore, this study falls in the average range of drop out. Due to the volunteer uptake, there was an overrepresentation of high-SES families which is common in research (Hales et al., 2013; Sirard et al., 2010); two thirds of the families were from high-SES as calculated by the WIMD. However, comparisons can be made between families of similar SES, living in similar environmental conditions. An additional limitation includes the difference in researcher between the first interview and second and third interviews where there was consistency. Finally, the study did not report objectively measured PA or SB and relied on self-report to understand the changes in PA and SB during the COVID-19 pandemic.

Therefore, future research should seek to provide a mixed methods approach to PA and SB changes at home to incorporate the use of accelerometers to objectively measure these behaviours. Low SES families should be prioritised, and comparisons could be made in PA and SB at home between families with varying levels of affluence. Although beyond the scope of the present study, future research should seek to see if the changes have remained consistent post-pandemic and whether, as these children age, there is a long-term impact of the COVID-19 pandemic restrictions on PA and SB as they move into adulthood.

8.6 CONCLUSION

Use of the SDT allowed us to consider the factors involved in autonomy, competence and relatedness that influenced the motivation behind the children's increases and decreases in PA and SB. It was clear that imposing a controlling environment on the children largely decreased their PA opportunities and subsequently their motivation to be physically active. Furthermore, this decreased their levels of autonomy and relatedness as they could not participate in PA with others, this lack of a social element further decreased PA. The results of this study provide an insight into the changes in PA and SB throughout the varying levels of restrictions in the COVID-19 pandemic. Changes in schooling provision, clubs and societies opening and closing, attitudes and motivations and the availability and accessibility of PA- and SB-inducing equipment all contributed to the fluctuating levels of PA and SB throughout the pandemic. In terms of applied implications should children have to spend a considerable amount of time in their home environment again in the future, measures should be taken to provide alternative opportunities to be physically active, both indoors and outdoors. The findings can further inform the need to reverse these decreases in PA through ensuring that children's voices are heard, particularly about PE lessons. Although PA has increased following the lockdowns, it is imperative that children are given a range of opportunities to be physically active to reverse any negative impacts of the COVID-19 restrictions.

THESIS MAP

	Study		Outcomes
1	Wales 2021 Active Healthy Kids (AHK) Report Card: The Fourth Pandemic of Childhood Inactivity	***Aim***	To summarise the findings of the Active Healthy Kids Wales 2021 Report Card process and to present and interpret the results for physical activity domains for children and young people.
		Key Findings	Grades ranged from F for overall physical activity and sedentary behaviour indicators, through to a B- for the school indicator. All but three grades remained the same or decreased from the 2018 version of the Report Card and it was the first time that Wales did not have any inconclusive grades.
2	Associations Between Swimming & Cycling Abilities and Fitness In 9–11-Year-Old Boys and Girls	***Aim***	To examine the associations between fitness and swimming and cycling proficiency in primary school boys and girls.
		Key Findings	All components of physical fitness were associated with swimming and cycling abilities when accounting for age, body mass index (BMI), deprivation, gender, and sports club attendance. There were also gender interactions visible with cardiorespiratory fitness, grip strength and power.
3	Motor Competence Between Children with and without Additional Learning Needs: A Cross Sectional Population-Level Study	***Aim***	To explore motor competence in children with and without additional learning needs at a population-level.
		Key Findings	Children with additional learning needs were less proficient in their motor competence than their typically developing peers across all tasks of the Dragon Challenge assessment.
4	A Socioecological Perspective of how Physical Activity and Sedentary Behaviour at Home Changed during the First Lockdown of COVID-19 Restrictions: HomeSPACE Project	***Aim***	To improve understanding of the impact of COVID-19 lockdowns on children's physical activity and sedentary behaviour at home using the socioecological model as a theoretical framework.
		Key Findings	An interaction of factors together with the dynamic nature of the home environment presented both barriers and facilitators to children's physical activity and sedentary behaviour at home during the first lockdown of the COVID-19 pandemic.
5	Qualitative Changes in Children's Physical Activity and Sedentary Behaviours Throughout the COVID-19 Pandemic: The HomeSPACE Project	***Aim***	To track changes in experiences of children's physical activity and sedentary behaviour across time related changes in COVID-19 pandemic restrictions in the context of the self-determination theory.
		Key Findings	Factors involved in autonomy, competence and relatedness influenced the motivation behind the children's increases and decreases in physical activity and sedentary behaviour. Imposing a controlling environment on the children largely decreased their physical activity opportunities and subsequently their motivation to be physically active.

9 THESIS SYNTHESIS

The goal of this chapter is to synthesise and discuss the overall results of the studies included within this doctoral thesis. I will start by revisiting and recapping the aims of the research, followed by a synthesis of the key findings from the individual studies and the overarching findings from the whole body of research. The strengths and limitations of the studies will also be discussed, followed by suggestions for future research. The final two sections will include recommendations for practice and policy and finally some personal reflections on completing this body of work.

9.1 THESIS AIMS RECAP

The overall aim of this doctoral research was to investigate children's physical activity, fitness, and motor competence. The research was adapted midway, due to the COVID-19 pandemic that swept the world during early 2020, and the refocus allowed me to explore the effects that lockdown restrictions had on physical activity levels. The change in direction of research also provided an opportunity to expand the thesis and to develop further research skills that otherwise might not have been possible. The specific aims were a) to summarise the findings of the Active Healthy Kids Wales 2021 Report Card process and to present and interpret the results for eleven quality indicators of physical activity in children and young people; b) to examine the associations between fitness and swimming and cycling proficiency in primary school boys and girls; c) to examine motor competence in children with and without additional learning needs at a population-level; d) to improve understanding of the impact of COVID-19 lockdowns on children's physical activity and sedentary behaviour at home, using the socioecological model as a theoretical framework; and e) to investigate factors that influenced changes in children's experiences of physical activity and sedentary behaviour across time related to changes in COVID-19 pandemic restrictions, and in the context of the self-determination theory.

9.2 KEY FINDINGS

Study 1 provided an updated overview of children's physical activity across Wales through the Active Healthy Kids (AHK) process. Grades ranged from B- through to F, with all but three grades decreasing or remaining the same since the last report card in 2018. This was the fourth iteration of the process and the first time that there were no inconclusive grades. It was also the first time that a grade was allocated to the physical literacy and physical fitness indicators, whilst the school indicator provided a grade after being inconclusive in 2018. Bringing together the three concepts of physical literacy, physical fitness, and school is an interesting approach in Wales, with the education reform and the new curriculum, something which was also briefly discussed in **Studies 4 and 5.** The new curriculum has no statutory guidance for swimming which is an important motor skill to develop and **Study 2** found that the important motor skills of swimming and cycling are associated with fitness. **Study 1** did not include an analysis of disability data unlike other member countries involved in the AHK Global Alliance. Therefore, **Study 3** revealed inequalities in motor competence between children with and without additional learning needs. **Study 1** highlighted the need to listen to children and young people's thoughts and opinions surrounding physical activity, therefore, **Studies 4 and 5** explored qualitative factors that families faced during imposed pandemic restrictions and how these impacted on children's physical activity and sedentary behaviour within the home environment. **Study 4** revealed that an interaction of factors at all levels of the socioecological model presented both barriers and facilitators to children's physical activity at home during the first lockdown of the COVID-19 pandemic. **Study 5** allowed me to revisit the same families to explore if, and how levels of physical activity and sedentary behaviour changed throughout the fluctuating COVID-19 restrictions. Using the self-determination theory throughout the analysis made it clear that imposing a controlling environment on the children largely decreased their physical activity opportunities and subsequently their motivation to be physically active. **Studies 4 and 5** adopted an in-depth qualitative approach allowing for deeper insight into factors impacting children's physical activity, sedentary time, and fitness.

The outcomes in this thesis have provided novel findings to the scientific literature. **Study 1** built on previous research by the AHK-Wales working group to re-grade the indicators for the fourth time since 2014; but it was the first time that there were no inconclusive grades. This implies that there is a greater volume and range of data available within the physical activity scope in Wales. However, data is still missing to cover all age groups and demographics. The findings from this study show that the efforts being made to increase physical activity in children across Wales remain largely ineffective; the government indicator highlights the need for policies to be implemented. Whilst there were 26 national instruments identified that included a physical activity element, findings suggest that these largely do not have a monitoring and evaluation plan, any identified resources, or an accountable organisation. The new curriculum in Wales may help with this, by giving schools autonomy to create their own curriculum, based on their own strengths and challenges around health and wellbeing. On the other hand, this could pose a lack of consistency in providing physical activity opportunities and this needs to be closely monitored during its roll out; particularly regarding motor skills being efficiently developed.

Building on the findings from **Study 1** and the concerns raised around the new curriculum, particularly the noticeable lack of mandatory swimming or cycling, **Study 2** explored these skills in relation to fitness. Fundamental movement skills have previously been associated with fitness (Jaakkola et al., 2019), yet little research has explored swimming and cycling skills specifically. There is a large, and ever-growing research base exploring fundamental movement skills, but two of the potentially most important but rarely assessed skills, swimming, and cycling, are related to measures of fitness, suggesting that establishing surveillance data of swimming and cycling abilities should be a focus for professionals and policy makers. The novel associations that **Study 2** established between swimming and cycling and physical fitness, and the differences between boys and girls, provide further evidence to support Stodden et al's. (2008) Developmental Model. The latter proposed a direct pathway between motor competence and physical activity, which is mediated by health-related fitness. Robinson (2015) found strong evidence that motor competence is associated with physical activity, healthy related fitness, and weight status. More recently, Barnett et al. (2022) supported this by finding a strong positive pathway from motor competence to health-related fitness, but indeterminate in the opposite direction. We could not determine the direction of the association in our research, due to the cross-sectional design, however, based on Barnett et al's. (2022) findings, we can speculate that swimming and cycling can lead to higher health-related fitness.

Given the lack of national data on physical activity in children with disabilities and therefore only one out of the eleven indicators in **Study 1** being able to comment on disability inequalities, **Study 3** investigated children across Wales with disabilities and their motor competence. Broader research within this area has, to-date, focused on specific conditions, leading to small sample sizes. To contribute to this evidence base, and based on new guidance from the Welsh Government around categorisation of children with Special Educational Needs (SEN) - now encompassed within the term Additional Learning Needs (ALN) - **Study 3** merged SEN and ALN categorisations. The already established evidence states that children with Autism Spectrum Disorder (Pan et al., 2009), ADHD (Villa, 2018) and Down Syndrome (Volman et al., 2007) have lower motor competence than typically developing children, but these studies had small sample sizes; our study had a nationally representative large sample size. **Study 3** also provided deeper insight into this area and the findings of which supported the need for a fully inclusive approach to improving low levels of motor competence in children with ALN.

Many studies have previously explored barriers and facilitators to children's physical activity, yet few have focused on the home environment, and none during the global pandemic. Our work largely supported previously findings that pets (Morrison et al., 2013), peer (Martins et al., 2014) and parent support (Rebold et al., 2016) and good weather (Levin et al., 1999) were facilitators of children's physical activity. On the other hand, school is commonly cited as a facilitator of physical activity as it can provide multiple opportunities for physical activity (Neil-Sztramko et al., 2021). However, in **Studies 4 and 5**, the notion of 'schooling' could be considered a barrier, as home-schooling increased screen-time, and therefore sedentary behaviour. **Studies 4 and 5** provided insight into the reasons behind changes in children's physical activity and sedentary behaviour at home during the COVID-19 pandemic which was also observed in quantitative work within the same population (Sheldrick et al., 2022).

9.3 Strengths and Limitations

This research provides insight into the physical activity, motor competence and physical fitness in children and young people before, during and in the recovery from the COVID-19 pandemic. A major strength of all five studies is the novelty and that they all address gaps in the literature to add to the existing evidence base. The large sample sizes and mostly representative demographics across **Studies 1, 2 and 3** are a major strength of this body of work. Whilst there is not equal representation of participants from a range of ages, ethnicities and socioeconomic backgrounds, the sample is representative of the proportions of children within the Welsh population. **Study 1** set the scene for the research and quantifies children's health and wellbeing in Wales, using a grading system that is easily comparable to other countries who took part in this research. A practical strength of **Study 1** includes the large authorship collaboration, where academics and practitioners from across the sector in Wales came together to establish a multi-disciplinary team with varying expertise to co-produce the paper output from this study. The varying expertise gave a real insight for greater depth to be included in the study. An additional strength for the first study was that this was the fourth iteration of this study in the last eight years, this enabled a comparison to be drawn using similar measures to previous years. Another strength of the first study was the addition of physical literacy as an indicator of children's health and wellbeing, which is a theme that is present across the research; Wales was the only country in the world to include a physical literacy element.

Studies 2 and 3 both drew on the physical literacy theme and provide strengths in the depth of statistical analysis that was undertaken. Both studies account for the variance present between schools by using a multi-level model and control for several co-founders including age, body mass index, ethnicity, and socioeconomic status. **Studies 4 and 5** provided the qualitative element to this body of work, something that **Study**

1 largely advocated for, to offer a greater depth of understanding. The pandemic offered the opportunity for a ‘natural experiment’. **Study 5** used a longitudinal approach to examine changes in perceptions and behaviours throughout various lockdown restrictions.

Together with the individual strengths of each study, the body of work provides strength in using mixed methods research and design; there are numerous grounds to argue the use of mixed methods over a monomethod design (Johnson & Onwuegbuzie, 2004). The thesis also brings together the components of physical activity, motor competence and fitness to further build on Stodden et al’s (2008) Developmental Model and the updated review of this model by Barnett et al. (2022). **Study 1** provides a thorough overview of the state of physical activity and sedentary behaviour in Wales, which further adds to the evidence base for the need for such models to inform interventions to improve the poor levels of physical activity. It also allows for a longitudinal comparison of the grades that were allocated to each quality indicator of physical activity. **Study 2** contributes research that could further strengthen the pathways suggested between motor competence and health-related fitness as strong links were highlighted between swimming, cycling and physical fitness. **Study 3** may not directly contribute towards the Developmental Model, but it raises issues with the evidence behind the model as populations with additional learning needs or disabilities have been seemingly overlooked in the development of such a model. **Study 4** highlights how removing opportunities for physical activity can impact on a child’s quality of life and that there are several barriers and facilitators to physical activity within the home that need to be considered to inform home-based intervention. Home-based intervention would subsequently provide much needed intervention evidence to inform further development of the model. **Study 5** delivers on the longitudinal approach that Barnett et al. (2022) request.

Despite the strengths outlined, the empirical work in the thesis is not without its limitations. Whilst it has been highlighted that **Studies 1, 2 and 3** included large representative samples, **Studies 4 and 5** did not boast this same strength. As the two final studies were qualitative, naturally they had smaller sample sizes, yet these did not provide a representative sample with only two fathers being represented compared to 18 mothers based on a volunteer sample; and largely made up of families with high and medium levels of socioeconomic statuses. All studies, excluding **Study 3**, relied on self-reporting within the range of data that was used, and this can be problematic, due to recall bias, particularly with children. This overuse of self-report data has led to a lack of objective data across the body of work. Within **Study 1** there was a large reliance on self-report surveys and questionnaires of which, each have their own limitations. For example, the School Health Research Network (SHRN) survey incorporates the Health Behaviour in School-aged Children (HSBC) survey, which has shown reliability in assessing physical activity and sedentary behaviour, however, evidence is lacking on the validity of assessing sedentary behaviour (Su et al., 2022). The fitness tests that were used within **Study 2** were mostly validated as per the critique within the literature review. However, perhaps the most important component of fitness that was tested was cardiorespiratory fitness measured by the 20mSRT, which poses limitations such as motivation to continue and a child's ability to pace their running (Tomkinson & Olds, 2008). The Dragon Challenge, used in **Study 3**, has also reported limitations in terms of its generalisability, including its inclusivity for use with children with disabilities and in other cultures (Tyler et al., 2018). The main limitations within **Study 4 and 5** surround the use of self-reported behaviours via interviews and the lack of a representative sample.

9.4 FUTURE DIRECTIONS

Amalgamated, the studies within this research further emphasise the importance of monitoring and tracking children and young people's physical activity, physical fitness, and motor competence at a population-level. The findings have highlighted the importance of evaluating physical activity and its indicators in the paediatric population, particularly the changes and trends considering the COVID-19 pandemic. Further studies are warranted, and importance is placed on disseminating and translating the research into meaningful and practical outcomes.

Study 1 and the work produced as an outcome of the Active Healthy Kids Wales Report Card was a good starting point for identifying grades on children and young people's physical activity and changes in the physical activity indicators across Wales since the previous report card published in 2018. Despite providing a good insight into the state of children's physical activity in Wales, more can be done to improve the depth of research and the dissemination of such important messages from the Active Healthy Kids network. Other countries within the network have produced more detailed information using the same methods but including gender and deprivation breakdowns and some have gone on to produce a para-report card, using data from children and young people with disabilities. This would add a new dimension to the Active Healthy Kids Wales approach; findings from **Study 3** emphasise this need. Further research of a qualitative nature is also needed to help understand the reasoning behind the low grades - a practical suggestion includes a piece of research presenting the Report Card to a group of children and young people and exploring their journeys from the first Report Card in 2014 through to the latest study included in this thesis of the 2021 Report Card results.

Whilst a greater depth of understanding would be beneficial for **Study 1**, the same holds true for **Study 2**, where further objective measures such as device-based measures of physical activity would permit a greater insight into the frequency, intensity, and duration, as at present the motor skills of swimming and cycling and the sports club attendance were self-reported. Future research should focus on these foundational movement skills, to gain further insight into the importance of developing these at a young age, both for an increase in fitness and the subsequent positive health outcomes, but also for the opportunity to access a broad range of physical activities. Additional research in this area should include schools and their experiences with swimming and cycling, particularly with the new curriculum in Wales and the lack of citations for both skills within the health and wellbeing area of learning and experience.

Objective device-based measures could also enhance the findings of all studies. Whilst the relationship between motor competence and physical activity has been widely explored, the association between these two components in children with Additional Learning Needs has not, and the use of these measures would also enhance the field in this area. To my knowledge, only one study to date has focussed on device-based measures within the home environment during the pandemic (Sheldrick et al., 2022), therefore longitudinal changes within the home during and in the recovery from the pandemic would enhance this knowledge base and build on both **Studies 4 and 5. Study 5** was of a longitudinal nature and included a time-point in the recovery from the COVID-19 pandemic, however, further research is needed to continue to track the impact of the COVID-19 pandemic on children's physical activity and sedentary behaviours.

Overall, children's health and wellbeing should be priority of researchers to improve levels of physical activity, fitness and motor competence and there are many directions which the future research should take. All these routes should have a combined impact on providing understanding and information to those who can have an impact on the children, including parents/guardians, educators, and the children themselves. Further, intervention research is also needed. A whole systems approach is required to develop interventions with the aim of improving children's physical activity levels, motor competency and physical fitness. These interventions should be sufficiently evaluated through thorough research methods and using valid and reliable measures of physical activity, fitness, and motor competence such as those used in this thesis.

9.5 Considerations for Practical Applications & Recommendations

As a practitioner turned academic in physical activity, fitness, and motor competence, I consider myself a 'pracademic,' meaning someone who is both a practitioner and in academia. I am passionate about bridging the gap between research and practice and therefore, I believe that the practical applications and recommendations from this body of work are of paramount important. There has been a growing importance on closing the existing gap between research and practice, and although the gap is shrinking, the impact pathway of research on practice remains complex. Providing practical recommendations for professional practice has been a key part in my research journey, and being on a knowledge exchange scholarship has developed my skills in doing this. Not only have the studies and research within this body of work helped to inform practice at my company partner as part of the knowledge exchange scholarship, but the skills I developed enabled me to provide further practical considerations and recommendations to the company with the aim of improving their overall practice. This included providing a one-page overview with recommendations from **Study 2** (Appendix XI) together with co-creating and co-developing evaluations for their ongoing physical activity and play programmes.

Study 1 provided practical recommendations to improve the grades which were allocated to each quality indicator of children's physical activity and suggested that the results should be used to inform the decision making of policy makers and practitioners. The main recommendation was to prioritise the views of children and young people and understand their motives for being, or not being, sufficiently physically active; this is where there is a lack of qualitative evidence to support the grades given. **Studies 4 and 5** built on this suggestion and spoke to children and young people to gain their perceptions of physical activity and sedentary behaviour. Further, **Study 1** indicated that within policy, physical activity is seemingly conflated with 'obesity' and this needs to be rectified to reflect the wider health impacts of physical activity.

Practical considerations from **Study 2** involve the aforementioned changes to the curriculum in Wales and the importance of developing the proposed foundational movement skills of swimming and cycling. It is suggested that swimming should be explicitly reintroduced to the curriculum so that all children get the opportunity to learn the skill irrelevant of whether they have the opportunity away from school. Within England, swimming is still a key aspect of the curriculum and children are expected to reach a milestone of swimming 25m by the age of 11 years. This is not the case in Wales and giving schools the autonomy to create their own health and wellbeing curriculum, poses many challenges, including the lack of swimming opportunity and a reduction in active lessons.

Study 3 provides practical recommendations in the form of reducing motor competence inequalities between children with additional learning needs and those without. Physical educators should implement strategies within school to develop the motor competence of children with additional learning needs as school needs to be an inclusive environment.

Studies 4 and 5 highlight the issues with being physically active within the home environment and factors that can enable higher levels of physical activity within the home, such as having siblings, pets, available and easily accessible equipment, and parental support. These factors could be considered for children who are home-schooled full time to allow them to access sufficient levels of physical activity, including having equipment readily available.

In summary, from this body of work, there are four key practical applications and recommendations which, I propose, could help to improve children and young people's physical activity, physical fitness, and motor competence:

1. Listen to the views of children and young people; understand their reasoning for participation in physical activity and consider their opinions on how they would like to engage in physical activity and subsequently improve their fitness and motor competence.
2. Re-introduce swimming as a compulsory element on the curriculum. Not only is this from a safety point of view, but also as being able to swim allows access to a broad range of other activities through higher motor competence and an increased level of fitness.
3. Develop interventions to improve motor competence for a range of additional learning needs, rather than focusing on a specific additional learning need.
4. Provide at home opportunities to be physically active, such as making equipment available and accessible within the home environment.

Considering what needs to be done is one element of providing practical recommendations, but the other key element is how these would be effectively implemented. There are potential barriers to actioning these recommendations, and this is where policy needs to be reviewed, to enable positive change. The first practical recommendation would need researchers, practitioners, and policy makers to consult with children and young people before creating programmes or interventions, to ensure that their voices are heard and that programmes consider their opinions to maximise effectiveness. For the second key practical application, curriculum makers and schools need to consider the beneficial effects of learning to swim and include this as part of their own curriculum; this may require additional school funding to advocate for this activity. Funding would also be required to assist with the fourth practical recommendation by providing families with activity and skill promoting equipment to use it within the home. This has been trialled in one local authority in South Wales, with anecdotal positive outcomes.

With all these suggested considerations and recommendations for practical application of the findings, it is important to reflect on a whole system, holistic approach to ensure effectiveness of the proposed intervention at all levels. Schools, healthcare professionals, local sport development officers, parents, and government officials all have a responsibility to improve children's physical activity, fitness, and motor competence (National Institute for Health and Care Excellence, 2009). By implementing a whole systems approach, this would enable invested parties to work together to have maximum impact. Evaluation of any proposed programme is also imperative to continue to track outcomes.

9.6 Personal Reflections

As a practitioner in the field of physical activity, I embarked on this research journey wanting to further my knowledge on children's physical activity, fitness, and motor competence, and how these can be improved. The children I was working with at the time, were from deprived neighbourhoods and had limited opportunities for physical activity. These inequalities made me feel a sense of gratefulness for the physical activity opportunities that I had been exposed to from a young age, but also a horrible sense of injustice for these children. Within practice I often saw children who were overweight or obese, who struggled with their fitness and who were not meeting recommendations of physical activity; subsequently, having an anecdotal detrimental impact on their behaviour, social skills, and learning. I wanted my research to have a real-world impact on the lives of children and young people.

During the process of this research, it was too easy to become wrapped up in the technicalities, learning the statistics, the qualitative methods, and running the results, and to forget about the reason that these were being done. I was not only learning new skills, completing a PhD and gaining academic outputs, but I wanted to further research within this area and provide practical recommendations to improve the lives of children and young people. I often thought back to specific children I had worked with who deserved a right to be physically active but due to a vicious cycle of unfortunate events, they did not have this basic need fulfilled.

Reflexivity and reflection have both been important during the research process. I have always been a reflective individual and have engaged in taking a photo a day, accompanied with a caption, from the first to the last day of my PhD; this has helped me to reflect on my journey through starting a new life in the world of research. Reading back through some of my reflections has made me realise how much I have grown as a person and an academic through the process of completing this body of work all through the midst of a pandemic. Throughout the journey, I have gained both quantitative and qualitative research skills, learning how to analyse data at a complex level, conduct interviews with children and their parents and how to combine mixed methods findings to tell a meaningful story. I have disseminated these findings through a variety of methods and transferred knowledge to practitioners, with the aim of changing and improving elements in an applied setting. The skill that I have developed most throughout this process, is adaptability. The unforeseen pandemic turned the planned research upside down and although, at the time, I was extremely disappointed not to continue my research in the schools, I was able to further develop research skills and broaden my understanding of physical activity in a different context.

Who knows what the future will hold for me professionally or personally, but I do know that I want anything that I do to have a real-world impact. I am under no illusion that my research will change the world, but if every piece of research I conduct can provide at least one practical recommendation to a child, a parent, a teacher, or a sporting organisation with the aim of giving children better opportunities for physical activity, I will be content.

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11 Appendices

APPENDIX I: ACTIVE HEALTHY KIDS REPORT CARD

THE FOURTH PANDEMIC OF CHILDHOOD INACTIVITY IN WALES

ACTIVE HEALTHY KIDS WALES
REPORT CARD 2021

www.activehealthykidswales.net @AHK_Wales

Contents

Summary of Indicators and Grades

Physical Activity and Health Behaviour Outcomes	
Overall Physical Activity 17% of young people (11- to 16-year-olds) were active for at least 60 minutes across all seven days of the week. However, this figure decreased to 14% when only considering moderate-to-vigorous-intensity to align with international government guidelines. 22% of 8-11-year-old children participated in sport/exercise for at least 60 minutes across all seven days.	F
Organised Sport Participation On three or more occasions per week: 44% (7 - 9-year-olds, school years 3 and 4); 51% (9 - 11-year-olds, school years 5 and 6); 49% (11 - 14-year-olds, school years 7 - 9); 46% (14 - 16-year-olds, school years 10 and 11); 44% (16-year-olds); 46% (17-year-olds).	C
Active Play 42% of children and young people aged 5-17 years reported that they played outside most days and 33% reported playing outside a few days each week.	C+
Active Transportation Between 42% and 44% of primary school-aged children used active transport to travel to school. In two surveys of children aged 11 to 16-years, 35% and 33 % used active transport to travel to school, respectively. 73% of children aged 4-18 years used active travel to places where they play.	C-
Sedentary Behaviours 86% of young people (aged 11 to 16 years) spent two or more hours sitting during weekdays, with higher reports among boys and older children. 32% of children (aged 8-11 years) reported watching TV/screens for two hours or more every day of the week, with higher reports among boys and the most deprived grouping.	F
Physical Fitness When comparing to European Normative Values children were in the 40th percentile for both cardiorespiratory fitness and muscular fitness.	C-
Physical Literacy Physical competence 34%; confidence 69%; motivation 65% and PA 19%.	C-

Settings and Influences on Physical Activity and Health

Family and Peers Children reported 46% of adults were great and happy with children playing out. 10% of adults had volunteered in sport in the past 12 months, whilst 53% of adults met the MVPA guidelines of 150 minutes of physical activity per week.	D+
School 45% of primary schools offered an afternoon break. 69% of primary schools and 92% of secondary schools had at least one male specialist PE teacher, whilst 69% of primary and 80% of secondary schools had at least one female specialist PE teacher. 6% of children aged 11-12 years (school year 7) were offered the recommended 120 minutes per week, which decreased with age, with <1% of children aged 15 - 16 years offered this amount. 84% of primary (7 years old +) and 94% of secondary schools were offered regular access to extracurricular sport, whilst on average 66% across primary and secondary schools reported participation (68% males; 65% females). Indoor and outdoor space conducive to facilitate PA were provided to 72% of schools, whilst 64% of primary and 58% of secondary staff agreed/strongly agreed that their school has access to sufficient facilities to provide sport.	B-
Community and Environment 21% of people surveyed reported they were satisfied with places to play; 23% were very satisfied with clubs and activities; 21% were very satisfied with places to meet; 48% strongly agree that green space was suitable and 88% of children were happy with their area. 72% of children reported playing out, 24% reported being able to play everywhere they would like, 42% report great places to play, whilst 88% can walk to a park and 38% can walk to a facility. 45% reported feeling safe when playing in the Play Satisfaction Survey, whilst 70% reported feeling safe in the HAPPEN survey.	C
Government The RWG concluded that the grade would be decreased slightly from a C+ in 2018 to a C (50%) for this current Report Card. This is, in part, due to the expiry of previous policies specific to PA promotion that were subsequently replaced by an obesity policy that includes PA as one element. This was seen by the group as a retrograde step as it overlooks the wider health impacts of PA. There was also a perceived lack of progress in embedding PA in education policy and actions despite a recent revision of the national curriculum in Wales.	C

Active Healthy Kids-Wales Authors and Contributors

The Active Healthy Kids-Wales (AHK-Wales) Research Working Group (RWG) consisted of 21 members, including academics, postgraduate researchers, professionals, and practitioners with expertise in physical activity (PA) and access to national data sources. The academic lead (Professor Gareth Stratton) gained funding for and supervised the project, whilst the lead researcher (Amie Bethan Richards) led on sourcing and synthesising the data, organising the quality indicator (QI) groups and liaising with the Active Healthy Kids Global Alliance (AHKGA) regarding progress of the Wales RWG. The academic lead and lead researcher were also responsible for producing the Report Card and subsequent impact activity, including that of the website, social media, and further advocacy practices. Members of the RWG were allocated to QI groups, each with an associated lead, to collectively allocate grades to each QI.

Research Working Group Members

Project Lead	
1. Professor Gareth Stratton (GS)	Swansea University
Research Lead:	
2. Amie Bethan Richards (ABR)	Swansea University
Collaborators:	
3. Professor Kelly A Mackintosh (KAM) 4. Dr Nils Swindell (NS) 5. Malcolm Ward (MW) 6. Dr Emily Marchant (EM) 7. Dr Michaela James (MJ) 8. Professor Sarah Nicholls (SN) 9. Dr Maggie Miller (MMi)	Swansea University
10. Dr Lowri C Edwards (LCE)	Cardiff Metropolitan University
11. Dr Richard Tyler (RT)	Edge Hill University
12. Dylan Blain (DB) 13. Dr Nalda Wainwright (NW) 14. Dr Simon Williams (SW)	University of Wales Trinity Saint David
15. Marianne Mannello (MMa)	Play Wales
16. Dr Kelly Morgan (KM)	Cardiff University
17. Tim Evans (TE) 18. Amy Caterson (AC)	Sport Wales
19. Neil Canham (NC)	Sustrans
20. Julie Hobday (JH)	National Dance Company Wales
21. Dr Chris Roberts (CR)	Welsh Government

Acknowledgements

The RWG would like to thank The Waterloo Foundation for funding the project, grant number 1158-4603. ABR's work is funded by Knowledge Economy Skills Scholarship (KESS), as the funder of ABR's PhD. It is a pan-Wales higher level skills initiative led by Bangor University on behalf of the HE sector in Wales. It is part funded by the Welsh Government's European Social Fund (ESF) convergence programme for West Wales and the Valleys. Owain Stratton and Angelica Hart Lindh (hsc.studio) are also thanked for website production.

Funding

The AHK-Wales 2021 Report Card was developed through in-kind contributions from the RWG. Work was supported by a grant (1158-4603) from The Waterloo Foundation.

Philanthropic Contributions for AHK-Wales 2023

The AHK-Wales RWG is seeking funding from partners and stakeholders to develop the Active Healthy Kids-Wales 2023 Report Card.

Access to the AHK-Wales Report Card

Available on the Active Healthy Kids Wales website: www.activehealthykidswales.net

Referencing the AHK-Wales Report Card

Richards AB, Mackintosh KA, Swindell N, Ward M, Marchant E, James M, Edwards LC, Tyler R, Blain D, Wainwright N, Nicholls S, Mannello M, Morgan K, Evans T, Canham N, Hobday J, Caterson A, Williams S, Miller M, Roberts C and Stratton G. (2022). Active Healthy Kids Wales 2021 Report Card.

Future Report Cards

The Active Healthy Kids Wales 2021 Report Card is the fourth Active Healthy Kids Wales (AHK-Wales) Report Card following the inaugural, second Report Card and third Report Card published in 2014, 2016 and 2018, respectively.

The Active Healthy Kids Wales is part of the Active Healthy Kids Global Alliance 4.0 that will release Report Cards from 57 countries across 6 continents on 23rd October 2022 in Abu Dhabi, United Arab Emirates (UAE).

The target date for the publication of the next Active Healthy Kids Wales Report Card is in 2023.

Aims

The overall purpose of the AHK-Wales Report Card is to act as an advocacy tool and provide a lens over physical activity behaviours and influencing factors of children and young people within Wales.

The Active Healthy Kids Wales 2021 Report Card Aimed To:

1. Collate relevant data to provide a comprehensive overview of the status of physical activity and sedentary behaviour of children and young people across Wales.
2. Track trends in physical activity and sedentary behaviours in children and young people across Wales.
3. Present an international context for physical activity and sedentary behaviour in children and young people across Wales.
4. Identify gaps in the research and data related to children and young people's physical activity and sedentary behaviour across Wales.
5. Inform policy, strategy, services and professional practice in physical activity and sedentary behaviour in children and young people.
6. Make recommendations addressing the inequalities in physical activity that have been heightened by COVID-19 and associated lockdown measures.

Background and Context

The AHK-Wales RWG rationale for producing the AHK Report Card is that children and young people in Wales have some of the lowest levels of physical activity and fitness globally [1] and the highest prevalence of overweight and obesity in the UK [2]. Conversely, Wales is a policy pioneer in children's play [3], it has an Active Travel Act [4] and Well-being of Future Generations Act [5]. More recently, a new education curriculum with a statutory focus on health and wellbeing, of which physical activity is encompassed, this is coming into effect in September 2022.

The AHK-Wales RWG of academics, educators, and allied professionals are concerned about the health of children and young people in Wales. The group uses data on physical activity to advocate for children and young people's right to play, engage with sport and physical activity, and be active and healthy. The production of AHK Report Cards is to provide a clear evidence base on quality indicators related to physical activity. Given the Welsh Assembly's 20 recommendations [6] for augmenting children's physical activity, this Report Card aims to monitor their progress. The RWG and AHK network have agreed to focus on continuing impact activities between Report Cards by using the AHK-Wales 2021 results to advocate for investment in children and young people's physical activity.

Stages of Work

This is the fourth AHK-Wales Report Card following the inaugural [7], second [8] and third [9] Report Cards published in 2014, 2016 and 2018, respectively. Swansea University coordinated the work, supported by a national network of academics and professionals from sport, play, transport, public health, sport and exercise science, and education sectors. These constituents formed the RWG.

The RWG consisted of 21 academics and professionals from universities and the public sector in Wales. Professionals were invited to become part of the AHK-Wales RWG via e-mail in January 2020. The RWG consisted of researchers across four Universities in Wales and one university in England, professionals working in the Welsh Government, Play Wales, Sport Wales, and practitioners to co-produce the AHK-Wales 2021 Report Card.

Based on their expertise, eleven team leaders were assigned to specific indicators: Overall Physical Activity (KAM); Organised Sports Participation (RT); Active Play (MMa); Active Transport (NW); Sedentary Behaviours (KM); Physical Fitness (DB); Family and Peers (SN); School (EM); Community and Environment (MJ); Government (MW); Physical Literacy (NW).

The group met once a quarter between July 2020 and January 2022 with meetings lasting for approximately two hours (Figure 1). Over the seven meetings, AHK-Wales team leaders presented findings for the 11 indicators for the whole group. Discussions followed each presentation and consensus was decided on each grade. The RWG was co-ordinated by a project leader and a postgraduate researcher. The project leader (GS) secured funding for the project and outlined the programme of work. The research lead (ABR) was responsible for arranging meetings, finding data, contacting team leaders, and producing Report Card materials.

Meeting 1: 8th July 2020

1.1 Formation of 2021 RWG – Introductions
1.2 Review of 2018 Report Card including methodology
1.3 Discussion on what impact the group wants to have
1.4 AHKGA registration update

Meeting 2: 25th November 2020

2.1 Interim timelines set for group to work towards
2.2 Debate on whether to include COVID-19 data

Meeting 3: 10th February 2021

3.1 AHKGA updates including their proposed timeline
3.2 Discussion of appointment of group leaders
3.3 Detailed discussion of available data sources

Meeting 4: 12th May 2021

4.1 Confirmation not to use COVID-19 data
4.2 AHKGA Fitness and Active Play Webinar Feedback from DB and MMa
4.3 All groups (exception of sedentary behaviour and organised sport) presented data suitable to their group and opened discussion for next steps.

Meeting 5: 21st July 2021

5.1 Distribution and discussion of new benchmarks for Global Matrix 4.0
5.2 All groups provided updates and presented an interim grade

Meeting 6: 10th November 2021

6.1 Active play, physical fitness, physical literacy, and school groups presented updates
6.2 Example narrative production
6.3 Completed a table of grades from 2014, 2016, 2018, 2022 for comparison.

Meeting 7: 19th January 2022

7.1 Confirmation of funding allocation
7.2 Final grades presented and accepted

Figure 1. AHK-Wales 2021 RWG Meetings Outcomes.

Methodology

The AHK-Wales 2021 RWG collated and analysed results to assign grades using the "best possible evidence" from nationally representative data, for example, the National Survey for Wales and the School Health Research Network Surveys. This approach is consistent with past AHK-Wales Report Cards.

Following the AHK Global Alliance grading system, the RWG assigned an individual grade to each of the 11 indicators. The grading system used was developed by the Canadian group and is adopted by all countries participating in the AHK Global Alliance. The grades range from A+ where 94-100% of children are meeting the criteria, to F where 0-19% meet the recommended threshold. Inconclusive (INC) indicated that data was inadequate or not available (see Table 1).

Table 1. Active Healthy Kids Global Alliance grading system.

Grade	Descriptor	Prevalence
A+		94 - 100 %
A	Wales is succeeding with most children and adolescents	87 - 93 %
A-		80 - 86 %
B+		74 - 79 %
B	Wales is succeeding with well over half of children and adolescents	67 - 73 %
B-		60 - 66 %
C+		54 - 59 %
C	Wales is succeeding with about half of children and adolescents	47 - 53 %
C-		40 - 46 %
D+		34 - 39 %
D	Wales is succeeding with under half of children and adolescents	27 - 33 %
D-		20 - 26 %
F	We are succeeding with very few children and youth	< 20 %
Inc.	Incomplete grade - data not sufficient or adequate	N/A

This report is based upon the best available evidence and recognised that most of the available data in Wales were susceptible to bias (i.e., self-reported data as opposed to objective methods). However, this bias is evident around the globe as self-report data are cost-effective and accessible to larger populations. Further, the AHK-Wales 2021 RWG have included recommendations on the evidence required for future AHK-Wales Report Cards.

Process used to assign grades

The process that was used to assign the grades for the indicators consisted of:

1. Exploring and collating the best available evidence for each quality indicator. This resulted in the use of the following data: School Health Research Network (SHRN) Student Health and Wellbeing Survey (19/20) [10], SHRN School Environment Questionnaire (2019/20) [10], Sport Wales School Sport Participation Survey (2018) [11], Sport Wales School Sport Provision Survey (2018) [11], Further Education Sport and Active Lifestyles Survey (2018) [12], Health and Attainment of Pupils in a Primary Education Network (HAPPEN) Survey (2018-20) [13], Play Sufficiency Survey (2018/19) [14], The National Survey for Wales (2018/19) [15], Swan-Linx and Bridge-Linx Data (2013/20) Dragon Challenge Data (2014 - 2020) Movement Assessment Battery for Children (2018).
2. Each quality indicator was assigned a sub-group to work on assigning a grade and a group leader was appointed who organised sub-group meetings and led in the discussions and production of results.
3. During whole group meetings the sub-group leaders presented any developments since the last meeting and a rationale for using the surveys to best represent the indicator was discussed. Nationally representative data was preferable, but where not available, the best available data were used.
4. Data for each quality indicator were considered against a recommendation or benchmark aligned with the AHK Global Alliance guidelines.
5. The AHK Global Alliance provided guidelines on the percentages that represented each grade produced from a F to A+, including an INC grade which represented that there was inconclusive data to assign a grade as in Table 1.
6. Any biases in the data were recorded together with any inequality results that the data could provide, and any major gaps in the data were considered as limitations.
7. Each sub-group suggested recommendations for how to improve the grade or the measurement of the indicator.
8. The quality assurance and verification of grades process included the sub-group agreeing on a proposed grade, followed by presenting this to the wider AHK-Wales group referring to survey methodology and data quality. Following a whole-group discussion, grades were either confirmed or the sub-group would work on any suggestions before presenting again at the next meeting.

Results

The following sections provide an outline of each quality indicator and the criteria used to assign a grade including recommendations or benchmark, data sources used to assign grades including trends, biases, and gaps, and finally some suggestions on how to improve the grade in the future.

Physical Activity

Health Behaviours and Outcomes

Overall Physical Activity (F)

17% of young people (**11- to 16-year-olds**) were active for at least 60 minutes across all seven days of the week. However, this figure decreased to 14% when only considering moderate-to-vigorous-intensity to align with international government guidelines. 22% of **8-11-year-old** children participated in sport/exercise for at least 60 minutes across all seven days.

Background

The World Health Organization (WHO) defines physical activity as any bodily movement produced by skeletal muscles resulting in energy expenditure above resting. Physical activity therefore encompasses all activities (i.e., active transport, physical education, leisure time activities, exercise), irrespective of intensity (light, moderate or vigorous). Physical activity is associated with numerous positive health outcomes, such as preventing and managing non-communicable diseases (e.g., cardiovascular disease, cancer, and diabetes), improving physical (cardiorespiratory and muscular) fitness, reducing symptoms of anxiety and depression, enhancing bone strength and density, maintaining a healthy body mass, enhancing cognitive function, and improving overall well-being. Reducing physical inactivity for children and adolescents is a key priority: the Global Action Plan on Physical Activity 2018-2030[16] seeks to reduce physical inactivity by 15%.

The WHO released guidelines on physical activity in 2020[17] strongly recommending that children aged 5-17 years should do at least 60 minutes, on average, of moderate-to-vigorous-intensity, mostly aerobic, physical activity, across the week. Moreover, vigorous-intensity aerobic activities, together with those that strengthen muscle and bone, should be incorporated at least three days a week. Given the availability of evidence, the latter component of international guidelines could not be considered, so the Research Working Group focused on the overall time spent being physically active as the benchmark to allocate a grade to this indicator.

Benchmarks

Percentage of children and adolescents who meet the Global Recommendations on Physical Activity for Health, which recommend that children and youth accumulate at least 60 minutes of moderate-to-vigorous-intensity physical activity (MVPA) per day, on average.

Data Sources Used

1. The School Health Research Network's Student Health and Wellbeing survey (2019/2020), children aged 11 to 16 years (n=115,944)
2. The HAPPEN survey (2018-2020), children aged 8 to 11 years (n=1,329)

Deciding on a Grade

The School Health Research Network: Student Health and Wellbeing Survey (2019) collated self-report sedentary data on 110,877 children aged 11 to 16 years old. Distributed to 94% of schools (n=198) in Wales, young people were asked how many days, across a week, they were physically active for a total of at least 60 minutes. The survey found that 17.0% of young people (11- to 16-year-olds) were active for at least 60 minutes across all seven days of the week. However, this figure decreased to 14.4% when only considering moderate-to-vigorous-intensity to align with international government guidelines. More boys (18.4%) reported engaging in MVPA, in comparison to girls (10.3%) and those who identified as neither a boy nor a girl (17.7%). A decline in the proportion of young people was found in age, with the highest MVPA among Year 7 pupils (11 years; 20.0%) and the lowest among Year 11 pupils (16 years; 9.5%). A lower percentage (11.7%) of young people from less affluent families met the recommended daily physical activity guidelines, compared to 16.5% from more affluent families. The proportion of White (14.2%) and Black Minority Ethnic (14.9%) children reporting being active was similar.

The HAPPEN survey collected self-report data on 1,329 children aged 8 to 11 years old. The survey was distributed among 27 primary schools across three local authorities in Wales. Children were asked 'in the last seven days, how many days did you do sports or exercise for at least one hour in total?.' The survey showed that 22% of 8- to 11-year-old children did sport/exercise for at least 60 minutes across all seven days. Boys reported more engagement (27%) than girls (17%). There was little variation with age (21-24%) or socioeconomic status (20-24%).

The Research Working Group assigned an F to this category when taking the sample size and representation (i.e., sub-national population data for HAPPEN) into account. This grade has decreased from the 2018 AHK-Wales Report Card. However, it is important to note that the data utilised, and thus the questions used, for the 2018 overall physical activity indicator differed, with the current questions also capturing more specific MVPA, rather than total physical activity, in line with current guidelines and benchmarks. Furthermore, the data included refers to being physically active for 60 minutes 'across all seven days', rather than 'at least four days' or '60 minutes per day on average', which were deemed inappropriate given our national physical activity guidelines, available data, and divergence from our previous national Report Card. The current grade also incorporates a new dataset, with HAPPEN data availability for 2020.

Major Gaps in the Welsh Data

There continues to be no large-scale studies using device-based assessment of physical activity (e.g., accelerometery) of children and adolescents in Wales. This is particularly important given the evidence of over-reporting of physical activity levels via self-report when compared to accelerometer-measured physical activity. It could be proposed that the ongoing longitudinal device-based assessment of physical activity levels in 800 8- to 16-year-olds, stratified by age, sex, and socioeconomic status, across Wales, as part of the Welsh Institute of Physical Activity, Health and Sport (WIPAHS), should be expanded. Beyond the HAPPEN survey, there is currently limited research available in Wales for children under the age of 11 years and no data available for those under 8 years old. This needs to be addressed through robust, systematic, data collection methods. Greater attention needs to be given to socioeconomic patterning. Consideration should be given to 24-hour movements and behaviours. The effect of interventions to enhance physical activity levels need to be quantified.

How to Improve the Grade in the Future

The best available evidence shows that the majority of children and young people in Wales need to increase their physical activity levels. This can be achieved through a range of behaviours including dance, sport, active transportation, and active play.

A significant effort needs to be made to address the very low physical activity levels among young people in Wales. High-quality evidence using device-based measures, while simultaneously capturing information on the duration (e.g., per day, per week), context (e.g., school time, leisure time) and type (e.g., sport, active transport, play) of physical activity, is needed to inform the design of effective strategies, interventions, and policy.

Organised Sport Participation (C)

On three or more occasions per week: 44% (7 - 9-year-olds, school years 3 and 4); 51% (9 - 11 year olds, school years 5 and 6); 49% (11 - 14 year olds, school years 7 - 9); 46% (14 - 16 year olds, school years 10 and 11); 44% (16-year-olds); 46% (17-year-olds).

Background

There are currently no specific recommendations for the amount of sport and dance that children and young people should participate in. However, organised sport participation is one way to potentially increase overall physical activity levels in children and young people in Wales.

For the Active Healthy Kids Wales 2021 Report Card, Research Work Group has returned to using 'the percentage of children and young people who take part in sport on three or more occasions a week' as the benchmark for grading this indicator. Although Sport Wales' Vision of 'Every Child Hooked on Sport for Life' and the term 'hooked on sport' has now changed and is no longer used, the indicator (children/young people who take part in sport on three or more occasions a week) remains.

Benchmarks

For children ages 7-16 years old - The percentage of children who take part in sport on three or more occasions a week, in an extracurricular (school-based) or a community club setting. Curricular PE activity is not included.

For young people aged 16+ years old - The percentage of young people who take part in sport/physical activity on three or more occasions a week, in any setting.

Data Sources Used

1) Sport Wales, School Sport Survey (2018), children aged 7 to 16 years (n=118,893)
2) The Further Education Sport and Active Lifestyles Survey (2018), students aged 16+ years (n=3,857)

Deciding on a Grade

The School Sport Survey (2018) showed that 48% of children took part in sport on three or more occasions a week in an extracurricular or community club setting. These data showed an upward trend in the percentage of children taking part in sport on three or more occasions a week from 27% to 40%, in 2011 and 2013, respectively, and has levelled off at 48% over the last two survey cycles (2015 to

2018). Moreover, similar proportions of primary and secondary pupils participate in extracurricular or community sport three or more times per week - 47% of primary pupils in Years 3-6 and 48% of secondary pupils in Years 7-11. There remains a sex difference in participation levels, with 50% of boys and 46% of girls participating in extracurricular or community sport at least three times per week. Furthermore, socioeconomic inequalities also exist and have widened slightly from 2015 to 2018, with the gap in participation rates between the least deprived and most deprived increasing by 2% from 2015 (the disparity in participation between FSM1 (least deprived) and FSM4 (most deprived) in 2015 was 11%, the disparity in participation between these same two quartiles in 2018 was 13%). However, the gaps between ethnicities/ethic groups and between those who are impaired/disabled and those who are not, have closed from 2015 to 2018.

The Further Education Sport and Active Lifestyles Survey (2018) showed that 44% and 46% of students aged 16 and 17, respectively, take part in sport or physical activity on three or more occasions per week. The findings in relation to subgroups (sex, age, ethnicity, disability, and socioeconomic status) emphasise that inequalities exist. There remains a sex difference in participation levels, although this gap has closed from 2015 to 2018. Disparities between ethnic groups also exist, with students from a Black/African/Caribbean/Black British ethnic group being more likely to participate in sport/physical activity three or more times a week (45%) than White (43%) and Asian/Asian British (35%) ethnic groups. Furthermore, there remains a difference between those who are impaired/disabled and those who are not, with 33% of students with an impairment/disability participating three or more times a week in 2018, compared with 45% of those who did not identify an impairment/disability. This gap has widened from 2015 to 2018.

The Research Working Group assigned a C to this indicator as, 48% of children taking part in extracurricular (school based) or community club (outside of school) sport on three or more occasions per week, while 44% and 46% of students aged 16 and 17, respectively, take part in sport or physical activity on three or more occasions per week. Full calculation for grade: 'Taking part in sport on three or more occasions per week' = 44% (years 3-4) + 51% (years 5-6) + 49% (years 7-9) + 46% (years 10-11) + 44% (16-year-olds) + 46% (17-year-olds) /6 = 47% = C grade. This grade is unchanged from the 2016 AHK-Wales Report Card, but has decreased from the 2018 AHK-Wales Report Card. It is important to note that different questions and surveys were used for the grading of this indicator in 2018 compared to the 2014, 2016, and 2021 Report Cards. Therefore, the changes in grades across Report Cards should be viewed with caution.

Major Gaps in the Welsh data:

There is a lack of evidence on children of early years (under 5 years old), this needs to be addressed through systematic robust data collection methods. Current surveys regarding participation in sport/dance/physical activity promoting clubs in Wales do not capture the duration of the sessions that children and young people take part in. The 2018 School Sport Survey and the Further Education Sport and Active

Lifestyles Survey both used self-report methods, although, a major strength of the School Sport Survey is its reach and coverage, with the survey being the largest survey of its kind in the UK.

How to Improve the Grade in the Future

An increase in participation in sport, dance and organised physical activities/adventures in children and young people should be a priority in Wales, so that "everyone can have a lifetime enjoyment of sport" and Wales can be transformed into an Active Nation (The Vision for Sport in Wales, Sport Wales). To encourage participation, there should be a focus on maintaining investment in sport programmes, managing competitive structures in an inclusive manner, including a wider range of dance programmes, and introducing alternative sports. Promoting physical literacy and the inclusion of physical education as a core subject in the school curriculum should also be considered. In addition, efforts should be made to address the inequalities that exist. Finally, there is a need for more detailed research across the age range, including objective measures.

Active Play (C+)

42% of children and young people aged 5-17 years reported that they played outside most days and 33% reported playing outside a few days each week.

Background

There is no specific recommendation for the duration of time spent in active play or the amount of time being active outdoors. However, active play, particularly outdoors, contributes to overall physical activity. The UK-wide Chief Medical Officers' guidelines for physical activity recommend that to receive the health benefits from physical activity we should recognise the importance of play for children's development.

Children under 5 years old (Early Years) - Children who are capable of walking unaided should be physically active daily for at least 180 minutes (3 hours), spread throughout the day. For children who cannot yet walk unaided, physical activity should be encouraged from birth, especially through floor-based play and water-based activities in safe environments.

The physical activity guidelines for children and teenagers aged 5 to 18 years recommend that: Children should engage in a variety of types and intensities of physical activity every day to develop movement skills, muscular fitness, and bone strength. Activities can include hopping, skipping, and swinging on playground equipment using body weight or working against resistance.

Benchmarks

The Research Group used the percentage of children and youth who engage in unstructured/unorganised active play for several hours a day and the percentage of children and youth report being outdoors for several hours a day.

Data Sources Used

1) The Play Satisfaction Survey (2018/2019), children aged 4-18-years (n= 5,111)
2) The School Health Research Network's Student Health and Wellbeing survey (2019/2020), children aged 11 to 16 years (n=115,944)

Deciding on a Grade

For the benchmark *percentage of children and youth who report being outdoors for several hours a day,* we used information from the Play Sufficiency Survey 2018-2019 which asked how children how often they go out to play or hang out with friends. 42% of children aged 5-17 report playing out most days. 33% children report playing out a few days each week.

"I learn new things and climb trees" What children say about play in Wales, which reports on the survey data, indicates that 5,884 responses from children were included in the final data set. When set in context of the whole population of children in Wales (567,709), the sample provides a 95% probability that the responses accurately reflect the attitudes of the whole population. 51%% were girls and 49% were boys. The largest group responding (where ages were given) were aged 8 to 11 years (63%).

For the benchmark *percentage of children and youth who engage in unstructured/unorganised active play for several hours a day*, we used the School Health Research Network (SHRN) Student Health and Wellbeing Survey 2019/20. Playing with friends is included in the definition of exercise in the survey. 41.6 % responded 'often or more' to the question 'how often, during the most recent summer holidays, did you exercise in your free time so much that you got out of breath or sweated.'

Undertaken every two years, the survey provides a regular snapshot of 11-to-16-year old's' health behaviours. 198 (94%) schools participated, from which 119,388 11 to 16-year-olds provided responses (a 77% response rate)

The Active Play Indicator Group assigned a C+ to this category. When taking the Play Satisfaction Survey responses to the question 'days spent playing out' into account, the group slightly deviated from the recommended > *2h/day*. The group determined that responses of '*most days*' and '*a few days*' each week were representative of the benchmark 'several days' a week. When considered alongside the SHRN responses, a numerical grade of 58 was allocated. This grade has slightly improved from the last AHK-Wales Report Card completed in 2018. However, it should be noted that data for that Report Card only included the information from the response 'most days' each week.

Major Gaps in the Welsh Data

The SHRN survey only collected data on children aged 11 to 16 years old. The Play Satisfaction Assessment Survey only reported 13 of 22 local authorities in Wales. It was also not possible to identify the ages of around 2,000 children (out of nearly 6,000) in the survey. Also, collecting data from children in unstructured play in ethically and logistically challenging. Both the Play Satisfaction Survey and the School Health Research Network Survey use self -report methods to obtain data. The Play Satisfaction Survey is run by individual local authorities and methods for data collection vary across Wales. There is limited research available for children under 5 years old (early years) and where this is available, it tends to be gathered through parent surveys and views.

How to Improve the Grade in the Future

Playing is a natural and enjoyable way for children to keep well and be happy. It is their way of supporting their own health and wellbeing. There is a well-established body of solid evidence that shows the contribution that play, particularly self-organised play, can make to children's long-term and immediate wellbeing, to their physical health and to their mental health and resilience. The following can improve opportunities for play:

Prioritising the views of children:

- Piloting and developing space assessment tools that put children at the centre of informing how local communities are being used and can be utilised to benefit own health and wellbeing.

Making the most of community assets:

- Schools, as a central resource for the local community, should consider the options to make their school grounds available for free play after school and at weekends.

Protecting play time:

- Schools should include a minimum amount of time for play and break time for all children.
- These breaks should not be withdrawn as part of behaviour management or to finish off work.
- Schools should offer a range of opportunities that allow for child-led play

Active Transportation (C-)

Between 42% and 44% of primary school-aged children used active transport to travel to school. In two surveys of children aged 11 to 16-years, 35% and 33 % used active transport to travel to school, respectively. 73% of children aged 4-18 years used active travel to places where they play.

Background

Although there are no formal guidelines for active transport, active transport is widely promoted by the National Institute for Health and Social Care Excellence, Public Health Wales, Sustrans and the Department of Health as a simple and sustainable way to promote physical activity. Beyond its benefits to children's health through physical activity, which include improved cardiovascular fitness, better cardiometabolic health, improved body composition and academic attainment, active transport also reduces car travel leading to reduced congestion, air pollution and economic savings.

Benchmarks

The benchmark used by the Research Work Group to allocate a grade to this indicator were the proportion of children and young people who use active transport to get to school and to places where they play.

Data Sources Used

1. The National Survey for Wales (2018/2019), secondary school children (n= 950) and parents of primary school children (n = 1,450)
2. The HAPPEN survey (2018-2020), children aged 8 to 11 years (n=1,329)
3. The School Health Research Network's Student Health and Wellbeing survey (2019/2020), children aged 11 to 16 years (n=115,944)
4. The Play Satisfaction Survey (2018/2019), children aged 4-18-years (n= 5,111)

Deciding on a Grade

The National Survey for Wales (2018/2019) asked secondary school children (n= 950) and parents of primary school children (n = 1,450) how they/their child travels to school on a typical day. The survey showed that 44% and 33% of primary and secondary school children respectively, use active modes of transport to travel to school. A small gender difference was seen with a higher proportion of boys (46%) using active transport to primary school compared to girls (43%). At secondary school, this trend was reversed with more girls using active transport (35%) compared to boys (31%). The proportion of children using active transport was also greater in urban compared to rural primary schools (urban 47%; rural 34%) and secondary schools (urban 40%; rural 19%). In this survey there has been no change in the proportion of children using active transport since the last survey conducted in 2016/2017. However, there was an increase in the proportion (from 8% to 12%) of primary school children walking alone.

The HAPPEN survey (2018-2020) asked children aged 8 to 11 years (n=1,329) how they got to school and how they got home from school on the previous day. The survey showed that 42% of children used active travel to school and 45% used active travel to get home. A small gender difference was seen with a higher proportion of boys using active travel to (43%) and from (48%) school compared to girls (41% to school and 43% from school). The proportion of children using active transport also increased with age with 45% and 51% of children in Year 6 used active travel to and from school respectively compares to 37% and 41% in Year 4. When drawing comparisons across socioeconomic groups, there was a clear gradient, with the most affluent group reporting higher active travel (37%) compared to the most deprived (21%).

The School Health Research Network's Student Health and Wellbeing survey (2019/2020) asked children aged 11 to 16 years (n=115,944) how they travelled to school on a typical day. The survey showed that 35% of children used active transport to get to school. Reports were found to be higher among boys (37%) than girls (33) % and reports were higher among the most deprived children (42%) compared to the most affluent (32%).

The Play Satisfaction Survey (2018/2019) asked children aged 4-18-years (n= 5,111) How they usually travel to 1) school and 2) places where they play. The survey showed that 42% of children used active transport to get to school and 73% used active transport to get to places of play. Report for both questions were found to be higher for boys (to school 43%; to places for play 76%) compared to girls (to school 41%; to places for play 70%). There was a clear gradient between age and transport to school with reports increasing with age (5-7-year-olds 35% vs >14-year-olds 60%). Report for active transport to places of play also varied by age but did not follow a clear gradient. The lowest reports were seen in the 8 to 11-year-olds (69%) compared to >14-year-olds (79%).

The Research Working Group assigned a C- to this category, considering that active transport to school ranged between 33% and 43% and accounting for the first inclusion of a question addressing active transport to a destination other than school. This grade has increased from a D+ in the last AHK-Wales Report Card completed in 2018. It is important to note that the grade increase reflects the inclusion of more data sources and in particular the inclusion of data on active transport to destinations other than school. Thus, this grade provides a more complete picture of this indicator opposed to reflecting evidence of an upward trend in the use of active transport.

Major Gaps in the Welsh Data

There has been an increase in the data for this indicator compared to previous Report Cards. Thus, this grade provides a more complete picture of the indictor. However, this data is all self-report and does not monitor the frequency, intensity, time, or type of active transportation, this would provide a more comprehensive understanding of children and young people's active transportation.

How to Improve the Grade in the Future

This is the first AHK-Wales Report Card to include data on active transport to a destination other than school and it demonstrates that transport behaviours differ according to context. More data is needed on transport in different settings that provide the opportunity for active transport, such as travel to shops, recreational facilities and visiting friends and family.

Sedentary Behaviours (F)

86% of young people (aged 11 to 16 years) spent two or more hours sitting during weekdays, with higher reports among boys and older children. 32% of children (aged 8-11 years) reported watching TV/screens for two hours or more every day of the week, with higher reports among boys and the most deprived grouping.

Background

Sedentary behaviour is characterised as any waking behaviour whereby energy expenditure ≤1.5 metabolic equivalents (METs), while in a sitting, reclining, or lying posture. Sedentary behaviour is related to poor health outcomes among children and adolescents, such as poorer cardiometabolic health and fitness, increased adiposity, poorer behavioural conduct/pro-social behaviour, and reduced sleep duration. An emerging evidence base also suggests sedentary behaviour is associated with well-being and quality of life. Children and young people typically spend a large proportion of their day engaging in sedentary pursuits, such as sitting down whilst at school (e.g. during lessons or break time), non-active travel (e.g. bus or car), and sitting during leisure time (e.g. watching television or playing video games). It is currently unknown whether a dose-response relationship exists between sedentary behaviour and health outcomes among young people. That said, the World Health Organization (WHO) notes that adverse health effects of sedentary behaviour are generally stronger for television viewing or recreational screen time than for total sedentary time. Earlier studies observed a reduction in physical and psychosocial health outcomes amongst young people who spend less than two hours engaging in sedentary behaviours.

Benchmarks

The benchmark used by the Research Working Group to allocate a grade to this indicator was 'the percentage of young people who exceed the recommended sedentary time guidelines (i.e. two or more hours)'. Data on sedentary behaviours, such as time spent sitting during free time on weekdays or screen time, were used.

Data Sources Used

1. The HAPPEN survey (2018-2020), children aged 8 to 11 years (n=1,329)
2. The School Health Research Network's Student Health and Wellbeing survey (2019/2020), children aged 11 to 16 years (n=115,944)

Deciding on a Grade

The School Health Research Network: Student Health and Wellbeing Survey (2019) collated self-report sedentary data on 110,877 children aged 11 to 16 years old.

Distributed to 198 schools in Wales, young people were asked how much time spent sitting they had undertaken outside of school hours during free time on weekdays.

The survey showed that 86.4% of young people spent two or more hours sitting during weekdays. Reports were found to be higher among boys (87.2%) compared to girls (85.7%). When drawing comparisons across age groups, there was a clear gradient, with the lowest 'two or more hour' reports among Year 7 pupils (76.7%) and the highest reports among Year 11 pupils (92.2%). No clear patterning in 'two or more hours' reports were found when comparing across socioeconomic (low 86%, medium 87.5% and high 86.2%) or ethnic (White 86.7% vs Black, Asian and minority ethnic 86.1%) groupings.

The HAPPEN survey collected self-report data on 1,329 children aged 8-11 years old. The survey was distributed among 27 primary schools across three local authorities in Wales. Children were asked 'In the last 7 days, how many days did you watch TV/play online games/use the internet etc. for 2 or more hours a day (in total)?'.

The survey showed that 32% of children reported watching TV/screens for two hours or more every day of the week. The proportions reported between boys and girls were different (34% boys and 31% girls). Across the school year groups, the highest reports of daily screen time were found among children in Year 5 (aged 9-10 years; 36%) compared to Year 4 (33%) and Year 6 (29%) peers. Socioeconomic data showed a difference in proportions, with 37% and 21% of the most deprived and most affluent children, respectively, reporting two or more hours of screen time daily.

The Research Working Group assigned an F to this category when taking the sample characteristics into account (i.e. sample representation and self-reporting). This grade has not changed from the 2018 AHK-Wales Report Card. It is important to note that the questions used for the 2018 sedentary indicator differ, with the 2018 questions also capturing sedentary behaviours on weekends. The current grade also incorporates a new dataset, with HAPPEN data availability for 2020.

Major Gaps in the Welsh Data

Both the School Health Research Network: Student Health and Wellbeing Survey and the HAPPEN survey used self-report methods to obtain data on sedentary behaviour. There are no large-scale studies using device-based assessments of sedentary behaviour, for example, with the use of accelerometers, in the United Kingdom. Beyond the HAPPEN survey, there is currently limited research available in Wales for children under the age of 11 years. This gap needs to be addressed through robust, systematic, data collection methods. Greater attention needs to be given to socioeconomic patterning, exploring sedentary periods on a continuum and by behaviour. The effect of interventions to reduce time spent sitting needs to be quantified.

How to Improve the Grade in the Future

The best available evidence shows that the majority of children and young people in Wales need to reduce their time spent sedentary. A significant effort needs to be made to address the very high amount of time spent in sedentary pursuits among young people in Wales. To inform the design of effective strategies, there is a need to first generate high-quality evidence using device-based measures, while simultaneously capturing information on the duration (e.g. per day, per week), context (e.g. school time, leisure time) and type (e.g. sitting using the phone, watching television) of sedentary behaviours.

Physical Fitness (C-)

When comparing to European Normative Values children were in the 40th percentile for both cardiorespiratory fitness and muscular fitness.

Background

Physical fitness is defined as Characteristics that permit a good performance of a given physical task in a specified physical, social, and psychological environment.

Physical fitness comprises multiple components. However, evidence shows cardiorespiratory and muscular fitness to be important indicators of for health and well-being in young people [18] these components were utilised within this narrative for physical fitness. Such an approach was also used in the 2018 Australian Report Card.

Benchmarks

Average percentile achieved on certain physical fitness indicators based on the normative values published by Tomkinson et al. (2018) [19].

Data Sources Used

1. Swansea University Fun Fitness days (2013 - 2020) through the Swan-Linx & Bridge-Linx projects, children aged 9 - 12 years, (n=4,778)

Deciding on a Grade

The overall grade for physical fitness was decided upon using comparison of the best available data to the Tomkinson et al (2018) data as indicated by the AHK Global Matrix 4.0 benchmarks. Available data for both cardiorespiratory fitness and muscular fitness were used. Based on the best available data from the Swansea University Fun Fitness Days data, the Research Working Group assigned a C- to this category as for both cardiorespiratory fitness and muscular fitness boys and girls from Wales typically fall into the 40th percentile.

Major Gaps in the Welsh Data

There remains a lack of nationally representative data for all components of fitness across childhood and adolescence. Consideration should be given to how such surveillance methods could be implemented to monitor the fitness of young people so that the effectiveness of different policy, programmes and initiatives on physical fitness can be assessed.

How to Improve the Grade in the Future

To improve this grade, greater opportunities for young people in Wales to regularly engage with health-enhancing levels of physical activity are required. These should come from the full range of contexts including:

- Schools - Recent curriculum developments in Wales provide an excellent opportunity to consider how young people can be best supported to lead active and healthy lives, particularly under the health and well-being area of learning experience.
- School based physical education
- Active play
- Extracurricular clubs
- Active transport

Fun and engaging activities that maximise opportunity for physical activity and develop long-lasting motivation for physical activity throughout life should be the focus.

Physical Literacy (C-)

Physical competence 34%; confidence 69%; motivation 65% and PA 19%.

Background

Sport Wales adopts Whitehead's definition of physical literacy, namely: "the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life" [20]. Physical literacy is considered a 'holistic' concept and acknowledges the physical, affective, and cognitive domains as equally important [21]. Sport Wales' definition is comprised of physical skills, confidence, motivation, knowledge and understanding and lots of opportunities and illustrated in Figure 2.

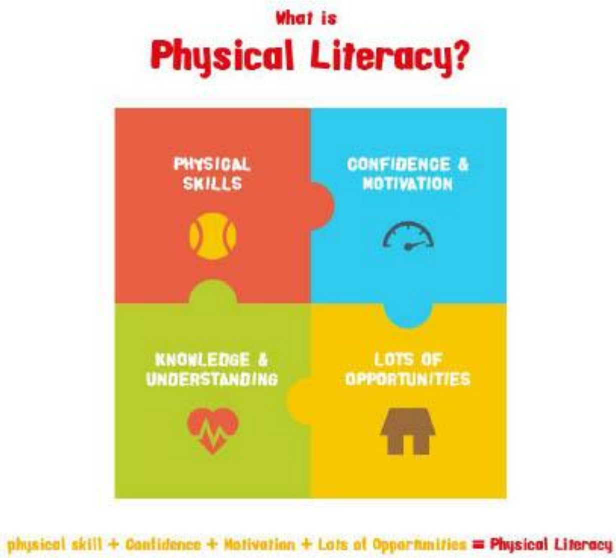

Figure 2. Sport Wales' definition of physical literacy

Sport Wales continues a focus on physical literacy with a group of physical literacy consultants appointed to support the work of national governing bodies of sport. This alters the focus to a more community and lifelong approach supporting the national governing bodies to reflect principles of physical literacy in their work.

Benchmarks

There were no set benchmarks from the Active Healthy Kids Global Alliance for this indicator. However, The Research Work Group explored the best available representative data to assign a physical literacy grade. In doing this, the Group divided the concept into four sub-indicators: Physical Competence, Motivation, Confidence and Physical Activity as a behaviour that was representative of physical literacy.

There was no available data for the cognitive (Knowledge and Understanding) domain. However, there were data from six sources to support a score in Physical Competence, Motivation, Confidence and Physical Activity.

Data Sources Used

1. The HAPPEN survey (2018-2020), children aged 8 to 11 years (n=1,329)
2. The School Sport Survey (2018), children aged 7-16 years (n=118,893)
3. The Further Education Sport and Active Lifestyles Survey (2018), students aged 16+ years (n=3,857)
4. Dragon Challenge (2014-2020), children aged 9 12 years (n=4555)
5. Movement Assessment Battery for Children (Movement ABC) (2018), children aged 5 - 7 years (n=92)

Deciding on a Grade

Physical Competence -33.8%

The Dragon Challenge showed that 65% of children achieved bronze and silver categories whilst 35% of children achieved gold, showing good levels of competence. More girls than boys in the bronze and silver categories for girls, those living in quintile one (most deprived) had a significantly lower adjusted mean DC score than quintiles two, four, and five (least deprived). While for boys, adjusted mean Dragon Challenge score was significantly lower in quintile one compared to quintiles three, and five.

The Movement ABC Data showed that 67.4% of the children scored under the 15th percentile: 48.9% were 'red category',18.5% were 'amber category,' 32.6% were classed as having no movement difficulty ('green category').

Confidence - 69.4%

The HAPPEN Survey highlighted that 86% *'feel confident to take part in lots of different activities,'* and 83% *'feel good at lots of different activities.'* Whilst the Sport Wales, School Sport Survey showed that 79.8% *'confident in trying new activities'* and 58.7% *comfortable in taking part in PE lessons and school sport.'* The

Further Education (FE) Sport and Active Lifestyle Survey reported that 54.5% were *'confident in trying new sports.'*

Motivation - 64.9%

The HAPPEN Survey showed that 92% *'want to take part in physical activity'* whilst in the Sport Wales, School Sport Survey 62.9% reported that they *'enjoy PE lessons a lot.'* In the FE Sport and Active Lifestyle Survey 40% *'enjoy doing sport when not at college a lot.'*

Physical Activity - 19%

The SHRN data showed that 18% of 11-to-16-year olds were active for at least 60 minutes across all seven days (26% Year 7; 12% Year 11). This reduces to 14.4% when looking at MVPA (20.0% in Year 7; 9.5% Year 11). The HAPPEN Survey showed that 20% were 'physically active for one hour or more every day.'

Based on the scores from the subcategories giving an overall score of 46.7%, the Research Work Group decided to grade Physical Literacy as C-. It is important to recognise that levels of confidence and motivation are considerably higher in the younger age groups and there is a noticeable decline across the age group from Primary to FE.

Major Gaps in the Welsh Data

Current research still does not account for the holistic nature of the concept. Research tends to consider the domains separately and there is limited research that considers interactions between the domains. As such, there is a need to be more consideration of qualitative and mixed methods approaches to capture more experiences of physical literacy journey.

How to Improve the Grade in the Future

Investment from Welsh Government in this concept via Sport Wales continues to be implemented, which could aid in improving the grade. Whilst the new curriculum within Wales may mean greater focus on more holistic aspects of concept. There is a potential for work in Sport Wales with Physical Literacy consultants and Welsh Institute for Physical Activity Health and Sport for opportunities to consider different forms of data for assessing Physical Literacy which could be used in future Report Cards.

Settings and Influences on Physical Activity and Health

Family and Peers (D+)

Children reported 46% of adults were great and happy with children playing out. 10% of adults had volunteered in sport in the past 12 months, whilst 53% of adults met the MVPA guidelines of 150 minutes of physical activity per week.

Background

There are currently no specific recommendations regarding the influence of family and peers on the meeting of recommended physical activity guidelines. However, research across varying age groups and geographic settings has shown that encouragement by and/or participation of family and peers in activity can increase children's own levels of physical activity and subsequently their overall health (1-5).

Benchmarks

1) *% of family members who facilitate physical activity and sport opportunities for their children (based on % volunteering in sport during the past 12 months)*

2) *% of parents who meet the Global Recommendations on Physical Activity for Health (at least 150 min of moderate-intensity aerobic physical activity or least 75 min of vigorous-intensity aerobic physical activity weekly)*

3) *% of children and youth with friends and peers who encourage and support them to be physically active (based on response to question, "What are adults like when you play?")*

Data Sources Used

1. The Play Satisfaction Survey (2018/2019), children aged 4-18-years (n= 5,111)
2. The School Health Research Network's Student Health and Wellbeing survey (2019/2020), children aged 11 to 16 years (n=115,944)
3. Sport Wales, School Sport Survey (2018), children aged 7-16 years (n=118,893)

Deciding on a Grade

The Play Satisfaction Survey showed that children reported 46% of adults were "great and happy with children playing out," with another 43% indicating adults are "ok and alright about children playing out." The National Survey for Wales (2018/19) showed that 10% of adults had volunteered in sport in the past 12 months, whilst 53% of adults met the MVPA guidelines of 150 minutes of physical activity per week.

Based on the findings described above, the Research Working Group assigned a D+ to this indicator. This reflects the averaging of (10% + 53% + 46%)/3 = 36% = Grade D+. This grade has increased slightly from the 2018 AHK-Wales Report Card grade of a D. It is, however, important to note that different questions and surveys were used for the grading of the 2021 Family and Peers indicator compared to the 2014 and 2016 Report Cards, which included response to a question concerning the probability of children being 'hooked on sport' (percentage of children who take part in sport on 3 or more occasions a week, in an extracurricular (school-based) or a community/club setting if their parents or peers/friends are also involved in sport. This question has since been removed from the survey in which it formerly appeared. Therefore, the changes in grades across Report Cards should be viewed with caution.

Major Gaps in the Welsh data

The is no data available to assess two of the five suggested benchmarks (% of family members (e.g., parents, guardians) who are physically active with their kids, and % of children and youth who encourage and support their friends and peers to be physically active). Data used to assess two of the remaining three benchmarks are tangential to these rather than directly aligning with the guidelines proposed. More and better data are needed to assess this area.

How to Improve the Grade in the Future

Research has shown that encouragement by and/or participation of family and peers in activity can increase children's own levels of physical activity and subsequently their overall health. Parents are therefore urged to engage in physical activity or sports with their children on a regular basis, especially in the evenings and on weekends and holidays. Parents should support the use of active transport options where it is safe and feasible. They should also encourage their children to explore physically active challenges within their local/home environment, and to participate in clubs/groups that involve physical activity.

School (B-)

45% of primary schools offered an afternoon break. 69% of primary schools and 92% of secondary schools had at least one male specialist PE teacher, whilst 69% of primary and 80% of secondary schools had at least one female specialist PE teacher. 6% of children aged 11-12 years (school year 7) were offered the recommended 120 minutes per week, which decreased with age, with <1% of children aged 15 - 16 years offered this amount. 84% of primary (7 years old +) and 94% of secondary schools were offered regular access to extracurricular sport, whilst on average 66% across primary and secondary schools reported participation (68% males; 65% females). Indoor and outdoor space conducive to facilitate PA were provided to 72% of schools, whilst 64% of primary and 58% of secondary staff agreed/strongly agreed that their school has access to sufficient facilities to provide sport.

Background

Children spend a large proportion of their waking hours in the school setting, and thus schools are considered a key setting for providing opportunities for physical activity. Physically active behaviours can be facilitated through school design, provision of facilities and equipment and curricular and extra-curricular opportunities.

Benchmarks:

1. *% of schools with active school policies (e.g., daily physical education (PE), daily physical activity, recess, "everyone plays" approach, bike racks at school, traffic calming on school property, outdoor time).*
2. *% of schools where the majority (≥80%) of students are taught by a PE specialist.*
3. *% of schools where the majority (≥80%) of students are offered the mandated amount of PE*
4. *% of schools that offer physical activity opportunities (excluding PE) to the majority (>80%) of their students*
5. *% of children who have access to PA opportunities at school in addition to PE*
6. *% of schools with students who have regular access to facilities and equipment that support physical activity (e.g., gymnasium, outdoor playgrounds, sporting fields, multipurpose space for physical activity, equipment in good condition)*

Data Sources Used

1) The HAPPEN survey (2018-2020), children aged 8 to 11 years (n=1,329)
2) SHRN School Environment Questionnaire (SEQ) 2019/20 (2020 report)
3) Sport Wales, School Sport Survey (2018), children aged 7-16 years (n=118,893)
4) Sport Wales, School Sport Provision questionnaire (completed by PE teacher/coordinator from all state primary (n=869) and secondary schools (n=186) in Wales)

Deciding on a Grade

Benchmark 1 -The HAPPEN survey asked children aged 8-11 '*Does your school have an afternoon break?*' Out of 134 primary schools, 45% (n=60) offered an afternoon break. No data was available for secondary schools. This dataset is not nationally representative, however no other school policy data were available.

Benchmark 2 - The School Sport Survey (provision) asked '*Over the course of the CURRENT academic year (2017-2018), how many teachers or teaching assistants have helped to deliver P.E. and sport activities in the school?*'. Stratified by gender, 69% of primary schools and 92% of secondary schools had at least one male specialist PE teachers, and 69% of primary and 80% of secondary had at least one female specialist PE teacher.

Benchmark 3 - The SHRN SEQ 2019-20 asked how many minutes per week were allocated to PE within the formal curriculum. Results show a concerningly low proportion of schools offering the mandated (120 minutes) amount of PE, and a decrease from 6% in year 7 to 1% in year 11 (school year: 8: 6%, 9: 4%, 10: <1%). Results from the School Sport Survey (provision) 2018 showed a mean of 99 minutes per week allocated to PE per week in primary schools and 95 minutes in secondary schools. Though this data source was not included in the grade as it does not align specifically with the benchmark, this is below the recommended 120 minutes. Further data shows that 55% of primary and 83% secondary PE teachers/coordinators agree that '*more time should be devoted to PE at my school*'. Whilst a promising finding from this provision survey shows that 82% of primary (years 3-6) and 96% of secondary (years 7-11) PE teachers/coordinators agree that '*the quality of PE delivery at the school is generally high*', this is not reflected in results from the participation survey with pupils. Results show that 57% of females and 69% of males report to enjoy PE lessons '*a lot*', with a higher majority of those in primary school reporting this (73% compared to 54% in secondary school).

Benchmark 4 - The School Sport Survey (provision) 2018 survey asked '*Which year groups have access to regular extracurricular sport/PE? (minimum of once per week throughout a season or term).*' On average, 84% of primary (years 3-6) and 94% of secondary schools (years 7-11) offered their year groups regular access to extra, overall average 89%. Using a different cut-point, the SHRN SEQ questionnaire showed 72% of secondary schools offer physically active opportunities to at least three class years 3-5 days per week. 57% primary and 66% of secondary schools in the School

Sport Survey (provision) survey report that *more time should be devoted to extracurricular sport.*

Benchmark 5 - The School Sport Survey (participation) completed by pupils reported *'Any participation in extracurricular sport in the past year (All young people in Wales in school years 3 to 11 (n=118,893))'*. Average results show 66% of children and young people report any participation, with this ranging from 74% in primary (years 3-6) to 60% in secondary school (years 7-11). There were minimal differences by gender (males: 68%, females: 65%). Differences in participation were observed by local authority differences, ranging from 58% to 79%.

Benchmark 6 - Response categories to '*student access to physical activity resources outside of lesson time (during lunch/after school)*' were refined to include a minimum requirement of indoor (gym/sports hall) and outdoor (playground/sports field/grass pitches) spaces that are conducive to/facilitate physically active behaviours. Indoor facilities were available to 75% (during lunch) and 80% (after school) and outside facilities to 77% (during lunch) and 53% (after school) of schools; overall average: 72%. 64% of primary and 58% of secondary staff strongly agreed/agreed slightly that their school has access to sufficient facilities to provide sport, though this question did not include a broader reference to physical activity.

The benchmarks specific to the School indicator capture a broad range of components of the school environment including policy, dedicated PE curriculum time, PE specialist staff, wider physically active opportunities, children's access to PA opportunities, access to PA facilities and equipment. The School Working Group recognise these benchmarks to be of equal importance and assigned even weighting, assigning an overall average of 60% and a grade of B-.

Major Gaps in the Welsh data:

The data sources used for the School indicator relied on self-report surveys completed either by PE coordinators, senior management, or pupils. Given the nature of the benchmarks, assessing these through objective measures would be challenging and self-report surveys provide a low-cost method in assessing population-level data relevant to schools. This therefore means that some of the data available does not necessarily reflect specific benchmark outcomes

How to Improve the Grade in the Future

The new *Curriculum for Wales* is due to be rolled out from 2022, with a renewed statutory focus on *Health and Wellbeing* as one of six *Areas of Learning and Experience* of the new curriculum. Whilst this step forward may enable schools to place direct focus on health and wellbeing behaviours including physical activity through the curriculum and wider school policy, there will not be mandated time requirements for PE provision. The new curriculum provides schools with autonomy to design and implement a curriculum that meets the needs of their pupils, and it is up to individual schools to decide on the importance and value placed on activities to facilitate physically active behaviours both within the curriculum and wider school environment. It is likely this will vary considerably between schools, local authorities, and regions. It is important for future research and surveillance to track school-level differences in whole-school physical activity/PE provision, and evaluation research could examine this variation and its association with children's outcomes across education, health and wellbeing. The School Research Working Group proposes recommendations for consideration:

- The *Curriculum for Wales* should include a minimum amount of time for physically active opportunities including PE, play and break times, and extra-curricular activities.
- Physically active opportunities should be prioritised and not withdrawn or replaced by other school commitments. This includes protecting play and break time for children.
- Schools should offer a range of physically active opportunities throughout the school day and should consult with pupils to explore types of activity requested and tailor activity provision to the needs and voices of pupils.

Community & Environment (C)

21% of people surveyed reported they were satisfied with places to play; 23% were very satisfied with clubs and activities; 21% were very satisfied with places to meet; 48% strongly agree that green space was suitable and 88% of children were happy with their area. 72% of children reported playing out, 24% report**ed** being able to play everywhere they would like, 42% report great places to play, whilst 88% can walk to a park and 38% can walk to a facility. 45% reported feeling safe when playing in the Play Satisfaction Survey, whilst 70% reported feeling safe in the HAPPEN survey.

Background

Built environments, and well-functioning local communities (the spaces where young people live, go to school and play, have been cited as important facilitators of physical activity. The Community and the Environment indicator refers to perceived safety, access, and availability of facilities and spaces that provide opportunities for physical activity in children and young people. Research using objective measures of physical activity via accelerometry has shown the number of park spaces, multi-use pathways (e.g., pavements for walking and cycling) and gyms in local neighbourhoods positively influences physical activity levels. However, there are no specific recommendations.

Benchmarks:

1) *% of children or parents who perceive their community/municipality is doing a good job at promoting physical activity (e.g., variety, location, cost, quality) = C-*

2) *% of children or parents who report having facilities, programs, parks, and playgrounds available to them in their community = C*

3) *% of children or parents who report living in a safe neighbourhood where they can be physically active = C+*

Data Sources Used

1) The National Survey for Wales (2018/2019), secondary school children (n= 950) and parents of primary school children (n = 1,450)
2) The Play Satisfaction Survey (2018/2019), children aged 4-18-years (n= 5,111)
3) The HAPPEN survey (2018-2020), children aged 8 to 11 years (n=1,329)

Deciding on a Grade

The National Survey for Wales asked about dissatisfaction/satisfaction of places to play outdoors (21% were very Satisfied), how satisfied, or dissatisfied participants were with clubs or activities in the local area (23% were very satisfied), how satisfied or dissatisfied participants were with places to meet and get together (21% were very satisfied), whether local green space is suitable for children and young people (48% strongly agreed). The questions were reliant on subjective self-report of perceptions of the local areas in Wales and were adult-led. There was no available data by age, gender, or deprivation.

During the 2019 play sufficiency assessment process, Play Wales asked all 22 local authorities to share their survey data. Play Wales received data from 18 local authorities, but when data were examined, 13 had provided information in a format required to support the development of a consistent data set. Additionally, because the sample is opportunistic (respondents were not chosen but chose to participate) the proportion of children and teenagers responding in each local authority varied widely. It was not feasible to assess the participants ages. In total, 5,884 responses from children were included in a final dataset.

The 'What Children Say About Play In Wales' reported on what type of places children could hang out in (72% reported playing out), if children could play in all the places they wanted to (24% reported they could play in them all), how good the places they play were (42% said they were great), do they feel safe when playing (45% reported always feeling safe) and, how do children get to play (52% reported travelling with an adult by car). There was no available data by age, gender, or deprivation.

The HAPPEN Survey is a health and wellbeing survey completed by 8 - 11-year-olds across Wales in primary schools. The survey includes measures of health behaviours such as physical activity, sedentary behaviour, sleep, diet and dental health and wellbeing. This data included 7521 responses. The survey asked about active travel to school (39% reported active travel), active travel from school (41% reported active travel), how safe children feel in their areas (67%), if they could walk to school (68% reported that they could), if they could walk to a park (82% reported that they could), if they could walk to a facility (34% reported that they could) and, how happy children were with their local areas (88% reported that they were happy). Overall, girls reported slightly lower percentages and those who were more deprived reported higher instances of active travel and walking but reported feeling less safe in their areas. The HAPPEN Survey relies on self-report from children.

The group decided on an overall grade of a C for the community and built environment indicator for 2021. However, the group wants to note that this is based on data from three of the six recommended benchmarks, which has been deemed sufficient by the AHKGA but further highlights significant gaps in research and knowledge.

Major Gaps in the Welsh data:

Additional data sources have been made available since 2018 and it is apparent that the evidence-base is growing in this area, it is still reliant on self-report data from both children and adults. There are still no objective measures available for this indicator. As with the 2018 AHK Report Card, further data collection, research, and interventions are needed to reduce the barriers towards physical activity and play in communities. To date, data has relied on self-report and there is little consistency between local authorities' objective data capture therefore it is difficult to assume a picture of Wales as a whole.

How to Improve the Grade in the Future

Improvements in perceived safety, access, and facilities may produce reductions in sedentary time and improvements in physical activity, outdoor and active play. The role of local communities in this respect has been highlighted by the coronavirus pandemic (SARS-CoV-2), which saw many people's interest in their local community heightened. For young people, who typically spend a large proportion of their time within their communities (including the physical environment where young people live, go to school and play), the ability to be active in their local area is particularly important for developing and living healthily and well. Therefore, it is important we prioritise built environments and local communities are prioritised when promoting active, healthy lifestyles.

Government (C)

The RWG concluded that the grade would be decreased slightly from a C+ in 2018 to a C (50%) for this current Report Card. This is, in part, due to the expiry of previous policies specific to PA promotion that were subsequently replaced by an obesity policy that includes PA as one element. This was seen by the group as a retrograde step as it overlooks the wider health impacts of PA. There was also a perceived lack of progress in embedding PA in education policy and actions despite a recent revision of the national curriculum in Wales.

Background

Physical Activity is high on the Welsh Government's policy agenda and is mentioned across a variety of policy arenas (Sport, Health, Environment, Sustainable Development, Planning, Transport, Education etc.) However, at both national and local level it is one of the few portfolios that does not have either a statutory requirement or a stable 'home' and is moved as an add-on into a range of other portfolios whenever there is any kind of re-shuffle or re-organisation. Since the last Report Card there was a government decision to strategically merge physical activity within the emerging obesity strategy which risks marginalising the wider impacts of physical activity on health. The government also established a tripartite partnership of national organisations (Wales Physical Activity Partnership) to drive the physical activity agenda forward in Wales. This included Public Health Wales, Sport Wales, and Natural Resources Wales. Whilst ostensibly an improvement by recognizing the broader influences on physical activity, it also overlooks the critical role of other sectors including Education, Local Government, and the Voluntary Sector amongst others. Sharing responsibility amongst three national organisations continues to dilute the benefit of having a single responsible lead organisation or person providing leadership and accountability for this critical portfolio. There is still little systemic funding for Physical Activity promotion or delivery although one positive development since the last Report Card is the establishment of the Healthy and Active Fund. The fund now has a modest £5.9m available over four years and there are 16 projects, however the competitive and limited nature of the funding model means that many potential beneficiaries are overlooked.

It is evident that certain sectors continue to have a fragmented and ineffectual support for promoting physical activity, not least education where despite national reports on the low levels of physical activity amongst children in Wales; recommendations from a national group looking at Physical Literacy; key recommendations from a National Assembly cross-party report on children's physical activity and a major revamp of the National Curriculum in Wales there is still very little overt evidence of increased support for the Education sector, other than the establishment of an 'Educational Settings sub-group of the Wales Physical Activity Partnership Board (WPAP) including members from the Welsh Government Education Policy division. Indeed, the Welsh Government rejected the recommendations to "make 120 minutes of physical education in schools a minimum statutory requirement.", pinning their hopes on the new curriculum. Meanwhile, guidance provided by Estyn on physical activity in schools, whilst offering good advice on the range of physical activity gives no indications on even a minimum amount that should be provided. And a recent Estyn report on School impact on pupils' Health & Wellbeing only referenced 'Physical Activity' once and 'Exercise' once?

Data Sources Used

Guided by the HEPA PAT tool we considered the evidence relating to key policy domains that influence physical activity in children including: Health, Education, Sport, Transport, Environment, Design & Planning, Play, Sustainable Development, and Cross-cutting (i.e. cut across all policy portfolios). Within each of these domains a range of key 'elements' were identified from the HEPA PAT tool refined by the research working group (RWG), that could individually or collectively impact on the effectiveness of the policy instrument. These elements included:

- Number & breadth of policies
- Identified supporting actions
- Identified accountable organisation(s)
- Identifiable reporting structures
- Monitoring & Evaluation plans
- Identified funding/ resourcing

Table 2. 26 documents from 9 sectors were assessed.

Sector	Title of Document	Type
Health	UK Chief Medical Officers' Physical Activity Guidelines	G
	Public Health (Wales) Act 2017	L
	Healthy Weight, Healthy Wales Strategy	S
	Public Health Wales Long Term Strategy 2018-2030. Working to achieve a healthier future for Wales	S
Health & Sport	Getting Wales Moving	O
Sport	Enabling Sport in Wales to Thrive	S
	Physical Activity of Children and Young People Report and Annexe A	O
	Disability Sport Wales Vision Statement	O
Education	Curriculum for Wales Guidance 2020	G
	Physical Literacy - an all-Wales approach to increasing levels of physical activity for children and young people, 2013	O
	Framework on embedding a whole-school approach to emotional and mental well-being.	O
Transport	Active Travel (Wales) Act 2015	L
	An Active Travel Action Plan for Wales, 2016	AP

Environment	Natural Resources Policy 2017	S
	Our Contribution to the Protection and Improvement of Health and Wellbeing	O
	Natural Resources Wales - Managing Today's Natural Resources for Tomorrow's Generations	S
	The Clean Air Plan for Wales 2020	S
	Environment (Wales) Act 2016	L
Urban Design & Planning	Planning (Wales) Act 2015	L
	Planning Policy Wales, 2020	S
	Future Wales: The National Plan 2040	S
Cross-cutting	Prosperity for All, 2017	S
Play	Welsh Assembly Government Play Policy, 2002	S
	Play in Wales: Play Policy Implementation Plan, 2006	AP
	Wales: A Play Friendly Country, 2014	G
Sustainable Development	The Well-being of Future Generations (Wales) Act 2015	L

*Key: S - Strategy/ Policy; AP - Action Plan; G - Guidance; L - Legislation; O - Other

There are a number of national programmes designed to increase physical activity amongst children & young people in Wales, some operate at the UK level but have a Welsh component (This Girl Can; Change4Life; StreetGames) and a few are in the process of being evaluated before decisions on their future are made (Free Swim Programme; Dragon Multi-skill & Sport.) There is limited robust evidence on the effectiveness of these programmes at present.

Deciding on a Grade

Unlike the other indicators there are no purely objective measures that can be used to inform the Report Card. However, after utilising the WHO Europe Health-enhancing physical activity (HEPA) policy audit tool (PAT)v2 to inform the 2018 Report Card, we developed a complementary weighted scoring tool that provided an objective measure aligned to the Report Card. The methodology was published in Health Promotion International in 2020[23]. The same process was used to score this indicator for the latest Report Card. In interpreting this indicator, we included national policies, strategies, action plans, legislation and a few other advisory and technical documents that have a direct bearing on children's physical activity, which were still 'active.'

The final scoring matrix was as follows:

- No. and breadth of relevant policies - 10% (5% No. & 5% Breadth) = **8%**
- Identified supporting actions - 20% = **15%**
- Identified accountable organisation - 25% = **14%**
- Identifiable reporting structures - 15% = **6%**

- Identified funding and resources - 20% (5% no. of identified national programmes & 15% funding) = **5%**
- Monitoring & Evaluation Plan - 10% = **2%**

Applying this led to an overall score of **50%** that translates to a C grade.

Major Gaps in the Welsh data:

It is evident from the difficulties in compiling meaningful robust data for the Report Card that there continue to be significant national data gaps in many of the indicators that inform physical activity for children and young people. This is a feature that appears to have deteriorated in recent years following the revision and streamlining of national surveys that took place in 2018.

How to Improve the Grade in the Future

Whilst the wider environmental approach to physical activity promotion is to be welcomed, this has been compromised by the selective and limited range of engagement across policy sectors. Recent global events have compounded this problem as priorities changed and organisations tend to turn inward during times of crisis. There remain opportunities however, to re-engage with communities and organisations in a coordinated effort to tackle physical inactivity together.

Whilst there is of course a relationship between physical inactivity and obesity with many overlapping issues, there remain key issues that are mutually exclusive to physical activity which have far greater impacts both physiologically and mentally than those confined to obesity. It is simplistic and potentially dangerous to assume that strategies designed to address obesity will therefore also improve physical activity. Whilst some may, others will not, and opportunities will be missed. This policy 'marriage of convenience' also risks sending out the wrong messages. Increasing physical activity may help reduce obesity but will not eradicate it, whilst reducing obesity will not significantly reduce physical inactivity nor the many other health issues associated with it.

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APPENDIX II: LIST OF ACTIVE HEALTHY KIDS MEDIA ACTIVITY

- **BBC Wales**
- **BBC Cymru Fyw**
- **BBC 1 Wales – *Breakfast* (2)** (29.08.22)
- **BBC 1 Wales – *News at One***
- **BBC 1 Wales - News at Six**
- **BBC 1 Wales - News at Ten**
- **ITV 1 Wales - *ITV Lunchtime News***
- **ITV 1 Wales - ITV News London**
- **S4C — Newyddion S4C (2)**
- **BBC Radio Wales (10)**
- **SW Evening Post** (30.08.22; Pg.10)
- **The Western Mail** (30.08.22; Pg.22)
- **ITV**
- **Swansea Bay News**
- **Wales Online**
- **Golwg 360**
- **Eastern Eye**
- **Bangladesh Weekly**
- **SriLanka Weekly**
- **Pakistan Weekly**
- **India Weekly**
- **Asian Times**
- **GG2**
- **Deeside**
- **Nation.Cymru**
- **Wales News Online**
- **Wrexham.com**
- **Evening Post**
- **That's TV**

APPENDIX III: CHAT SURVEY

CHAT

* Required

About You

1. **First Name** *

2. **Last Name** *

3. **What school do you go to?** *

4. **What year are you in?** *

   Mark only one oval.

   ◯ Year 4
   ◯ Year 5
   ◯ Year 6
   ◯ Year 7

5. **What is your date of birth? (type it in)**

   Example: December 15, 2012

6. **Gender** *
Mark only one oval.

- ( ) Boy
- ( ) Girl

7. **Do you consider yourself to have a disability or health problem?** *
Check all that apply.

- [ ] No
- [ ] Yes - Wheelchair user
- [ ] Yes - Physical disability
- [ ] Yes - Blind or have low vision
- [ ] Yes - Deaf or poor hearing
- [ ] Yes - Learning difficulty
- [ ] Yes - Mental health difficulty e.g. Anxiety, Depression
- [ ] Yes - Health condition e.g. Asthma, Diabetes, Epilepsy
- [ ] Other: ______________________

YESTERDAY

Firstly, think carefully about what you did YESTERDAY and then answer the following questions....

8. **1. What did you eat for breakfast YESTERDAY?** *

Check all that apply.

☐ Nothing

☐ Sugary cereal e.g. cocopops, frosties, sugar puffs, chocolate cereals

☐ Healthy cereal e.g. porridge, weetabix, readybrek, muesli, branflakes, cornflakes

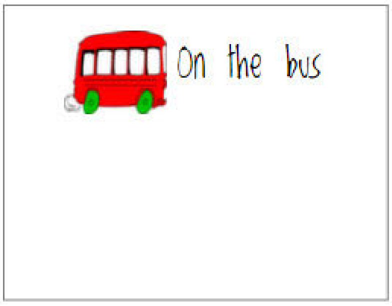
- [ ] Snacks
- [ ] Fruit

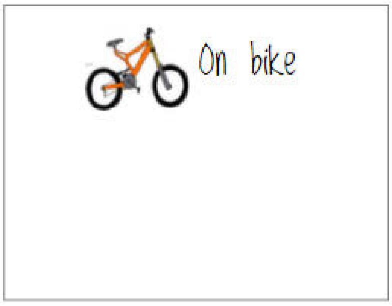
- [ ] Toast
- [ ] Cooked breakfast

- [ ] Yoghurt
- [ ] Other:

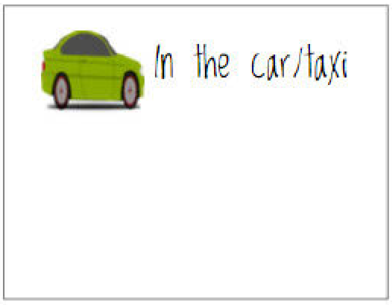
9. **2. How did you get to school YESTERDAY morning?** *

Mark only one oval.

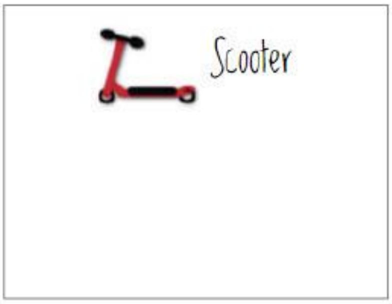




- ◯ On the bus
- ◯ On bike



- ◯ In the car/taxi
- ◯ Walked



- ◯ Ran/jogged
- ◯ Scooter

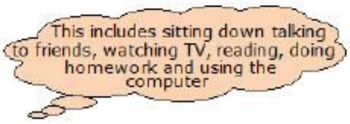
- ◯ Skateboarded/Rollerbladed

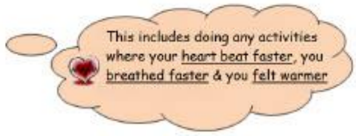
10. **3. What did you have to eat for lunch YESTERDAY?** *

Mark only one oval.

- ◯ School dinner
- ◯ Packed lunch
- ◯ Nothing

11. **4. What did you do for MOST of your break-times YESTERDAY? (This includes lunchtime)** *
Mark only one oval.





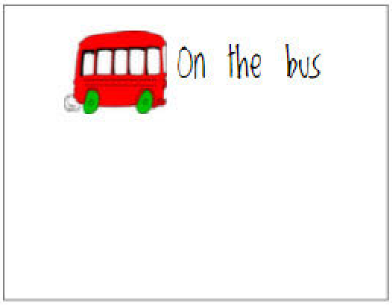
( ) Sat around inside or outside
( ) Ran around

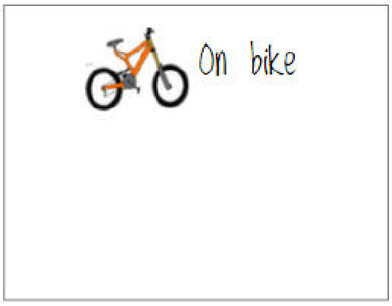
( ) Stood around
( ) Walked around

12. **5. Do you have an afternoon break at school?** *
Mark only one oval.

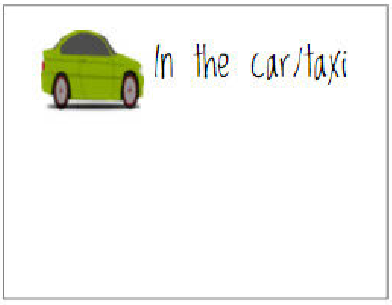
( ) YES
( ) NO

13. **6. How did you get home YESTERDAY?** *
Mark only one oval.



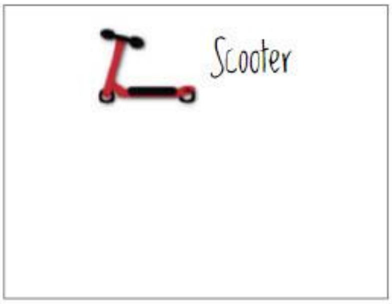


- [ ] On the bus
- [ ] On bike



- [ ] In the car/taxi
- [ ] Walked

Ran/jogged

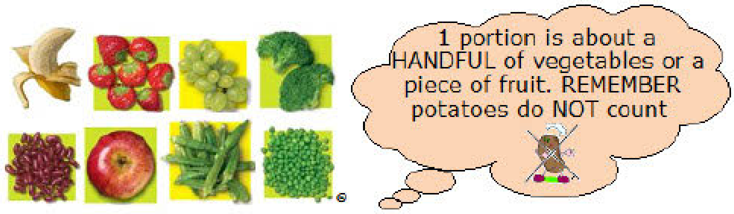


Scooter

Skateboarded/Rollerbladed

AFTER SCHOOL

14. 7. How many portions of fruit and vegetables did you eat YESTERDAY? *

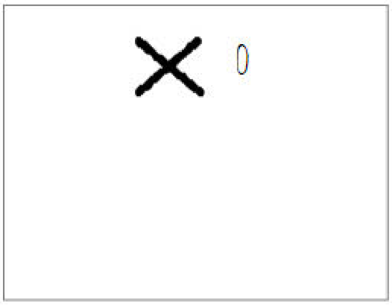


Mark only one oval.

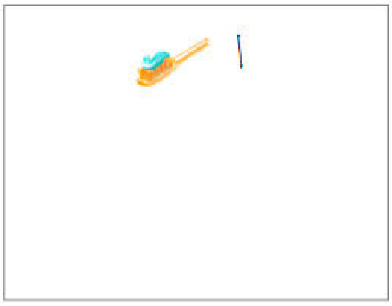
- ( ) 0
- ( ) 1
- ( ) 2
- ( ) 3
- ( ) 4
- ( ) 5
- ( ) 6
- ( ) 7
- ( ) 8+

15. **8. How many times did you brush your teeth YESTERDAY?** *

Mark only one oval.



( ) 0



( ) 1

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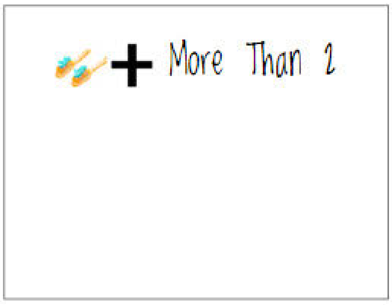


( ) More than 2

16. 9. What time did you fall asleep YESTERDAY (to the nearest half hour)? *

Mark only one oval.

- 7:00pm
- 7:30pm
- 8:00pm
- 8:30pm
- 9:00pm
- 9:30pm
- 10:00pm
- 10:30pm
- 11:00pm
- 11:30pm
- 12:00am
- 12:30am
- 1:00am
- 1:30am
- 2:00am
- 3:00am
- 3:30am
- 4:00am

17. **10. What time did you wake up TODAY (to the nearest half hour)?** *

Mark only one oval.

- ( ) 5:00am
- ( ) 5:30am
- ( ) 6:00am
- ( ) 6:30am
- ( ) 7:00am
- ( ) 7:30am
- ( ) 8:00am
- ( ) 8:30am
- ( ) 9:00am

THE LAST WEEK

NOW think about what you did in the last 7 days...

18. **11a. In the last 7 days, how many days did you do sports or exercise for at least 1 hour in total (This includes doing any activities or playing sports where your heart beat faster, you breathed faster and you felt warmer?** *

Mark only one oval.

- ( ) 0 days
- ( ) 1-2 days
- ( ) 3-4 days
- ( ) 5-6 days
- ( ) 7 days

19. **11b. In the last 7 days, how many days did you watch TV/play on consoles/use iPad/use the internet etc. for 2 or more hours a day (in total)?** *
Mark only one oval.

- 0 days
- 1-2 days
- 3-4 days
- 5-6 days
- 7 days

20. **11c. In the last 7 days, how many days did you feel tired?** *
Mark only one oval.

- 0 days
- 1-2 days
- 3-4 days
- 5-6 days
- 7 days

21. **11d. In the last 7 days, how many days did you feel like you could concentrate/pay attention well in class?** *
Mark only one oval.

- 0 days
- 1-2 days
- 3-4 days
- 5-6 days
- 7 days

22. **11e. In the last 7 days, how many days did you drink at least one fizzy drink (e.g. coke, fanta, sprite)** *
Mark only one oval.

- 0 days
- 1-2 days
- 3-4 days
- 5-6 days
- 7 days

23. **11f. In the last 7 days, how many days did you eat at least one sugary snack (e.g. chocolate bar, sweets)** *
Mark only one oval.

- 0 days
- 1-2 days
- 3-4 days
- 5-6 days
- 7 days

24. **11g. In the last 7 days, how many days did you eat take away foods (e.g. McDonalds, KFC, chinese)** *

Mark only one oval.

- ◯ 0 days
- ◯ 1-2 days
- ◯ 3-4 days
- ◯ 5-6 days
- ◯ 7 days

Sport and Activity

25. **12. These questions are going to ask you how you feel about physical activity (This includes any activity where your heart beats faster, you breathe faster and you feel warmer)** *

Mark only one oval per row.

	Strongly agree	Agree	Disagree	Strongly disagree
I want to take part in physical activity	◯	◯	◯	◯
I feel confident to take part in lots of different physical activities	◯	◯	◯	◯
I am good at lots of different physical activities	◯	◯	◯	◯
I understand why taking part in physical activity is good for me	◯	◯	◯	◯

26. **13a. How many times do you take part in a sports club OUTSIDE OF SCHOOL each week?**

Mark only one oval.

0	1	2	3	4	5	6	7	8	9	10
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

27. **13b. If you take part in a sports club OUTSIDE of school, what is the name of the sports club? (For example Swansea Rugby Club Under 11's)**

28. **14. Are you a member of cubs, brownies, scouts or guides?** *

Mark only one oval.

- Yes
- No

29. **15. Which of these sports or physical activities would you MOST like to try? (That you haven't tried before)** *

Mark only one oval.

Athletics

Basketball

Cricket

Dance

Gymnastics

Hockey

◯ Multi Skills

◯ Netball

◯ Rugby

◯ Tennis

◯ Swimming

◯ None of these

◯ Other:

30. **16. Can you ride a bike WITHOUT STABILISERS?** *

Mark only one oval.

◯ Yes ◯ No

31. **17. Can you swim 25 metres WITHOUT A FLOAT OR ARMBANDS? (This is 1 length of a standard swimming pool)** *

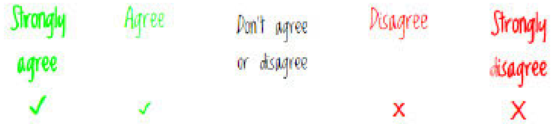
Mark only one oval.

◯ Yes ◯ No

You and your feelings

This part of the survey is going to ask you how you feel. There are no right or wrong answers. You should just pick the answer which is best for you.

32. **18. Tell us if you agree or disagree with the following:** *



Mark only one oval per row.

	Strongly agree	Agree	Don't agree or disagree	Disagree	Strongly disagree
I am doing well at school					
I have lots of choice over things that are important to me					
There are lots of things I'm good at					

19. On a scale of 0 to 10 (0 being very unhappy and 10 being very happy, how do you feel about:

33. **Your Health** *

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	10	
Very unhappy												Very happy

34. **Your School** *

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	10	
Very unhappy												Very happy

35. **Your Family** *

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	10	
Very unhappy												Very happy

36. **Your Friends** *

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	10	
Very unhappy												Very happy

37. **Your Appearance (how you look)** *

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	10	
Very unhappy												Very happy

38. **Your Life** *

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	10	
Very unhappy												Very happy

39. **20. Remember, there are no right or wrong answers, just pick which is right for you.** *

Mark only one oval per row.

	Never	Sometimes	Always
I feel lonely			
I cry a lot			
I am unhappy			
I feel nobody likes me			
I worry a lot			
I have problems sleeping			
I wake up in the night			
I am shy			
I feel scared			
I worry when I am at school			
I get very angry			
I lose my temper			
I hit out when I am angry			
I do things to hurt people			
I am calm			
I break things on purpose			

Your Local Area

40. **21. On a scale of 0 to 10 (0 being not very safe and 10 being very safe), how safe do you feel playing in your area?** *

Mark only one oval.

	0	1	2	3	4	5	6	7	8	9	10	
Not very safe												Very safe

41. **22a. From your house, can you walk to school?**

Mark only one oval.

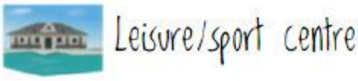
- Yes
- No

42. **22b. From your house, can you easily walk to a park?**

Mark only one oval.

- Yes
- No

43. **22c. From your house, can you easily walk to a leisure centre/sports centre?**



Mark only one oval.

- Yes
- No

44. **23. Are you happy with the area that you live in?**

Mark only one oval.

- Yes
- No

45. **24. If you could change something to make you and your friends healthier and happier, what would you change?**

Well done, you've completed the questionnaire.

Thank you!

Don't forget to press submit below!

Powered by Google Forms

APPENDIX IV: SWANLINX STANDARD OPERATING PROCEDURE

Field Measures of Health and Fitness in Children

Practical Workbook and Training Tool

Contents Page

1. Introduction

1.1 Swan-Linx Overview

Swan-Linx is a longitudinal project run by A-STEM researchers at Swansea University that collects data on the health, fitness and physical competence of primary age children in Swansea. Schools are invited to attend a Fitness Fun Day where the children take part in a range of health and skill related fitness measures before going back to school to complete the Child Health and Activity Tool (CHAT) with HAPPEN researchers. The CHAT is an online questionnaire that collects data on a wide spectrum of health and lifestyle-related behaviours including; sleep, diet, physical activity, mental health, active travel and environment.

After the Fitness Fun Day, the participating school receives a report comparing their school data with Swansea averages while data of consenting participants is input into the Secure Anonymised Information Linkage (SAIL) databank for linkage to future health records and educational attainment outcomes.

Through Swan-Linx, objective measures of physical competence are collected using the Dragon Challenge V1.0, which is administered during the transition weeks for school children progressing from Primary to Secondary education. The Dragon Challenge is designed as a continuous circuit that enables the efficient assessment of a number of stability, locomotion and manipulative skills that are deemed crucial for successful participation in physical pursuits and sports throughout the life course.

1.2 Field Fitness Test Batteries

There have been many methods to assess the different components of fitness in children over the past few decades. Numerous studies have used a battery of fitness field tests to assess fitness in children in a relatively non-intrusive, cost effective and simple manner (Ekblom et al., 2005). This has allowed fitness testing to evolve from a focus on sporting performance to assessing health-related outcomes (Freedson et al., 2000). There are many fitness testing batteries that have been used; including; AAHPER (American Alliance for Health and Physical Education and Recreation), Youth Fitness Test, YMCA Fitness Trust and FITNESSGRAM in the US (Freedson et al., 2000).

In Europe, possibly the most widely used fitness battery test is EUROFIT (Adam et al., 1988). EUROFIT was developed by the council of Europe and provides data on several components of skill and health-related fitness. It includes simple measures of cardiorespiratory fitness (CRF), agility, hand-eye coordination, BMI, upper body strength, muscular endurance and balance.

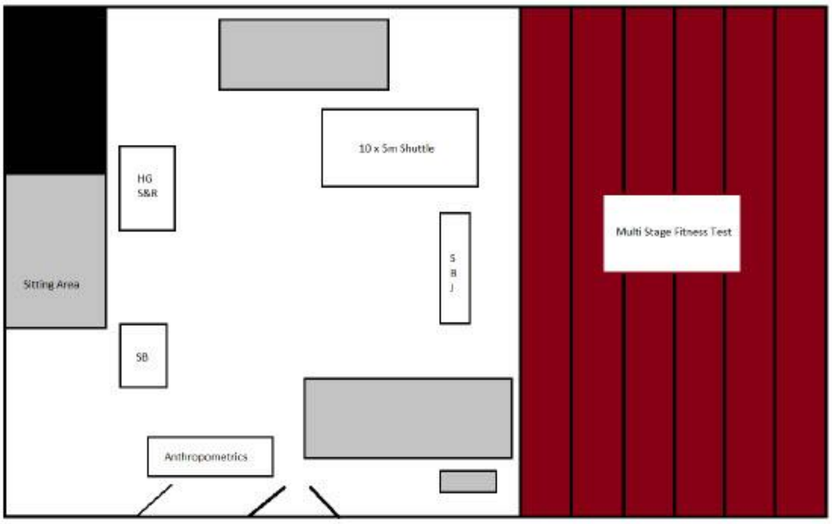
1.3 Swan-Linx Fitness Fun Day Measures

Testing methods used during the Fitness Fun Day (FFD) are based on the same methods used by SportsLinx in Liverpool since 1998. The FFD battery is comprised of 5 circuits stations, 6 measures and the Multi Stage Fitness Test. The measures are designed to capture a range of health-related fitness skills including; agility, speed, flexibility, strength, muscular endurance and cardiorespiratory fitness (CRF). Please see Table 1 for a list of Fitness Fun Day Measurements. Fitness Fun Day activity station sheets and scripts can be found in the Appendices of this manual.

Table 1 – Swan-Linx Fitness Fun Day Measures

Measure	Description	Station Sheet
Anthropometrics	From the children's measures (height, sitting height and weight), children's Body Mass Index (BMI) is calculated, and age and gender specific cut-off points are used to provide a percentage of children classed as an unhealthy weight (overweight and obese).	Appendix 1
Speed Bounce	The speed bounce test measures a child's agility, speed, coordination and stamina. These components of fitness are important in many sports and dance where athletes need to change direction quickly and often.	Appendix 2
Sit and Reach	The sit and reach test is a common measure of flexibility, and specifically measures the flexibility of the lower back and hamstring muscles.	Appendix 3
Handgrip Dynamometer	The handgrip strength test measures the holding strength of the hand and forearm muscles. Generally, people with strong hands tend to be strong elsewhere, so this test is often used as a measure of strength. Each unit is equivalent to lifting 1 bag of sugar.	Appendix 4
5 x 10 Shuttle Run	The objective of this test is to assess the child's speed and agility by accelerating between marked lines and rapidly changing direction.	Appendix 5
Standing Broad Jump	The standing broad jump is a test that measures the explosive power of the legs. A medium to good standing long jump score is between 115 – 168cm for boys and 105 – 158cm for girls.	Appendix 6
Multi Stage Fitness Test	The 20m multistage shuttle run is a test of running endurance that relies on the heart pumping blood to the large muscles in the legs, as well as breathing increasing to take in oxygen. Research shows that for children of this age, a score of 33 shuttles for boys and 25 shuttles for girls is the threshold for healthy fitness, and children who fail to reach this threshold are at an increased risk of future cardiometabolic diseases.	Appendix 7

1.4 Fitness Fun Day Station Layout



2. Swan-Linx Fitness Fun Day

The Fitness Fun Day is an all-day event that is split into two sessions. In the morning session, a school will bring their Year 5/6 children to the Indoor Training Centre where the first part of the Fitness Fun Day will take place. During the session, the children will engage with a number of different health and fitness measures in small groups (10-14 participants per group). The session will follow a circuit format and the circuit will end when all children have rotated through the stations. Each station will be allocated 15 minutes to measure and record participants, before the next rotation. The circuit will take on average 1 hour and 15 minutes to complete. At the end of the circuit, the children will be invited to take part in the Multistage Fitness Test (also known as Bleep test). When all children have taken part, the school group will then return to their school to complete an online questionnaire in the afternoon session. The Child Health and Activity tool (CHAT) is administered by HAPPEN researchers and asks a number of questions relating to physical activity, wellbeing, nutrition and mental health.

2.1 Diversity, Inclusivity and Respect

Swan-Linx operates under the values set out by Swansea University and works hard to promote and support the participation of all individuals by creating a safe environment that upholds dignity, respect and fairness. Swan-Linx achieves the latter by understanding, respecting, appreciating and recognising difference in individuals and strives to accommodate all participants in their active engagement during the Fitness Fun Day. Swan-Linx expects all researchers, research assistants and partners to operate in line with the above.

2.2 Case Study

Prior to a Fitness Fun Day, Swan-Linx was made aware that an individual who was set to attend the session had severe visual impairment and would be accompanied by a learning assistant. At the beginning of the session, the coordinator worked alongside the participant and learning assistant to assess the level of support the individual would need and how best to modify stations to enable safe participation. The coordinator assigned the participant a research assistant who acted as support and guide through the activities, working closely with the individual and always accompanied by the learning assistant. Throughout the course of the session, the individual was able to confidently take part in the activities and finished the day having taken part in all measures.

3. Swan-Linx Partners

Swan-Linx works in partnership with a number of organisations to deliver the Swan-Linx project. Please see below for partner details and roles within the project.

3.1 HAPPEN – Health and Attainment of Pupils in a Primary Education Network

HAPPEN is a network of health, education and research professionals aimed at improving the health, wellbeing and education outcomes of primary school children in Swansea. In collaboration with the Swan-Linx project, objective and self-reported data is collected on children aged 9-11. This data is fed back to schools through individualised reports comparing the health and wellbeing of their pupils to county averages. Data is presented alongside health guidelines and links to local school-based health initiatives. A novel aspect of HAPPEN is the use of data linkage. This data collected at Fitness Fun Days is linked to anonymous, routinely collected data including GP records, hospital admissions and educational attainment using the SAIL (Secure Anonymised Information Linkage) databank. Finally, this data can be used to evaluate the impact of school-based interventions on outcomes such as fitness, wellbeing and education.

3.1.1 Roles within Swan-Linx

- Delivering afternoon session of Fitness Fun Day
- Handling CHAT data
- Creating and sending out School and Child Fitness Fun Day Reports
- Recruiting potential Swan-Linx schools through HAPPEN network

3.2 Active Young People Team, City and County of Swansea

The Active Young People (AYP) team is funded by Sport Wales and are responsible for providing a variety of exciting sport and physical activity opportunities for young people up to 16 years of age, as part of their school extra-curricular programmes and within their local communities. AYP Swansea would like to see 'every Child Hooked on Sport for Life' and we have several projects to help achieve this across the City, these include; Play to learn, Dragon Multi-skills and Sport, 5x60, physical literacy in the community and Young Ambassadors.

Our aim is to ensure that all children and young people are participating in sport and physical activity, and where appropriate, have the support to excel. AYP is committed to continuing to work with partners to ensure that sporting opportunities are actively encouraged as part of a broader life experience and that the participation gap between those living in poverty and those not is closed.

Having been involved in Swan-Linx since the start of the project in Swansea, AYP Swansea has seen it develop over the years and feel that it is provides vital data to help achieve our vision of 'every child hooked on sport'.

For further information please contact sarah.mccoubrey@swansea.gov.uk - 01792 635414 (Senior Active Young People Sports Development Officer)

3.2.1 Roles within Swan-Linx

- Attending morning session of Fitness Fun Day
- Coordinating and sending Young Ambassadors to morning Fitness Fun Day sessions
- Identifying 'most wanted' sport/physical activity session for each Swan-Lin school
- Organising appropriate time for sport/physical activity session with school and Gower College
- Attending sport/physical activity session (quality assurance)

3.3 Gower College

3.3.1 Roles within Swan-Linx

- Providing research assistants for Swan-Linx Fitness Fun Days (morning sessions)
- Liaising with AYP to organise sport/physical activity deliver sessions
- Delivering sport/physical activity session in school

3.4. Swan-Linx Partnership Pathway

Figure 1 below gives a visual pathway detailing the overall Swan-Linx process from Fitness Fun Day to delivery of sport/physical activity sessions and signposting, and what partner(s) are responsible for each step.

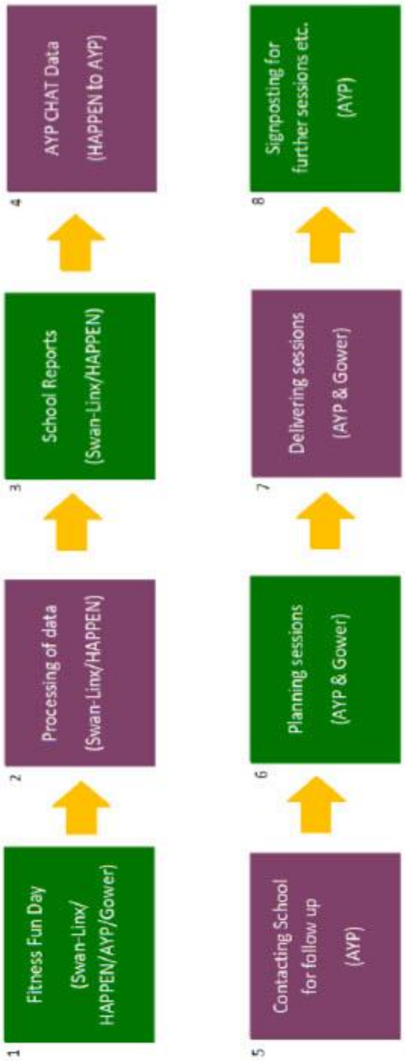


Figure 1: Swan-Linx Partnership Pathway

4. Standing Operating Procedure – Prior to Fitness Fun Day

4.1 Fitness Fun Day Dates

- Agree Fitness Fun Day dates with Fitness Fun Day Group
- Contact Indoor Training Centre and book dates
- Update Fitness Fun Day group of booked testing dates

4.2 School Recruitment

- Draft and send recruitment email to Swan-Linx schools
- Liaise with schools and book into requested testing date – work on first come, first served principle
- Send Fitness Fun Day Information pack to schools
- Request Pre-Fitness Fun Day information from schools (Appendix 8)

4.3 Consent

- Arrange suitable date/time for consent assembly in school
- Liaise with HAPPEN who will attend the assembly to deliver information on CHAT and second part of Fitness Fun Day at school
- Print off consent forms – ensure school code is input into header (e.g. BT20176, CD2018) – (Appendix 9)
- In assembly, cover following areas; introductions, Swan-Linx background information, activities during Fitness Fun Day, doing your best, anonymity, data uses, right to refuse to take part, having fun, consent forms, offering opportunity to ask any questions
- Organise a one week turn around on consent and arrange a suitable time to collect forms from school
- Collect consent and address any issues
- Input and process consent using Consent Template (Appendix 10) sign off all consent forms and store in Swan-Linx locker in ASTEM hub – Bay Campus, Swansea University
- Highlight missing consent and chase up with school

4.4 Equipment

- Book lab equipment with Sport Science Lab at Bay Campus using Excel Booking Form (Appendix 11). Contacts = Wendy Clark/ Rebecca Dietzig –w.a.clark@swansea.ac.uk ; r.e.dietzig@swansea.ac.uk – equipment needed - Sitting height stadiometer, SECA digital scales, sit and reach box
- ITC will have other equipment needed for Fitness Fun Day - Other equipment needed will be available to use at the ITC. Inform the ITC staff of what equipment is needed and you will be able to access this from the store cupboards. You will need - Standing Broad Jump mat, 2 x Speed Bounce Mats, Dish/dome markers – 10 x 5m shuttle and station boxes, benches for stations and seating area, Cones for multi stage fitness test. You will have access to the sound system in the ITC which will play audio through an AUX lead (iPod/laptop are ideal)
- Organise remaining Swan-Linx equipment located in A-STEM hub (handgrip dynamometers, standing height stadiometer, 30m measuring tape, pens, stopwatches, blank recording forms, spare participant numbers)
- Transport lab equipment to ITC

- Organise school register and participant numbers (school code and number format e.g. ST1 – ST100)

5. Standard Operating Procedure – On the Fitness Fun Day

- Set up Swan-Linx circuit
- Brief research team
- Send two assistants to collect school from National Pool – leave at 9:20am to meet school at 9:30am
- Welcome school, instruct participants to take coats/jumps off and sit on benches in sitting area
- Introduce yourself to teacher(s) in charge and deliver introduction speech (Appendix 12)
- Register and participant numbers
- Allocate participants into groups (A, B, C, D, E)
- Direct groups to warm up leaders and begin 10-minute warm up
- Stop warm up and direct groups to stations, one group at a time
- Start Swan-Linx circuit, ensuring 15 minutes per station
- In the event that a station finishes before the allotted 15 minutes, request that station researchers play active games with participants to maintain engagement and body temperature
- Track stations and group movements to ensure fluid transitions between stations, keep regular contact with teacher(s) in charge and be on hand for first aid and problem solving
- At the end of station rotations, direct group A, B, C onto sprint track – groups D and E into sitting area to be monitored and controlled by teachers
- Prepare group A. B and C for Multistage fitness test – ensure all participants have shoe laced tied and are aware of the procedure of recording lap achieved with research team. Also make clear that when a participant has finished the MSFT and recorded their lap achieved, the participant is required to engage in a walking cool down that will be running in the middle of the ITC.
- Repeat for groups D and E
- Debrief school in sitting area, inform them of second part of Fitness Fun Day back at school and thank them for their time and participation!
- Allocate 2 research team members to escort school group back to National Pool and wait until school have safely departed.
- Remaining research team members to collect equipment, tidy up ITC and return equipment to secure lockers.
- Debrief entire research team – discuss what went well, what didn't go well and summarise what we can learn from and adapt for the next Fitness Fun Day. Thank research team for attendance!

5.1 Risk Assessment

Swan-Linx Risk Assessment

SEVERITY		
Score	**Descriptor**	**Explanation**
0	Damage to property	Incident resulting in no injury but causing damage to property or equipment
1	Minor injury/illness	Injury/illness not requiring application of first aid and not involving absence from work/study.
2	Medical attention	Injury/illness requiring medical attention
3	Major injury/illness	Injury/illness resulting in more than 3 days absence from work/study
4	Fatal injury/illness	Injury/illness causing death to an individual
5	Multi-fatalities	Injury/illness causing death to more than one person

Figure 1) Risk Rating system: Severity of the outcome

LIKELIHOOD		
Score	**Descriptor**	**Explanation**
0	Inconceivable	Cannot imagine incident will occur. Beyond belief.
1	Remote	Conceivable, but highly unlikely that incident will occur.
2	Unlikely	Doubtful that incident will occur
3	Possible	Feasible chance that incident will occur
4	Probable	Credible chance that incident will occur
5	Certainty	Incident will definitely occur. Sure to happen.

Figure 2) Risk Rating system: Likelihood of occurrence

RISK LEVEL ESTIMATOR							
		LIKELIHOOD					
SEVERITY		Certainty	Probable	Possible	Unlikely	Remote	Inconceivable
		5	4	3	2	1	0
Multi-fatalities	5	25	20	15	10	5	0
Fatal injury	4	20	16	12	8	4	0
Major injury	3	15	12	9	6	3	0
Medical attention	2	10	8	6	4	2	0
Minor injury	1	5	4	3	2	1	0
Damage	0	5*	4*	3*	2*	1*	0

Figure 3) Risk Rating system: Risk Level Estimator

** For health & safety purposes to enable the recording of near miss/damage incidents, the multiplication factor is removed and the appropriate likelihood numeric, applied.*

RISK INDEX TABLE (WORK ACTIVITIES)	
Score	Action
12 – 25	Unacceptable intolerable level of risk, not to proceed unless control measures can be implemented to eliminate or reduce risk to an acceptable level.
8 - 10	High level of risk still requiring documented risk reduction strategies
4 - 6	Moderate level of risk, consequences to be fully considered when completing risk assessment
1 - 3	Low level of risk but still requiring periodic monitoring and review.
0	No action required

Figure 4) Risk Rating System: Risk Index Table Work Activities

RISK ASSESSMENT: Swan-Linx *Page 1 – (Hazards)*		
School / Unit and Area:	A-STEM Research Unit – School of Sport and Exercise Science	
Risk Assessment undertaken by: Recommended to be 2 or more people	Hannah L Spacey	Prof. Gareth Stratton
	922632@swansea.ac.uk	g.stratton@swansea.ac.uk
Description of the work activity being assessed:	**Stations include:** 20metre multi-stage fitness test (bleep test), standing height, sitting height, mass, speed bounce, handgrip strength test, sit and reach, 10 x 5m shuttle run, standing broad jump.	
Persons Affected:	Staff ☐ Students ☐ Others ☒	
Details of Others:	Year 5 & 6 Primary school pupils (9-11 years old)	

HAZARD IDENTIFICATION Please provide details of the hazards associated with the area or task. **EXAMPLES INCLUDE:** Working at height, Manual Handling, Electricity, Fire, Noise, Contact with moving parts of machinery, Dust etc		**RISK RATING - without Controls** The Risk Rating (RR) and Degree of Risk are determined by multiplying the Severity (S) of injury by the Likelihood (L) of occurrence.			
		S	L	RR	Degree of Risk
1	**The ITC track:** Slips and trips. Surface could be slippery if pupils spill drinks.	1	2	**2**	Low
2	**Equipment:** Cones – pupils could trip on cones while playing games, athletics or during bleep test.	1	2	**2**	Low
3	**Speed Bounce:** Pupils could potentially trip over the speed bounce divider whilst partaking in activity.	1	3	**3**	Low
4	**Handgrip Strength Test**: Pupils could potentially strain their hand/arm if activity is not properly conducted.	1	1	**1**	Low
5	**Sit and Reach:** Pupils could potentially injure hamstring/lower back by overstretching.	1	2	**2**	Low
6	**10 x 5m shuttle:** Pupils could potentially trip while sprinting between the cones.	1	2	**2**	Low
7	**Standing Broad Jump:** Pupils could potentially trip/lose balance when jumping.	1	3	**3**	Low
8	**Bleep test:** Pupils may fatigue easily.	1	3	**3**	Low

CONTROLS TO BE APPLIED **Examples Include:** Elimination, Substitution for something less hazardous, Barriers or fixed guards, standard operating procedures and personnel protective equipment		Date Applied	RISK RATING - <u>with</u> Controls			
			S	L	RR	Degree of Risk
1	The ITC track – slips and trips. Pupils will be encouraged to wipe their trainers before entering ITC if it has been raining. A designated area for drinks will be away from the activity to avoid slips from drink spillages. Children will be advised to secure shoe laces before starting the session.	22/11/17	1	2	**2**	Low
2	Cones will be placed to demonstrate the 20-metre distance, but pupils will be told to try and avoid the cones by the research assistant.	22/11/17	1	2	**2**	Low
3	Pupils will see a demonstration of the correct way to jump over speed bounce divider, and advised to be as careful as possible.	22/11/17	1	2	**2**	Low
4	Pupils see a demonstration of the correct way to perform the test and will be supervised by trained research assistants throughout.	22/11/17	1	2	**2**	Low
5	A clear instruction of how to correctly perform the sit and reach will be delivered to the pupils before they attempt the station, and all pupils will be allowed one practice run.	22/11/17	1	2	**2**	Low
6	The track floor will be cleared to ensure nothing can be tripped over and the pupils will be made aware of the dangers of running into the cones. A full demonstration of the activity will be given of running in between the cones.	22/11/17	1	1	**1**	Low
7	Pupils will be given a full demonstration of how to perform a safe, effective standing broad jump and will be supervised by research assistants at all times.	22/11/17	1	1	**1**	Low
8	On the bleep test, pupils are asked to try their very best, however, pupils will be asked to tell an adult if they feel faint / dizzy. They will be asked to take a break and drink plenty of water.	22/11/17	1	2	**2**	Low
1.	**Examples of possible controls:** All appliances are to be PAT tested. Any new items are to be reported to estates. Users to undertake visual checks prior to use. Damaged equipment to be removed from use.	07/06/07	4	1	4	Moderate
Date of first assessment:		22/11/2017				
Assessment review dates:	10/08/2018					

6. Fitness Fun Day Data

- Download data from RedCap app and merge with pre-fitness fun day data (linked by participant number)
- Delete any records that do not have full consent
- Clean data set
- Calculate mean scores etc. that are required for the school report mail merge form (Appendix 13)
- Input data into mail merge document and send to HAPPEN
- Send HAPPEN school data set for merging with CHAT data
- Input fully merged data set (Swan-Linx and CHAT) into data sheet for Swan-Linx 5 testing period (2017/2018)

6.1 Calculating Maturity Offset – Excel Formulas

To calculate maturity offsets, split the datasheet by gender (0 = female, 1 = male) in Excel, and input the following formulas, substituting with participant data.

Males

=-9.236+(0.0002708*(Leg Length*Sitting Height))-(0.001663*(Age*Leg Length))+(0.007216*(Age*Sitting Height))+(0.02292*((Weight/Height)*100))

Females

=-9.376+(0.0001882*(Leg Length*Sitting Height))+(0.0022*(Age*Leg Length))+(0.005841*(Age*Sitting Height))-(0.002658*(Age*Weight))+(0.07693*((Weight/Height)*100))

6.2 BMI: IOFT and British Centiles

How to download the Growth Add-in for calculating BMI centiles/cut-offs (excel 2010)

Go to the following website to explain the different options for measuring and interpreting BMI in children:

https://www.noo.org.uk/NOO_about_obesity/measurement/children

Calculating BMI centiles for child populations:

In order to calculate BMI centiles for large numbers of children, the simplest and most accurate method is to use the 'LMS Growth' Microsoft Excel add-in software. Published at:

http://www.healthforallchildren.com/?product=lmsgrowth

This software can also be used to calculate centiles and z/SD scores for BMI and other child measurements such as height, weight, and waist circumference, and is available at no charge from Harlow

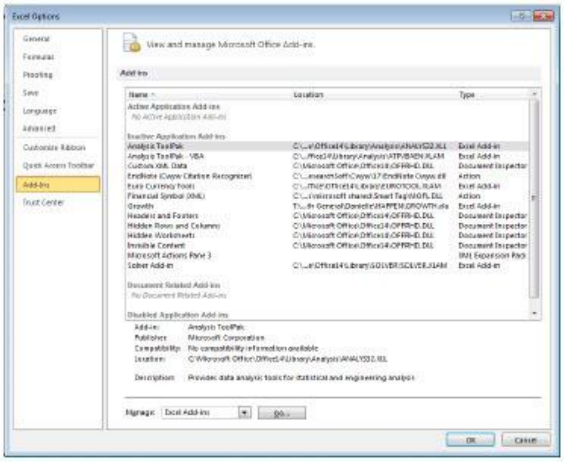
- Download the LMS Growth add-in (should be free to download), and a zip file will appear in your downloads folder

- There are always the README.TXT and GUIDE.PDF to give further instructions for installation.
- First, copy the file BRITISH1990.XLS (in the zip file) and paste in the Excel start up subdirectory or folder named XLSTART. This will be found under C:\Microsoft Office\Office14\XLSTART.

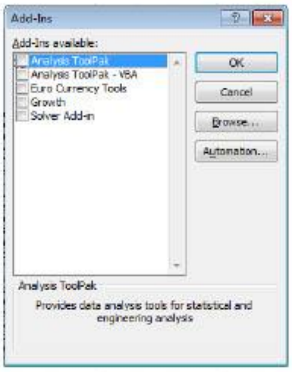
**** © A copy of the 1990 British growth data is included with the software which is subject to copyright and may not be extracted from or utilized in any other software. The copyright includes reproduction in any format. Prior to the software being supplied a copyright license must be agreed.

<u>How to link the Add-in to your current Excel File</u>

- Secondly you need to link the Add-in to the excel file you are using. This can be done by clicking File->Options->Add-ins (on the left-hand side). This will bring up a table...



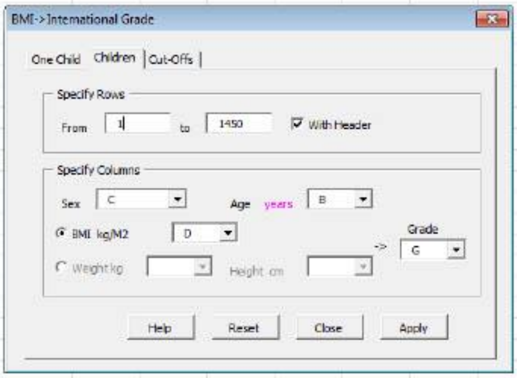
- at the bottom of the table there will be a drop down menu with the heading Manage and the default setting will read Excel Add-ins (see above)
- Provided the drop down menu says Excel add-ins, click GO (not OK), and this will bring up the following pop-up:



- Click in the growth tick box to link the BRITISH 1990 growth reference file to the current file you have open
- This should bring up an additional tab in the toolbar entitle 'Add-ins' and when clicking on this tab the wording LMSgrowth should appear in the top left hand corner with a drop down arrow next to it
- The Add-in is now installed, for further details regarding how to use the Add-in, please see below.

<u>How to use the LMS Growth Add-in to calculate IOTF cut-offs</u>

- Open your database within excel
- In order to calculate the IOTF, the minimum data requirements include age, gender and BMI. If the files are mixed gender needs to be in the following format: 1 or m=male / 2 or f=female
- Click the 'Add-ins' tab on the tool bar, and then the drop-down arrow next to the wording 'LMSgrowth'. Within this drop-down menu select 'BMI to International Grade' to pop-up the following

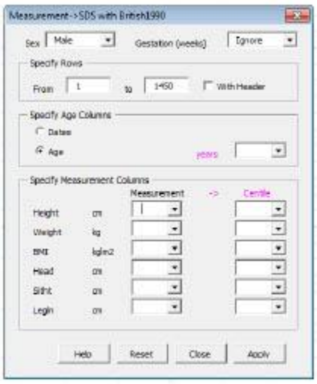


- Use the one child option if you are just calculating the BMI for an individual
- For a population use the children tab and ensure all the data is included in the 'specify rows' sections and use the 'with header' tick box as appropriate
- Use the drop down menus under 'specify columns' in order to select where the data is, e.g. click column C if the gender information is in column C and follow this through for the rest. The Grade option determines where the new data will be placed.
- Click 'apply'.
- The data will appear as -3, -2, -1, 0, 1, 2 and corresponds as follows:

Grade	BMI range at 18y	Code
Thinness grade 3	<16	-3
Thinness grade 2	16 to <17	-2
Thinness grade 1	17 to <18.5	-1
Normal weight	18.5 to <25	0
Overweight	25 to <30	1
Obesity	30+	2

How to use the LMS Growth Add-in to calculate British cut-offs

- Open your database within excel
- In order to calculate the British cut-offs , the minimum data requirements include age, gender and BMI. If the files are mixed gender needs to be in the following format: 1 or m=male / 2 or f=female
- Click the 'Add-ins' tab on the tool bar, and then the drop-down arrow next to the wording 'LMSgrowth'. Within this drop-down menu select 'Measurement to/from SDS' to pop-up the following



- Under Sex, select either male or female or if the data is mixed, select the corresponding column letter e.g. C
- Ensure all the data is included in the 'specify rows' sections and use the 'with header' tick box as appropriate
- Again, with age, ensure this is selected to the corresponding column letter.
- Where Centile appears in purple, this will originally read as SDS – therefore if you click directly on the purple SDS wording, this will change through various options, so select through until the wording reads Centile.
- Select the corresponding column for the BMI drop down menu and under the Centile Column (for BMI), select the column you would like the new data to appear in
- Click 'Apply'
- Scores for Centiles read as follows:

Underweight: ≤2nd centile
Healthy weight: >2 - <85th centile
Overweight: ≥ 85th centile
Obese: ≥95th centile

<u>7. Training Manual</u>

A training manual has been designed specifically for the Swan-Linx research assistants. Please see Appendix 14.

8. Important Contacts

Name	Position	Contact
Wendy Clark	Bay Campus Lab Technician	W.A.Clark@Swansea.ac.uk
Rebecca Dietzig	Bay Campus Lab Technician	r.e.dietzig@swansea.ac.uk
Sarah McCoubrey	Senior Active Young People Sports Development Officer	Sarah.McCoubrey@swansea.gov.uk
Helen John	Active Young People Co-ordinator	Helen.John@swansea.gov.uk
Emily Marchant	HAPPEN Coordinator	e.k.marchant@swansea.ac.uk
Hannah Spacey	Swan-Linx Coordinator	922632@swansea.ac.uk
Prof Gareth Stratton	Principle Investigator – Swan-Linx Director of A-STEM, Swansea University	g.stratton@swansea.ac.uk
Indoor Training Centre		01792 602400

9. Appendices

Appendix	Description
1	Anthropometrics
2	Speed Bounce
3	Sit and Reach
4	Handgrip Dynamometer
5	10 x 5m Shuttle Run
6	Standing Broad Jump
7	Multi Stage Fitness Test
8	Pre-Fitness Fun Day Information Pack
9	Consent forms
10	Consent Template – Excel sheet
11	Sport Science Lab Booking Form
12	Introduction Speech
13	Swan-Linx Report mail merge template
14	Training Manual – Research Assistants

Appendix 1 - Anthropometrics Script

Explaining the anthropometric measures to children:

	Assessment Item		
	Height	Weight	Sitting Height
What will you do?	You will have to stand as straight as possible with your shoes off then breathe in to best your best height	Stand on the scales without shoes and weather a t-shirt and shorts/gym wear	Sit on the special table and have your height measured from the bottom of your bottom to the top of your head
Why?	We want to record how much you are growing and compare some of your other results to your height	We want to record how much you are growing and compare some of your other results to your weight	We can use this to work out how long your legs are and how you are maturing physically
What will it tell you?	This will tell you how tall you are in centimetres (cm). If you measure your height every 3 months it will tell you how fast you are growing	How heavy you are	How long your legs are. How long your upper body is
Is it competitive?	Not at all, it's your measure and you can't change it	Not at all. But you can have a healthy weight by eating healthy foods and being physically active for at least 60 minutes per day	Not at all, it's your measure and you can't change it
How will you feel after it?	Hopefully you will feel good knowing how tall you are	Some people are worried about their weight and what they weigh. Nobody should be scared about their weight	Hopefully you will feel good knowing how your height is split between your upper and lower body
How can you help others?	Make sure that you help other people by respecting them so they can keep their results to themselves	Make sure that you help other people by respecting them so they can keep their results to themselves	Make sure that you help other people by respecting them so they can keep their results to themselves
Hints for Instructors	Make sure that children know that they can't change their height. Tell them to breathe in, keep their head level and make themselves as tall as possible	It is really important to make sure that you reinforce that you are what you weigh – this is your weight	Make sure that children know that they can't change their height. Tell them to breathe in and make themselves as tall as possible

Appendix 2

Speed Bounce Station Sheet

Speed Bounce events are part of the Sporthall series designed for the indoor use of school age competitors. This event is an exciting test of an athlete's speed, rhythm and coordination, involving double footed jumps over a foam wedge.

Equipment

- Stopwatch
- Foam Wedge
- Recording sheets/iPad

Personnel

- 2-3 people

Procedure

Participants must wear suitable footwear – this station is NOT to be completed in bare feet!

- Speed Bounce is a two-footed jump in which the participant must take off on two-feet and land on two-feet. The participants' feet should leave the mat simultaneously leave the mat and simultaneously land on the mat for one jump to be counted.
- The participant should cross the foam wedge as many times as possible within 30 seconds.
- If an incorrect technique is used, the participant should be stopped, offered an explanation and then allowed a fresh trial.
- An official should inform the participant when 10 seconds are remaining.
- The number of CORRECT bounces are counted toward the final score. It is not an offence to brush or clip the foam wedge during the activity.
- A practical trial is allowed – about 5 to 10 bounces provide an ideal opportunity to spot potential problems with technique.
- Participants must complete TWO trials.

Scoring

Two officials should count the 'correct' bounces. To promote participant engagement, researchers should invite the remaining participants to motivate the individuals taking part in the Speed Bounce and take part in the counting of correct bounces.

<u>Appendix 2 – Speed Bounce Scripts</u>

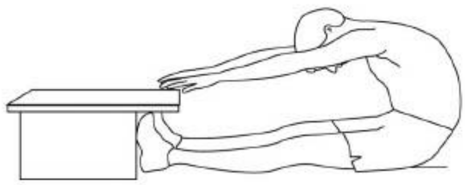
	Assessment Item – Speed Bounce
What will you do?	A two-footed jump back and forth as many times in 30 seconds.
Why?	This tells us how well coordinated you are and how you can keep this going when you're tired.
What will it tell you?	How fit you are when doing something that requires you to jump quickly in a long burst.
Is it competitive?	Yes, it is. Motivate yourself to keep going when you're tired. Tell yourself to do your best.
How will you feel after it?	You should feel very warm and tired in your legs. If you don't you will not have done your best.
How can you help others?	Help motivate them if they want you to.
Hints for Instructors	This is related to sport and dance performance and related to how well coordinated a child is. It is important to ask children to coordinate their arms and legs and keep their head as central over the barrier as possible. Motivate them by using the group to cheer them on but only if the participant wants them to.

Appendix 3 – Sit and Reach Station Sheet

The sit and reach test is a common measure of flexibility, and specifically measures the flexibility of the lower back and hamstring muscles. The test is important as tightness in this area is implicated in lumbar lordosis, forward pelvic tilt and lower back pain. The basic outline of the sit and reach test is described below.

Equipment

- Sit and reach box
- Recording sheets/iPad



Personnel

- 1-2 people

Procedure

This test involves sitting on the floor with legs stretched out straight ahead. Shoes should be removed and the soles of the feet are placed flat against the box, shoulder-width apart. Both knees should be locked and pressed flat to the floor – the researcher may assist by holding legs down, just above the knee joint. With the palms facing downwards, and the hands on top of each other or side by side, the participant reaches forward along the measuring line as far as possible and holds for 2 seconds. Ensure that hands stay side by side, not one hand reaching further forward than the other.

Scoring

The score is recorded to the nearest centimetre (cm) as the distance reached by the hand.

Appendix 3 – Sit and Reach Script

	Assessment Item – Sit and Reach
What will you do?	You will be asked to sit on the floor with your feet pressing against the sit and reach box, before stretching forward. You will have to stretch the muscles at the back of your legs and in your lower back.
Why?	This will tell how far you can stretch and how bendy and flexible you are. The muscles that stretch well are healthier. As you get older you will be less likely to have back pain or get injured playing sport if you have good flexibility.
What will it tell you?	This tells you if you can touch your toes and how bendy your muscles are.
Is it competitive?	No, this is not competitive. In fact, you should stretch forward slowly. You should make sure that you are warm when you do it.
How will you feel after it?	You might feel a little discomfort on the back of the legs but this is because you are making the muscles in the legs and back stretch as far as they can go, safely!
How can you help others?	By following proper instruction and stretching as far as you can go.
Hints for Instructors	Make sure that you inform the participants that muscles become more flexible when they are warm. Also mention some activities that require a lot of flexibility, such as; dance, gymnastics, swimming and remember to state that all activities need a certain amount of flexibility to protect joints.

Appendix 4 – Handgrip Dynamometer Station Sheet

The purpose of the handgrip strength test is to measure the maximum isometric strength pf the hand and forearm muscles. Handgrip strength is important for any sport in which the hands are used for catching, throwing or lifting. Also, as a general rule, people with strong hands tend to be strong elsewhere, so this test is often used as a general test of strength.

Equipment

- Handgrip Dynamometer
- Recording sheets/iPad

Personnel

- 1-2 people

Procedure

- The handle of the dynamometer should be adjusted if required – the base should rest on the first metacarpal (heel of palm), while the handle should rest on the middle of the four fingers.
- The participant holds the dynamometer in the hand to be tested with the arm extended above their head.
- When ready, the subject squeezes the dynamometer with maximum effort (maintained for 305 seconds), they bring their arm down to the side in a smooth motion.
- No other body movement is allowed.
- Make sure both hands are measured!

Scoring

Record the reading for each hand (kg).

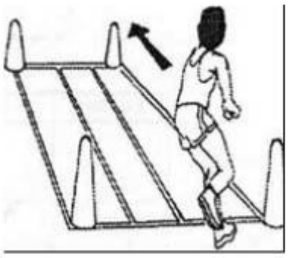
Appendix 4 – Handgrip Dynamometer Script

	Assessment Item – Handgrip Dynamometer
What will you do?	You will adjust the instrument to suit your hand size and then grip it as hard as you can.
Why?	You will do this to give a result for your basic strength.
What will it tell you?	It tells you how hard you can grip things and how strong you are.
Is it competitive?	Yes, you can be competitive against yourself, try as hard as you can – breathing out and shouting 'AHHHH' while you squeeze will help you to get a higher score!
How will you feel after it?	You will feel that you have exercised the muscles in your lower arms.
How can you help others?	Help motivate them if they want you to.
Hints for Instructors	Each kg recorded is about the same as a bag of sugar. Tell the children how many bags of sugar they can lift with their fingertips. Another tip is to tell the children what percentage of their body weight they can lift…amazing!

Appendix 5 – 10 x 5m Shuttle Run Station Sheet

The 10 x 5m shuttle run test is a test of speed and agility.

Equipment



- A flat, non-slip surface
- Stopwatch
- Measuring tape
- Marker cones
- Recording sheets/iPad

Personnel

- 2 people

Procedure

- Marker cones and/or lines are placed 5m apart.
- Start with a foot at one marker.
- When instructed by the timer, the participant runs to the opposite marker, turns and returns to the starting line.
- This is repeated until the participant has completed 5 times (covering 50 meters in total).
- At each marker, both feet must fully cross the line!

Scoring

Record the total time taken to complete the 50m course.

Record time to two decimal places e.g. 17.45s

Appendix 5 – 10 x 5m Shuttle Run Script

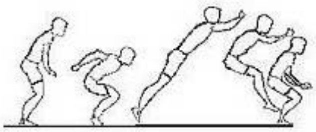
	Assessment Item – 10 x 5m Shuttle Run
What will you do?	You will sprint back and forth over a 5m distance, ten times.
Why?	This tells us how agile you are and how quickly you can change direction when running at speed.
What will it tell you?	Whether you are fast and agile and how you may use this in sport or dance.
Is it competitive?	Yes, compete against yourself and try to turn as quickly as possible to achieve your best time!
How will you feel after it?	You will feel a little tired but also great after running as fast as you can.
How can you help others?	Help motivate them if they want you to. You could even run with a friend to help motivate them.
Hints for Instructors	This is a measure of speed and agility and crucial for successful performance is sport and dance. The key is to show children how to turn quickly by turning the head to look back in the direction they want to go when they get to the line.

Appendix 6 – Standing Broad Jump Station Sheet

The standing broad jump, also called the Standing Long Jump, is a common and easy to administer test to measure the explosive power of the participant's legs.

Equipment

- Standing Broad Jump mat
- Recording sheets/iPad



Personnel

- 1-2 people

Procedure

- The participant stands behind the line marked on the standing broad jump mat with feet slightly apart.
- A two-foot take-off and landing is used, with the swinging of the arms and bending of the knees to provide forward drive.
- The participant attempts to jump as far as possible, landing on both feet without falling backwards.
- The participant has 3 attempts.

Scoring

The measurement is taken from the take off line to the nearest point of contact on the landing mat (back of heels).

Record the results for each attempt.

Appendix 6 – Standing Broad Jump Script

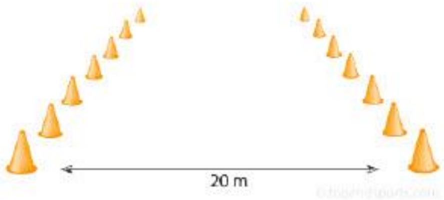
	Assessment Item – Standing Broad Jump
What will you do?	You will jump two-footed as far as you can.
Why?	We want to measure your leg power.
What will it tell you?	How far you can jump and how springy you are. This is good for sports and dance that require leg power.
Is it competitive?	Yes, it is. Make as big an effort as you can. Can you jump your own height?
How will you feel after it?	You should feel good and springy!
How can you help others?	Help motivate them if they want you to.
Hints for Instructors	Being powerful is important for all sports and dance. Tell participants to use their arms as well. What % of their height can they jump?

Appendix 7 – Multistage Fitness Test Station Sheet

The 20m multistage fitness test (MSFT) is a commonly used maximal running aerobic fitness test. It is also known as the 20m shuttle test, beep or bleep test.

Equipment

- 20m measuring tape
- Marking cones
- Bleep test CD/audio file
- CD player/sound system/laptop or iPod (AUX)
- Recording sheets/iPad
- Flat, non-slip surface



Personnel

- 2 people per bleep test group (max. of 3 groups at any one time) = 6
- 2 people for cool down group
- 3 people for pacing
- Total = 11 people

Procedure

This test involves continuous running between two lines, 20m apart in time to recorded bleeps. The subjects stand behind one of the lines facing the second line and begin running when instructed by the CD recording. The subject continues running between the two lines as prompted by the CD recording. After one minute, the bleeps will gradually increase in speed, and this will continue for every proceeding minute. If the line is reached before the bleep sound, the participant must stay at the line and wait for the next bleep before making way to next line. If the line is not reached before the bleep sound, the participant is warned and must continue to run to the line, before attempting to catch up with the next bleep. The participant is asked to finish the test if they fail to make the line (within 2 metres) on two consecutive bleeps.

Scoring

The participants' score is the number of shuttles reached before they were unable to keep up with the recording. Record the last lap completed (not necessarily the lap stopped at).

Appendix 7 – Multistage Fitness Test Script

	Assessment Item – Multistage fitness test
What will you do?	You will be asked to run back and forth over a 20m distance in time with a bleep.
Why?	We want to know what your fitness level is. This type of activity puts more demands on your heart, lungs, legs and your ability to keep going. We know that this measure is related to your health.
What will it tell you?	You will run as far as you can and you will know how many 20m shuttles you can complete! If you do 20 shuttles, that means you have completed 400m. A healthy score for girls is 25, and a healthy score for boys is 33.
Is it competitive?	The most important thing about this task is that you do your best and work as hard as you can. We know how hard you are working. This is not a race!!!
How will you feel after it?	You should feel very tired initially and your heart rate and breathing will be must faster than usual, but you will recover quickly during your cool down period. If you want to join back in for fun or to help motivate a friend, you are very welcome to do that.
How can you help others?	Help motivate them if they want you to.
Hints for Instructors	This test has been criticised for not recording accurate results. This is due to low motivation levels of children and not setting the test up in a positive, cooperative atmosphere. When participants stop and get their breath back, they should join back in and help a friend. At the end of the MSFT, the person with the highest score should not be running alone.

Appendix 8 – Fitness Fun Day Information for Schools

Fitness Fun Day: Information for Schools

Morning Session

Location – Indoor Training Centre, Swansea University

Time – 9.30am – 12.30pm

Activities – Children will take part in anthropometric measurements, standing long jump, 5 x 10m shuttle run, sit and reach, speed bounce, hand grip strength, multi-stage fitness test

Please arrive at the National Pool for 9:30am where a researcher will meet you and escort you to the Indoor Training Centre. We would encourage all children to arrive wearing their gym kits/suitable sporting attire with their own water bottles. We have access to a water machine but are unable to supply bottles or cups for the children to use.

Afternoon Session

Location – Your school

Time – 1:00pm – 3:00pm

Activities – Children will fill in an online health and activity questionnaire.

Please ensure that there are adequate numbers of computers, laptops and tablets for the children to use. The questionnaire can take 30-40 minutes to complete and children are asked to complete the questionnaire independently and in relative silence.

Checklist for Schools

1. Email researcher the total number of children in Year 5 and Year 6 along with a record of participant postcodes, date of birth, school year and gender
2. Distribute consent forms
3. Collect consent forms, ensuring any incomplete forms are filled in before handing back to researcher – INCOMPLETE CONSENT FORMS WILL RESULT IN THE CHILD NOT BEING ABLE TO PARTICIPATE IN THE FITNESS FUN DAY REPORT
4. Arrange transport to and from the Indoor Training Centre (arriving at 9:30am and leaving at 12:30pm)
5. Book appropriate IT facilities and class rooms for the afternoon session

Thank you for your support and we look forward to welcoming you to your fitness fun day soon!

Appendix 8 – Fitness Fun Day Information for Schools

Fitness Fun Day: Information for Schools

Why do we need participant information before the Fitness Fun Day?

Names - we need the names of the children who are expected to attend in order to assign each participant a research number before the fitness fun day. As all of the data we collect in Swan-Linx is anonymous, we use these research numbers to identify the children within the study when we are collecting measurements on the day.

D.O.B - We need the participants D.O.B to calculate decimal age and to calculate accurate BMI/IOFT scores.

School Year - We need to know what school year the children are part of for data sorting (e.g. Year 5, Year 6).

Gender - We need to know the gender of the children as there are variations between measurement norms and formulas. As we don't have the children's names, we need to identify this variable before the fitness fun day and analysis of data.

Postcodes - Swan-Linx needs to have a record of the postcodes for every child in order to work out deprivation codes. The postcodes are also needed for the second part of the day, where the children fill out the online questionnaire. On the first page of the questionnaire, it asks the children to give their postcode but due to the age of the children taking part, some of them may not know this information, hence why we ask for a list. For us to have an idea about where the children reside without knowing who they are, we use postcodes to map the area of residence of each participant. We also use postcodes for data linkage where the parent has consented.

All data is kept on password protected files, on a password protected hard drive which is locked in a secure locker in the A-STEM Research Hub at Swansea University's Bay Campus. After the data has been input and the fitness fun day is completed, any registers etc. are shredded/destroyed.

If you have any questions about the Fitness Fun Day or anything related to the information above, please feel free to contact –

Hannah L Spacey, Swan-Linx Co-ordinator

922632@swansea.ac.uk

Swansea University
Prifysgol Abertawe

Applied Sports Technology Exercise and Medicine Research Centre (A-STEM)
Sport and Health Portfolio, College of Engineering

PARTICIPANT INFORMATION SHEET
(Version 2.0, Date: 01/06/2017)

Project Title:
Health, motor skills (physical competency), fitness and lifestyle of School Children in Wales

Contact Details:
Hannah L Spacey – 922632@swansea.ac.uk / 07745332678
Richard Tyler – 837039@swansea.ac.uk
Professor Gareth Stratton – G.Stratton@swansea.ac.uk

You have been invited to take part in a Swansea University study. You have been chosen because you are between the ages of 8-13 years old and go to a school in Wales.

In this study you have the chance to take part in a fitness fun day, and complete a questionnaire about your health and lifestyle and about how physically active you are.

Physical activity is any movement that requires your body to work harder than it does whilst sitting, or resting. The fitness fun day will involve lots of fun physical activities that you may not have tried before which should be really enjoyable. These activities will include a 20m shuttle run to see how long you can run for, a shuttle sprint to see how quick you can run back and forth, gripping with your hands to find out your strength, sit and reach to find out how flexible you are, standing long jump to see how far you can jump, and speed bounce to see how many times you can jump in 30 seconds. You may also be invited to take part in another fitness fun day over the next year. You will be told when this will happen and are free to withdraw at any point.

You may also get asked to wear our BRAND NEW devices, and use the NEWEST technology to measure how fast you move forwards and backwards, side to side and up and down. This will be worn on your wrist and ankle during some of the physical activities. You may also be video recorded during some of the physical activities. This will help us see how well you have done.

You will not be forced to do any of the activities and can stop at any time without fear of penalty or having to worry about being in trouble.
If you have any questions, please ask.
THANK YOU!

Applied Sports Technology Exercise and Medicine Research Centre (A-STEM)
Sport and Health Portfolio, College of Engineering

PARTICIPANT ASSENT FORM

(Version 2.0, Date: 01/06/2017)

Project Title:
Health, motor skills (physical competency), fitness and lifestyle of School Children in Wales

Contact Details:
Hannah L Spacey – 922632@swansea.ac.uk / 07745332678
Richard Tyler – 837039@swansea.ac.uk
Professor Gareth Stratton – G.Stratton@swansea.ac.uk

	Please look at the following statements and put your initials if you agree. Example Sarah Jones: SJ	
	I have read the Participant Information Sheet	☐
	I understand what I will be doing if I take part	☐
	I have had a chance to think about taking part	☐
	I have had a chance to ask any questions	☐
	I agree that my data can be used in a research report and that I will not be named so no-one will know it was my information	☐
	I understand that all of the information will be kept private and only shared with the research team	☐
	I am happy to try to do the activities that the Swan-Linx Team want me to do during the fitness fun day, and complete the questionnaire at both times	☐
	I am happy to take part in this study	☐

Name of Participant	Date	Signature
Researcher	Date	Signature

Applied Sports Technology Exercise and Medicine Research Centre (A-STEM)
Sport and Health Portfolio, College of Engineering

Swansea University
Prifysgol Abertawe

HEADTEACHER INFORMATION SHEET

(Version 2.0, Date: 01/06/2017)

Project Title:
Health, motor skills (physical competency), fitness and lifestyle of Swansea School Children

Contact Details:
Hannah L Spacey – 922632@swansea.ac.uk / 07745332678
Richard Tyler – 837039@swansea.ac.uk
Professor Gareth Stratton – G.Stratton@swansea.ac.uk

1. Invitation Paragraph

The children in your school have been invited to take part in a new study that will look at the relationships between lifestyle behaviours, such as, sitting time, computer game play, fitness, sleep time, type of foods eaten and so forth. Other schools are also taking part in the study. They will be asked to take part in a Fitness Fun Day, where they will complete a series of physical activities and a questionnaire. The data we collect will help us assess different aspects of children's motor skills (physical competency), fitness and lifestyle. Please consider whether you are able to commit to the requirements stated below before signing the consent form.

2. What is the purpose of the study?

The purpose of this study is to investigate the health, motor skills (physical competence), fitness, lifestyle of children from selected schools. The study will also test an accelerometer which measures body movement. The data collected will be used in a postgraduate student's thesis and will assist in tracking children's health, physical activity and physical competency, to decide how best to help children become healthier and more involved in sport and physical activity in the future. The data collected will also be used to map results across Wales. This will help us to further analyse levels of health and fitness in children in terms of demographics.

3. Why have I been chosen?

The children in your school have been invited take part in the Fitness Fun Day as they attend school in Wales. During the day if any of the children do not feel happy about anything they are asked to do, they can stop at any time, without fear of penalty. If you need any more information about the study then please contact any member of the team on the details above.

4. What will happen to the children if they take part?

Your pupils will attend a Fitness Fun Day; this will involve a half day of fun physical activities which will measure the children's strength, speed, agility, endurance and flexibility. These activities include; 20m

Multi Stage shuttle runs (measures endurance), 10x5m sprint (measures speed and agility), handgrip (measures strength), sit and reach (measures flexibility), standing long jump (measures leg explosive power), and speed bounce (measures leg speed, agility and endurance).

During these physical activities, some of the children may be asked to wear a sensor called a SlamTracker accelerometer. This device will measure how fast the child moves forwards and backwards, side to side and up and down, and will only be worn during some activities. The activities will be no harder than what a child would do during school PE lessons. The children will also have weight, height and sitting height measurements recorded, take by a member of the research team listed. Measures of body weight are taken privately in a separate room or behind a screen, there will always be other children in the room or next to the screen but they will not be party to the results or be able to view the measures and no results are shared with the rest of the class. Children can choose not to have their anthropometric measurements taken if they do not want to be measured. We have followed this approach with around 70000 children in Liverpool since 1996. Finally, during the Fitness Fun Day session, the children will also be asked complete a questionnaire, about their health, physical activity and lifestyle, which will take about 30 minutes. There will be members of the research team and teachers present to assist the children in filling them in. All the activities during the Fitness Fun Day are aimed for the children's enjoyment and not as a competition. With your permission, a video camera will also be used to capture some of the activities the children are performing.

Your school may also be invited to participate in a further Fitness Fun Day within 12 months of your initial Fitness Fun Day. This helps to evaluate school-based interventions and track changes in children's fitness and health. You are free to withdraw your school at any point.

5. What are the possible disadvantages of taking part?

Taking part in the Fitness Fun Day activities poses no greater risk than a child would face during physical education lessons in school. However, in the unlikely event that a child feels unwell, there will be people monitoring the children during all parts of the fitness fun day, and the children's teachers will remain present at all times. A qualified first aider will always be present during the fitness fun day.

6. What are the possible benefits of taking part?

The Fitness Fun Day will be an active and very enjoyable day for the children and they will get to take part in a variety of different activities that they might not have taken part in before. They will be able to find out about their skills and fitness in relation to health and well-being. Further we want children to engage with their results. Therefore school data will be anonymised and made available to the school for educational purposes.

7. Will my taking part in the study be kept confidential?

All the data we collect from the children will be kept private and confidential; the children's names will be changed to numbers. Any hard copies of the questionnaires and fun day data will be kept in a secure office and computer files with any personal information will be password protected. The data obtained will only be looked at by responsible individuals of the research team from Swansea University and the City & County of Swansea, and the PLPS team (Sport Wales), or from regulatory authorities where it is relevant to the children's participation in the research. To enable us to track changes in heath over time we will also keep the secure data available for future linkage with other sets of data collected in the future such as GP visits or educational results for example.

8. What if I have any questions?

If you have any questions about what I have written above or anything to do with the study please don't hesitate to contact me or anyone from the research team as detailed above. If after the study you are concerned about how any aspect of the research was conducted please contact the Chair of the College Ethics Committee, Professor Mike McNamee (m.j.mcnamee@swansea.ac.uk)

Applied Sports Technology Exercise and Medicine Research Centre (A-STEM)
Sport and Health Portfolio, College of Engineering

HEADTEACHER CONSENT FORM

(Version 2.0, Date: 01/06/2017)

Project Title:
Health, motor skills (physical competency), fitness and lifestyle of School Children in Wales

Contact Details:
Hannah L Spacey – 922632@swansea.ac.uk / 07745332678
Richard Tyler – 837039@swansea.ac.uk
Professor Gareth Stratton – G.Stratton@swansea.ac.uk

Please INITIAL each box below

1. I confirm that I have read and understood the information sheet dated 01/06/2017 (Version number 2.0) for the above study and have had the opportunity to ask questions. ☐
2. I understand that the children's participation is voluntary and that I am free to withdraw my pupils at any time, without giving any reason, without their medical care or legal rights being affected. ☐
3. I understand that sections of the data obtained may be looked at by responsible individuals from the Swansea University or from regulatory authorities where it is relevant to the children's taking part in research. ☐
4. I am happy for any data collected in this study to be used in future health related studies where data collected will be linked to health outcomes and educational records ☐
5. I am happy for the activities to be video recorded for academic use ONLY. ☐

I agree to allow the pupils in my school to take part in the above study.

______________________	____________	____________________
Name of School	Date	Signature
______________________	____________	____________________
Name of Head Teacher	Date	Signature
______________________	____________	____________________
Researcher	Date	Signature

Applied Sports Technology Exercise and Medicine Research Centre (A-STEM)
Sport and Health Portfolio, College of Engineering

PARENT INFORMATION SHEET

(Version 1.0, Date: 01/06/2017)

Project Title:
Health, motor skills (physical competency), fitness and lifestyle of School Children in Wales

Contact Details:

Hannah L Spacey – 922632@swansea.ac.uk / 07745332678
Richard Tyler – 837039@swansea.ac.uk
Professor Gareth Stratton – G.Stratton@swansea.ac.uk

Please read the information below carefully before deciding whether to consent for your child's participation.

1. Invitation Paragraph

The children in your child's class have been invited to take part in a new study that will look at the relationships between lifestyle behaviours, such as, sitting time, computer game play, fitness, sleep time, type of foods eaten and so forth. The data we collect from all of the children taking part in the study will help us assess different aspects of children's motor skills (physical competency), fitness and lifestyle.

2. What is the purpose of the study?

The purpose of this study is to investigate motor skills (physical competency), fitness and lifestyle in children. The study will also test an accelerometer which measures body movement. The data collected will be used in a postgraduate student's thesis and will assist in tracking children's health, physical activity and physical competency, to decide how best to help children become healthier and more involved in sport and physical activity in the future. The data collected will also be used to map results across Wales. This will help us to further analyse levels of health and fitness in children in terms of demographics.

3. Why has my child been chosen?

All of the children in your child's class, including your child, have been invited to take part in the Fitness Fun Day. During the day, if your child does not feel happy about anything that they are asked to do, they can stop at any time, without fear of penalty. If you need any more information about the study then please contact any member of the team on the details above.

4. What will happen to your child if they take part?

Your child will attend a Fitness Fun Day with the rest of their class. This will involve a half day of fun physical activities which will measure children's strength, speed, agility, endurance and flexibility. These activities include; 20m shuttle run (measures endurance), 10x5m sprint (measures speed and

agility), handgrip (measures strength), sit and reach (measures flexibility), standing long jump (measures leg explosive power), and speed bounce (measures leg speed, agility and endurance). During the physical activities, some of the children may be asked to wear the SlamTracker accelerometer. This device will measure how fast your child moves forwards and backwards, side to side and up and down.
Your child will also have weight, height and sitting height measurements recorded, taken by a member of the research team listed. Measures of body weight are taken privately in a separate room or behind a screen, there will always be other children in the room or next to the screen but they will not be party to the results or be able to view the measures and no results are shared with the rest of the class, however, your child will not have to have them taken if they do not want to. All activities will be no harder than your child would do during school PE lessons. Finally, during the Fitness Fun Day session or at your child's school, your child will also be asked complete a questionnaire, about their health, physical activity and lifestyle, which will take about 30 minutes. There will be members of the research team and teachers present to assist your child in filling them in. All the activities during the Fitness Fun Day are aimed for the children's enjoyment and not as a competition. With your permission, a video camera will also be used to capture some of the activities the children are performing.
Your child may also be invited to take part in a further Fitness Fun Day within 12 months of their initial Fitness Fun Day. This can help evaluate school-based interventions and track changes in children's fitness and health. You and your child will be notified when this second Fitness Fun Day will take place, and are free to withdraw at any point.

5. What are the possible disadvantages of taking part?

Taking part in the Fitness Fun Day activities poses no greater risk than a child participating in school physical education lessons. However, in the unlikely event that a child feels unwell, there will be people monitoring the children during all parts of the fitness fun day, and the children's teachers will remain present at all times. A qualified first aider will always be present during the Fitness Fun Day.

6. What are the possible benefits of taking part?

The Fitness Fun Day will be an active and very enjoyable day for the children and they will get to take part in a variety of different activities that they might not have taken part in before. They will be able to find out about their skills and fitness in relation to health and well-being. Further we want children to engage with their results. Therefore school data will be anonymised and made available to the school for educational purposes.

7. Will my child taking part in the study be kept confidential?

All the data we collect from your child will be kept private and confidential; the children's names will be changed to numbers. Any hard copies of the questionnaires and fitness fun day data will be kept in a secure office and computer files with any personal information will be password protected. The data obtained will only be looked at by responsible individuals of the research team from Swansea University, City & County of Swansea, and the PLPS team (Sport Wales), or from regulatory authorities where it is relevant to your child's participation in the research. To enable us to track changes in heath over time we will also keep the secure data available for future linkage with other sets of data collected in the future such as GP visits or educational results for example.

8. What if I have any questions?

If you have any questions about what is written above or anything to do with the study, please don't hesitate to contact me or anyone from the research team (see contact details above). If after the study you are concerned about how any aspect of the research was conducted please contact the Chair of the College Ethics Committee, Professor Mike McNamee (m.j.mcnamee@swansea.ac.uk).

Swansea University
Prifysgol Abertawe

Applied Sports Technology Exercise and Medicine Research Centre (A-STEM)
Sport and Health Portfolio, College of Engineering

PARENT CONSENT FORM

(Version 2.0, Date: 01/06/2017)

Project Title:
Health, motor skills (physical competency), fitness and lifestyle of School Children in Wales

PLEASE RETURN THIS FORM TO SCHOOL TO CONSENT FOR YOUR CHILD TO TAKE PART IN THE PROJECT.

Contact Details:

Hannah L Spacey – 922632@swansea.ac.uk / 07745332678
Richard Tyler – 837039@swansea.ac.uk
Professor Gareth Stratton – G.Stratton@swansea.ac.uk

Please INITIAL each box below

1. I confirm that I have read and understood the information sheet dated 01/06/2017 (Version number 2.0) for the above study and have had the opportunity to ask questions. ☐
2. I am happy for my child to participate in this Fitness Fun Days and a second Fitness Fun Day within 12 months, and wear the SlamTracker accelerometer. ☐
3. I understand that my child's participation is voluntary and that I am free to withdraw my child at any time, without giving any reason, without their medical care or legal rights being affected. ☐
4. I understand that sections of the data obtained may be looked at by responsible individuals from the Swansea University or from regulatory authorities where it is relevant to the children's taking part in research ☐
5. I am happy for any data collected in this study to be used in future health related studies where data collected will be linked to health outcomes and educational records. ☐
6. I am happy for the activities to be video recorded for academic use ONLY. ☐

I agree to allow my child to take part in the above study.

______________________	____________	__________________
Name of Participant (child)	Date	Signature
Name of Parent/Guardian	Date	Signature
Researcher	Date	Signature

Appendix 10 – Consent database template (Excel)

First Name	Surname	Parent Consent							Child Assent								
		I confirm that I have read and understood the information sheet [illegible]	I am happy for my child to participate in the [illegible] Day	[illegible]	[illegible]	I am happy for any data collected in this study [illegible]	[illegible]	NOTES	I have read the Participant Information Sheet	I understand what I will be doing if I take part	I have had a chance to think about taking part	I have had a chance to ask any questions	[illegible]	[illegible]	[illegible]	[illegible]	NOTES
Hannah	Spacey		Y	Y	Y	Y	Y			Y	Y		Y	Y	Y	Y	

Appendix 11 – Lab booking form

Swansea University, Sports Science

Study Info: Equipment and Lab Requirements

Form A1: Study Information Sheet

1. **Project / Study Title:** Swan-Linx: Fitness Fun Day

2. **Study Type:** (Place * next to relevant box)

Dissertation	
Masters Project	
PhD Project	*
Consultancy	
Other	*

(If other, please explain)

Give a brief description of study/assessments:

Swan-Linx aims to measure physical literacy and fitness in children aged 9-11 in Swansea

3. **Dissertation/Study Supervisor:** Prof Gareth Stratton

4. **Names of all students in study:** Hannah Louise Spacey

OFFICE USE ONLY:

Ethical Approval (EA) obtained?	(Delete as required)	Yes / No
Risk Assessment (RA) completed?	(Delete as required)	Yes / No
Copy of EA & RA handed in?	(Delete as required)	Yes / No
Initial Consultation with Lab Tecl	(Delete as required)	Yes / No
Lab Training Completed?	(Delete as required)	Yes / No

Study Code:

5. **Estimated Testing Dates:** From: 7th October 201 To: 30th April 2018

6. **How often are you likely to be testing in lab each week?** N/A
(e.g. Approx. how many test sessions per week?)

7. **Equipment required:** List all equipment and state how often it is to be used (i.e. How many subjects / tests per subject)

Equipment (list)	How Often?	Equipment (list)	How Often?
Sitting Height Stadiometer	100 subjects/1 test		14 testing days
Digital Weighing Scales	100 subjects/1 test		14 testing days
Sit and Reach Box	100 subjects/1 test		14 testing days

8. **Consumables required:** (E.g. lancets, alcoswabs, BIA electrodes) - be specific
(N.B. Post Grad & Research Studies must supply their own consumables)

Product:	No. required	Product:	No. required:

9. Supervision: Who will be supervising during your testing in the lab?
(This person must be an approved supervisor who is first aid trained)

10. **Has this supervision been arranged and agreed?** (delete as required) Yes / No

10. **Student contact details** (to liaise re bookings):

Name:	Hannah L Spacey	Email:	922632@swansea.ac.uk	Tel. No:	7745332678
Name:		Email:		Tel. No:	
Name:		Email:		Tel. No:	

11. Test Information

Please list the protocols to be used in your test battery and how many times each test

Rebecca Dietzig 18/09/2017

Appendix 12 – Introduction Speech

Thank you for coming to the Indoor Training Centre today! First of all, I need to go over the safety for this morning. In the case of a fire, please head to the nearest exit and make your way to the fire assembly point in the car park. If you injure yourself or feel ill at any time during the morning, please notify myself, your teacher or one of the research team. If you need to use the toilet, please notify myself, your teacher or one of the research team and the same goes for getting drinks, jumpers etc.

Okay, so can anyone tell me what we are doing here today? [children respond with answers].

Wow, great - they are all brilliant answers! So today we would like you to take part in a few different physical activities, some of them you will have tried before, some you won't have. We'd would like you to give everything a go and try your best! It is important to remember that today is all about having fun and so I will ask you to be positive and supportive to your peers and help motivate those who are trying the activities for the first time today.

So, a little background about the Swan-Linx project. The study is looking at the health and fitness of 9-11-year-old children in Swansea. To date, over 3,500 children have been measured and we hope to continue to add to this number until all the primary schools in Swansea have taken part. Does anyone have any questions?

In a moment, your teacher will call out your name and a number. Please come up and collect your number, stick it onto your t-shirt and sit back down as quickly and quietly as possible. Your number will be your new identity during the day and you will need to give your number to the researchers at every station during the morning session. Your number will mean that we won't know your name and so all your data today will remain anonymous. Please make sure you take a mental note of your number as you will need this to complete the online questionnaire this afternoon.

Appendix 13 – Swan-Linx Mail Merge Template

SCHOOL	SC	YEAR	MSFT (SCHC	MSFT (20	HANDGRIP R (SCH	HANDGRIP R (201	HANDGRIP L (SC	HANDGRIP L (2016	S&R (SCH	S&R (201	SBJ (SCHO	SBJ (2016	SB (SCHO	SB (2016	10x5 (SCHOOL	10x5 (2016)
1	1	5 & 6	27	28	16.3	17.3	16.5	16.5	19	18	1.27	1.32	35	40	21.2	20.69
1	1	5 & 6	28	28	16	17.3	15	16.5	16	18	1.25	1.32	39	40	20.26	20.69
1	1	5 & 6	36	28	16	17.3	16	16.5	19	18	1.31	1.32	41	40	19.86	20.69
1	1	5 & 6	39	28	17.6	17.3	17	16.5	19	18	144	1.32	.	40	.	20.69
1	1	5 & 6	.	28	17.6	17.3	16.6	16.5	21	18	1.28	1.32	.	40	18.8	20.69

BMI (SCH	BMI (201	HEIGHT (S	HEIGHT (2	WEIGHT (S	WEIGHT (	% UNHEALT	% UNHEAL	HANDGRIP R (S	HANDGRIP	HANDRGIP L (	HANDGRIP	MIN R (SCHO	MIN R (2016)	MIN L (SCHOOL	MIN L (2016)	MAX R (SC	MAX R (20	MAX L (SC	MAX L (2	RANGE R	RANGE R(	RANGE L	RANGE L
19.2	19.2	140.9	142.3	38.7	39.2	33.3	28	16.3	17.3	16.5	16.5	5	1	5	2	25	35	25	31	20	34	20	29
19.1	19.2	140.8	142.3	38.2	39.2	25.6	28	16	17.3	15	16.5	7	1	5	2	24	35	25	31	17	34	21	29
18.5	19.2	140.6	142.3	36.6	39.2	32.6	28	16	17.3	16	16.5	5	1	5	2	26	35	25	31	21	34	20	29
18.5	19.2	144	142.3	38.5	39.2	20	28	18	17.3	17	16.5	12	1	12	2	23	35	23	31	11	34	11	29
19.3	19.2	141.7	142.3	39.3	39.2	.	28	17.6	17.3	16.6	16.5	11	1	12	2	26	35	25	31	15	34	13	29

#SHUTTLES (S	#SHUTTLES	% THRESHOLD (	%THRESHO	MIN (SCHOO	MIN (2016)	MAX (SCH	MAX (201	RANGE (S	RANGE (2	FLEXI (SCH	FLEXI (201	POWER (S	POWER (2	AGIL & ST	AGIL & ST	AGIL & SP	AGIL & SPEED (2016)
27	27	36	42	4	1	76	88	72	87	18.9	18	1.26	1.32	35	40	21.22	20.69
28	27	56	42	7	1	70	88	63	87	16	18	1.25	1.32	38	40	20.26	20.69
36	27	53	42	10	1	80	88	70	87	19	18	1.31	1.32	41	40	19.86	20.69
39	27	62	42	15	1	69	88	54	87	19	18	1.44	1.32	.	40	.	20.69
.	27	.	42	.	1	.	88	.	87	21	18	1.28	1.32	.	40	18.8	20.69

Appendix 14 – Swan-Linx Training Manual – Research Assistants

Swan-Linx Fitness Fun Day Training Manual

Research Assistants

2017/2018

1. Statement of Purpose

This manual is designed for members of the Swan-Linx research team as a tool to aid training and to ensure consistency between research groups. The manual should be read and understood by all research assistants before partaking in any Swan-Linx Fitness Fun Day. It is the responsibility of the research assistant to ensure that they fulfil the latter clause.

1.1 Diversity, Inclusivity and Respect

Swan-Linx operates under the values set out by Swansea University and works hard to promote and support the participation of all individuals by creating a safe environment that upholds dignity, respect and fairness. Swan-Linx achieves the latter by understanding, respecting, appreciating and recognising difference in individuals and strives to accommodate all participants in their active engagement during the Fitness Fun Day. Swan-Linx expects all researchers, research assistants and partners to operate in line with the above.

1.2 Case Study

Prior to a Fitness Fun Day, Swan-Linx was made aware that an individual who was set to attend the session had severe visual impairment and would be accompanied by a learning assistant. At the beginning of the session, the coordinator worked alongside the participant and learning assistant to assess the level of support the individual would need and how best to modify stations to enable safe participation. The coordinator assigned the participant a research assistant who acted as support and guide through the activities, working closely with the individual and always accompanied by the learning assistant. Throughout the course of the session, the individual was able to confidently take part in the activities and finished the day having taken part in all measures.

2. Swan-Linx Overview

Swan-Linx is a longitudinal project run by A-STEM researchers at Swansea University that collects data on the health, fitness and physical competence of primary age children in Swansea. Schools are invited to attend a Fitness Fun Day where the children take part in a range of health and skill related fitness measures before going back to school to complete the Child Health and Activity Tool (CHAT) with HAPPEN researchers. The CHAT is an online questionnaire that collects data on a wide spectrum of health and lifestyle-related behaviours including; sleep, diet, physical activity, mental health, active travel and environment.

After the Fitness Fun Day, the participating school receives a report comparing their school data with Swansea averages while data of consenting participants is input into the Secure Anonymised Information Linkage (SAIL) databank for linkage to future health records and educational attainment outcomes.

Through Swan-Linx, objective measures of physical competence are collected using the Dragon Challenge V1.0, which is administered during the transition weeks for school children progressing from Primary to Secondary education. The Dragon Challenge is designed as a continuous circuit that enables the efficient assessment of a number of stability, locomotion and manipulative skills that are deemed crucial for successful participation in physical pursuits and sports throughout the life course.

3. Swan-Linx Fitness Fun Day

The Fitness Fun Day is an all-day event that is split into two sessions. In the morning session, a school will bring their Year 5/6 children to the Indoor Training Centre where the first part of the Fitness Fun Day will take place. During the session, the children will engage with a number of different health and fitness measures in small groups (10-14 participants per group). The session will follow a circuit format and the circuit will end when all children have rotated through the stations. Each station will be allocated 15 minutes to measure and record participants, before the next rotation. The circuit will take on average 1 hour and 15 minutes to complete. At the end of the circuit, the children will be invited to take part in the Multistage Fitness Test (also known as Bleep test). When all children have taken part, the school group will then return to their school to complete an online questionnaire in the afternoon session. The Child Health and Activity tool (CHAT) is administered by HAPPEN researchers and asks a number of questions relating to physical activity, wellbeing, nutrition and mental health. Please see Table 1 for a list of Fitness Fun Day Measurements. Fitness Fun Day activity station sheets and scripts can be found in the Appendices of this manual.

Table 1: Fitness Fun Day measurements

Morning Session	Afternoon Session
Battery of fitness measures – • Anthropometric Measures • Speed Bounce - agility, speed, coordination and stamina • Handgrip – strength • Sit and Reach - flexibility • 10 x 5m Shuttle – speed, agility • Standing Broad Jump – explosive power • Multistage Fitness Test – cardiorespiratory fitness	Online Questionnaire – CHAT • Lifestyle • Wellbeing • Physical Activity • Diet • Sleep • Mental Health

4. Swan-Linx Partners

Swan-Linx works in partnership with a number of organisations to deliver the Swan-Linx project. Please see below for partner details and roles within the project.

4.1 HAPPEN – Health and Attainment of Pupils in a Primary Education Network

HAPPEN is a network of health, education and research professionals aimed at improving the health, wellbeing and education outcomes of primary school children in Swansea. In collaboration with the Swan-Linx project, objective and self-reported data is collected on children aged 9-11. This data is fed back to schools through individualised reports comparing the health and wellbeing of their pupils to county averages. Data is presented alongside health guidelines and links to local school-based health initiatives. A novel aspect of HAPPEN is the use of data linkage. This data collected at Fitness Fun Days is linked to anonymous, routinely collected data including GP records, hospital admissions and educational attainment using the SAIL (Secure Anonymised Information Linkage) databank. Finally, this data can be used to evaluate the impact of school-based interventions on outcomes such as fitness, wellbeing and education.

4.1.1 Roles within Swan-Linx

- Delivering afternoon session of Fitness Fun Day
- Handling CHAT data

- Creating and sending out School and Child Fitness Fun Day Reports
- Recruiting potential Swan-Linx schools through HAPPEN network

3.2 Active Young People Team, City and County of Swansea

The **Active Young People** (AYP) team is funded by Sport Wales and are responsible for providing a variety of exciting sport and physical activity opportunities for young people up to 16 years of age, as part of their school extra-curricular programmes and within their local communities. AYP Swansea would like to see 'every Child Hooked on Sport for Life' and we have several projects to help achieve this across the City, these include; Play to learn, Dragon Multi-skills and Sport, 5x60, physical literacy in the community and Young Ambassadors.

Our aim is to ensure that all children and young people are participating in sport and physical activity, and where appropriate, have the support to excel. AYP is committed to continuing to work with partners to ensure that sporting opportunities are actively encouraged as part of a broader life experience and that the participation gap between those living in poverty and those not is closed.

Having been involved in Swan-Linx since the start of the project in Swansea, AYP Swansea has seen it develop over the years and feel that it is provides vital data to help achieve our vision of 'every child hooked on sport'.

4.2.1 Roles within Swan-Linx

- Attending morning session of Fitness Fun Day
- Coordinating and sending Young Ambassadors to morning Fitness Fun Day sessions
- Identifying 'most wanted' sport/physical activity session for each Swan-Lin school
- Organising appropriate time for sport/physical activity session with school and Gower College
- Attending sport/physical activity session (quality assurance)

4.3 Gower College

4.3.1 Roles within Swan-Linx

- Providing research assistants for Swan-Linx Fitness Fun Days (morning sessions)
- Liaising with AYP to organise sport/physical activity deliver sessions
- Delivering sport/physical activity session in school

5. Swan-Linx Partnership Pathway

Figure 1 below gives a visual pathway detailing the overall Swan-Linx process from Fitness Fun Day to delivery of sport/physical activity sessions and signposting, and what partner(s) are responsible for each step.

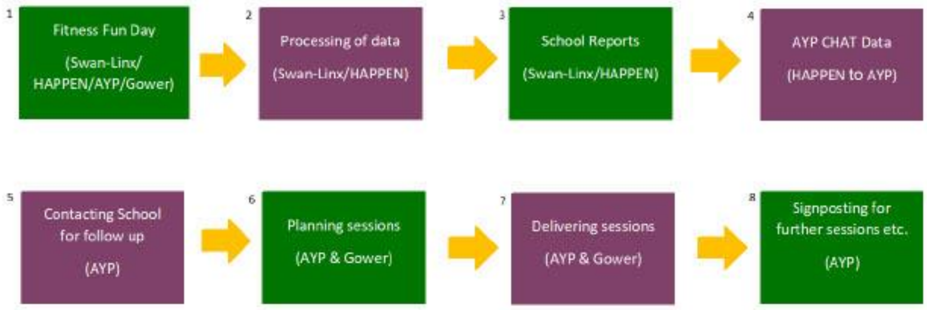


Figure 1: Swan-Linx Partnership Pathway

6. Research Assistant Roles and Responsibilities

During the Fitness Fun Day (morning) session, research assistants will have a number of roles and responsibilities that cover a range of skills such as; accurate measurement, precise data collection, organisation, problem solving and interpersonal communication. Research assistants are expected to approach these tasks with efficiency and professionalism at all times.

6.1 Research Assistant Operational Procedures – Fitness Fun Day (AM) session

1. Research assistants arrive at Indoor Training Centre by 8:30am
2. Research assistants to set up stations, organise sitting area and partake in a team briefing led by Swan-Linx coordinator (discussion topics: school information, expected number of participants, station timings, station allocations, warm up leader allocation, Q&A, any other business)
3. Two research team members will leave ITC at 9:15am to collect school from National Pool
4. School arrives at ITC – welcome!
5. Introduction and Fitness Fun Day briefing – Swan-Linx Coordinator
6. Swan-Linx coordinator to read register, allocate participant numbers and assign participants into groups
7. Research assistants to collect participant group and escort to warm up area
8. Research assistants to deliver appropriate warm up session for 10 minutes
9. At end of warm up, research assistants to lead participant group to Fitness Fun Day circuit station and when all groups are at correct stations, the session will begin
10. Research assistants are expected to conduct the station as follows;
    a. **Greet your participants** – 'Hello, Group A! How are you today?'.
    b. **Introduce yourself** – 'My name is Ben and I am a member of the Swan-Linx Research team'.

c. **Demonstrate activity** – 'Okay so can anyone tell me what they think we will be doing on this station today? [children answer]. Yes, they are all great answers! So, this station is called the Standing Broad Jump and it's designed to test the explosive power in your legs. I am going to talk you through what I would like you to do and I will then demonstrate how I would like to do it'.

d. **Organise group** – 'Okay, so now that I have explained the station to you and demonstrated how to do the activity, I am going to organise you into numerical order and this will be the order that you will have your go at the activity'.

e. **Measure outputs** – please ensure accurate measurement of activity output for all participants and stations.

f. **Record outputs** – please ensure accurate recording of activity output, paying special attention to the preferred metric unit

g. **Engage group** – Each group will be given 15 minutes at each station; however, some stations will be finished before others. Research assistants are expected to keep participants engaged and moving during the waiting period. No participants should be sitting down during this time. A good use of this time is to communicate with the group about sports and physical activities by creating a quick game.

    1. 'Who likes' Game example –
        - a. Get group to line up in a line
        - b. Instruct participants to run to another line and back if the statement applies to them
        - c. Statements can include –
            - i. Who likes football?
            - ii. Who likes hockey?
            - iii. Who likes running?
            - iv. Who likes swimming?
            - v. Who likes the colour blue?
            - vi. Who likes the colour green?
            - vii. Who has a dog?
            - viii. Who has a cat?
        - d. Please ensure that the 'Who likes' questions are inclusive, age appropriate and not likely to cause any negative feelings, feelings of exclusion or discrimination.

h. **Rotation** – One research assistant are expected to escort their group to their next station while the other research assistant is expected to welcome and greet the new station group

i. **Multistage Fitness Test** – The multistage fitness test is the last measure that the participants will be invited to take part in in the Fitness Fun Day. Research assistants are expected to follow the guidance of the Swan-Linx coordinator who will be overseeing the organisation and running order of the MSFT. During the MSFT, research assistants will be responsible for;

    - a. Guiding their participant group to relevant area (on 80m sprint track if group is running MSFT or into sitting area if group is waiting to take part)
    - b. Delivering a quick recap of the relevant information needed by participants to successfully run the MSFT (
        - i. What bleep to go on

ii. Which line to run to
iii. Number of shuttles missed to be disqualified,
iv. Participant needs to keep track of laps while running in order to report lap achieved to research assistant for data collection
v. Start slow, run at same pace as pacer
vi. When participant drops out they need to give their participant number and lap achieved to research assistant
vii. Participant to engage in cool down after exiting the MSFT
viii. Participant can jump back into the MSFT for motivation/support of remaining runners

c. There will be 3 research assistants assigned to each MSFT track (3 tests will run at the same time)
    i. Research assistant 1 = recording data
    ii. Research assistant 2 = monitoring
    iii. Research assistant 3 = pacing
d. Cool down – 2 research assistants will be allocated to organise and run the cool down section
    i. Instruct participants to walk up and down ITC (from high jump mat to pole vault mat) five times
e. Rotate and repeat for last groups

j. **End of session roles** – while Swan-Linx coordinator is debriefing school, research assistants are expected to QUIETLY pack up stations and organise equipment ready for storage. Research assistants are expected to say Goodbye to the school group as they leave, see below for examples of things to say
    a. 'Thank you for a great day'
    b. 'Have a safe journey'
    c. 'Great job everyone!'
    d. 'Goodbye!'
    e. 'Well done!!!'
k. **Escorting school** - Two research assistants will escort school back to National pool and wait until group has safely boarded the bus, before returning to the Indoor Training Centre
l. **Session Debrief** – The Swan-Linx coordinator will run a debriefing session with the research team to summaries session (discussion topics: what went well, what didn't go so well, future risk management, feedback, reminder of date of next session, any other business). Research assistants will be dismissed and can leave the Indoor Training Centre.
m. **Sport/physical activity session at school** – research assistants will be delivering a session of the 'most wanted' sport/physical activity at the Swan-Linx school. This will be organised and overseen by the Active Young People team and Gower College lecturers.

Swan-Linx Coordinator – Hannah L Spacey, 922632@swansea.ac.uk

Swan-Linx Principle Investigator – Prof. Gareth Stratton, g.stratton@swansea.ac.uk

Appendix 1 - Anthropometrics Script

Explaining the anthropometric measures to children:

	Assessment Item		
	Height	Weight	Sitting Height
What will you do?	You will have to stand as straight as possible with your shoes off then breathe in to best your best height	Stand on the scales without shoes and weather a t-shirt and shorts/gym wear	Sit on the special table and have your height measured from the bottom of your bottom to the top of your head
Why?	We want to record how much you are growing and compare some of your other results to your height	We want to record how much you are growing and compare some of your other results to your weight	We can use this to work out how long your legs are and how you are maturing physically
What will it tell you?	This will tell you how tall you are in centimetres (cm). If you measure your height every 3 months it will tell you how fast you are growing	How heavy you are	How long your legs are. How long your upper body is
Is it competitive?	Not at all, it's your measure and you can't change it	Not at all. But you can have a healthy weight by eating healthy foods and being physically active for at least 60 minutes per day	Not at all, it's your measure and you can't change it
How will you feel after it?	Hopefully you will feel good knowing how tall you are	Some people are worried about their weight and what they weigh. Nobody should be scared about their weight	Hopefully you will feel good knowing how your height is split between your upper and lower body
How can you help others?	Make sure that you help other people by respecting them so they can keep their results to themselves	Make sure that you help other people by respecting them so they can keep their results to themselves	Make sure that you help other people by respecting them so they can keep their results to themselves
Hints for Instructors	Make sure that children know that they can't change their height. Tell them to breathe in, keep their head level and make themselves as tall as possible	It is really important to make sure that you reinforce that you are what you weigh – this is your weight	Make sure that children know that they can't change their height. Tell them to breathe in and make themselves as tall as possible

Appendix 2

Speed Bounce Station Sheet

Speed Bounce events are part of the Sporthall series designed for the indoor use of school age competitors. This event is an exciting test of an athlete's speed, rhythm and coordination, involving double footed jumps over a foam wedge.

Equipment

- Stopwatch
- Foam Wedge
- Recording sheets/iPad

Personnel

- 2-3 people

Procedure

Participants must wear suitable footwear – this station is NOT to be completed in bare feet!

- Speed Bounce is a two-footed jump in which the participant must take off on two-feet and land on two-feet. The participants' feet should leave the mat simultaneously leave the mat and simultaneously land on the mat for one jump to be counted.
- The participant should cross the foam wedge as many times as possible within 30 seconds.
- If an incorrect technique is used, the participant should be stopped, offered an explanation and then allowed a fresh trial.
- An official should inform the participant when 10 seconds are remaining.
- The number of CORRECT bounces are counted toward the final score. It is not an offence to brush or clip the foam wedge during the activity.
- A practical trial is allowed – about 5 to 10 bounces provide an ideal opportunity to spot potential problems with technique.
- Participants must complete TWO trials.

Scoring

Two officials should count the 'correct' bounces. To promote participant engagement, researchers should invite the remaining participants to motivate the individuals taking part in the Speed Bounce and take part in the counting of correct bounces.

Appendix 2 – Speed Bounce Scripts

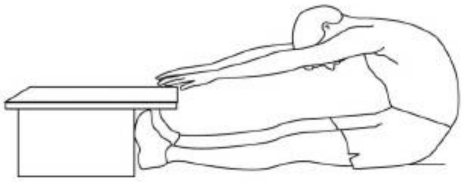
	Assessment Item – Speed Bounce
What will you do?	A two-footed jump back and forth as many times in 30 seconds.
Why?	This tells us how well coordinated you are and how you can keep this going when you're tired.
What will it tell you?	How fit you are when doing something that requires you to jump quickly in a long burst.
Is it competitive?	Yes, it is. Motivate yourself to keep going when you're tired. Tell yourself to do your best.
How will you feel after it?	You should feel very warm and tired in your legs. If you don't you will not have done your best.
How can you help others?	Help motivate them if they want you to.
Hints for Instructors	This is related to sport and dance performance and related to how well coordinated a child is. It is important to ask children to coordinate their arms and legs and keep their head as central over the barrier as possible. Motivate them by using the group to cheer them on but only if the participant wants them to.

Appendix 3 – Sit and Reach Station Sheet

The sit and reach test is a common measure of flexibility, and specifically measures the flexibility of the lower back and hamstring muscles. The test is important as tightness in this area is implicated in lumbar lordosis, forward pelvic tilt and lower back pain. The basic outline of the sit and reach test is described below.

Equipment

- Sit and reach box
- Recording sheets/iPad



Personnel

- 1-2 people

Procedure

This test involves sitting on the floor with legs stretched out straight ahead. Shoes should be removed and the soles of the feet are placed flat against the box, shoulder-width apart. Both knees should be locked and pressed flat to the floor – the researcher may assist by holding legs down, just above the knee joint. With the palms facing downwards, and the hands on top of each other or side by side, the participant reaches forward along the measuring line as far as possible and holds for 2 seconds. Ensure that hands stay side by side, not one hand reaching further forward than the other.

Scoring

The score is recorded to the nearest centimetre (cm) as the distance reached by the hand.

Appendix 3 – Sit and Reach Script

	Assessment Item – Sit and Reach
What will you do?	You will be asked to sit on the floor with your feet pressing against the sit and reach box, before stretching forward. You will have to stretch the muscles at the back of your legs and in your lower back.
Why?	This will tell how far you can stretch and how bendy and flexible you are. The muscles that stretch well are healthier. As you get older you will be less likely to have back pain or get injured playing sport if you have good flexibility.
What will it tell you?	This tells you if you can touch your toes and how bendy your muscles are.
Is it competitive?	No, this is not competitive. In fact, you should stretch forward slowly. You should make sure that you are warm when you do it.
How will you feel after it?	You might feel a little discomfort on the back of the legs but this is because you are making the muscles in the legs and back stretch as far as they can go, safely!
How can you help others?	By following proper instruction and stretching as far as you can go.
Hints for Instructors	Make sure that you inform the participants that muscles become more flexible when they are warm. Also mention some activities that require a lot of flexibility, such as; dance, gymnastics, swimming and remember to state that all activities need a certain amount of flexibility to protect joints.

Appendix 4 – Handgrip Dynamometer Station Sheet

The purpose of the handgrip strength test is to measure the maximum isometric strength pf the hand and forearm muscles. Handgrip strength is important for any sport in which the hands are used for catching, throwing or lifting. Also, as a general rule, people with strong hands tend to be strong elsewhere, so this test is often used as a general test of strength.

Equipment

- Handgrip Dynamometer
- Recording sheets/iPad

Personnel

- 1-2 people

Procedure

- The handle of the dynamometer should be adjusted if required – the base should rest on the first metacarpal (heel of palm), while the handle should rest on the middle of the four fingers.
- The participant holds the dynamometer in the hand to be tested with the arm extended above their head.
- When ready, the subject squeezes the dynamometer with maximum effort (maintained for 305 seconds), they bring their arm down to the side in a smooth motion.
- No other body movement is allowed.
- Make sure both hands are measured!

Scoring

Record the reading for each hand (kg).

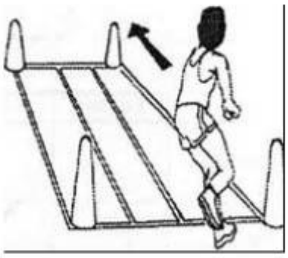
Appendix 4 – Handgrip Dynamometer Script

	Assessment Item – Handgrip Dynamometer
What will you do?	You will adjust the instrument to suit your hand size and then grip it as hard as you can.
Why?	You will do this to give a result for your basic strength.
What will it tell you?	It tells you how hard you can grip things and how strong you are.
Is it competitive?	Yes, you can be competitive against yourself, try as hard as you can – breathing out and shouting 'AHHHH' while you squeeze will help you to get a higher score!
How will you feel after it?	You will feel that you have exercised the muscles in your lower arms.
How can you help others?	Help motivate them if they want you to.
Hints for Instructors	Each kg recorded is about the same as a bag of sugar. Tell the children how many bags of sugar they can lift with their fingertips. Another tip is to tell the children what percentage of their body weight they can lift…amazing!

Appendix 5 – 10 x 5m Shuttle Run Station Sheet

The 10 x 5m shuttle run test is a test of speed and agility.

Equipment



- A flat, non-slip surface
- Stopwatch
- Measuring tape
- Marker cones
- Recording sheets/iPad

Personnel

- 2 people

Procedure

- Marker cones and/or lines are placed 5m apart.
- Start with a foot at one marker.
- When instructed by the timer, the participant runs to the opposite marker, turns and returns to the starting line.
- This is repeated until the participant has completed 5 times (covering 50 meters in total).
- At each marker, both feet must fully cross the line!

Scoring

Record the total time taken to complete the 50m course.

Record time to two decimal places e.g. 17.45s

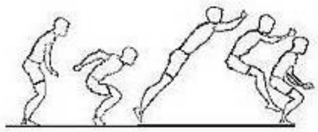
Appendix 5 – 10 x 5m Shuttle Run Script

	Assessment Item – 10 x 5m Shuttle Run
What will you do?	You will sprint back and forth over a 5m distance, ten times.
Why?	This tells us how agile you are and how quickly you can change direction when running at speed.
What will it tell you?	Whether you are fast and agile and how you may use this in sport or dance.
Is it competitive?	Yes, compete against yourself and try to turn as quickly as possible to achieve your best time!
How will you feel after it?	You will feel a little tired but also great after running as fast as you can.
How can you help others?	Help motivate them if they want you to. You could even run with a friend to help motivate them.
Hints for Instructors	This is a measure of speed and agility and crucial for successful performance is sport and dance. The key is to show children how to turn quickly by turning the head to look back in the direction they want to go when they get to the line.

Appendix 6 – Standing Broad Jump Station Sheet

The standing broad jump, also called the Standing Long Jump, is a common and easy to administer test to measure the explosive power of the participant's legs.

Equipment



- Standing Broad Jump mat
- Recording sheets/iPad

Personnel

- 1-2 people

Procedure

- The participant stands behind the line marked on the standing broad jump mat with feet slightly apart.
- A two-foot take-off and landing is used, with the swinging of the arms and bending of the knees to provide forward drive.
- The participant attempts to jump as far as possible, landing on both feet without falling backwards.
- The participant has 3 attempts.

Scoring

The measurement is taken from the take off line to the nearest point of contact on the landing mat (back of heels).

Record the results for each attempt.

Appendix 6 – Standing Broad Jump Script

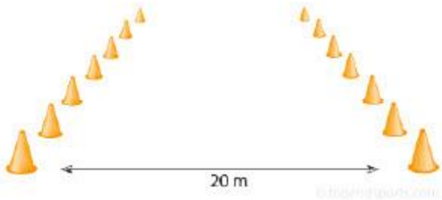
	Assessment Item – Standing Broad Jump
What will you do?	You will jump two-footed as far as you can.
Why?	We want to measure your leg power.
What will it tell you?	How far you can jump and how springy you are. This is good for sports and dance that require leg power.
Is it competitive?	Yes, it is. Make as big an effort as you can. Can you jump your own height?
How will you feel after it?	You should feel good and springy!
How can you help others?	Help motivate them if they want you to.
Hints for Instructors	Being powerful is important for all sports and dance. Tell participants to use their arms as well. What % of their height can they jump?

Appendix 7 – Multistage Fitness Test Station Sheet

The 20m multistage fitness test (MSFT) is a commonly used maximal running aerobic fitness test. It is also known as the 20m shuttle test, beep or bleep test.

Equipment

- 20m measuring tape
- Marking cones
- Bleep test CD/audio file
- CD player/sound system/laptop or iPod (AUX)
- Recording sheets/iPad
- Flat, non-slip surface



Personnel

- 2 people per bleep test group (max. of 3 groups at any one time) = 6
- 2 people for cool down group
- 3 people for pacing
- Total = 11 people

Procedure

This test involves continuous running between two lines, 20m apart in time to recorded bleeps. The subjects stand behind one of the lines facing the second line and begin running when instructed by the CD recording. The subject continues running between the two lines as prompted by the CD recording. After one minute, the bleeps will gradually increase in speed, and this will continue for every proceeding minute. If the line is reached before the bleep sound, the participant must stay at the line and wait for the next bleep before making way to next line. If the line is not reached before the bleep sound, the participant is warned and must continue to run to the line, before attempting to catch up with the next bleep. The participant is asked to finish the test if they fail to make the line (within 2 metres) on two consecutive bleeps.

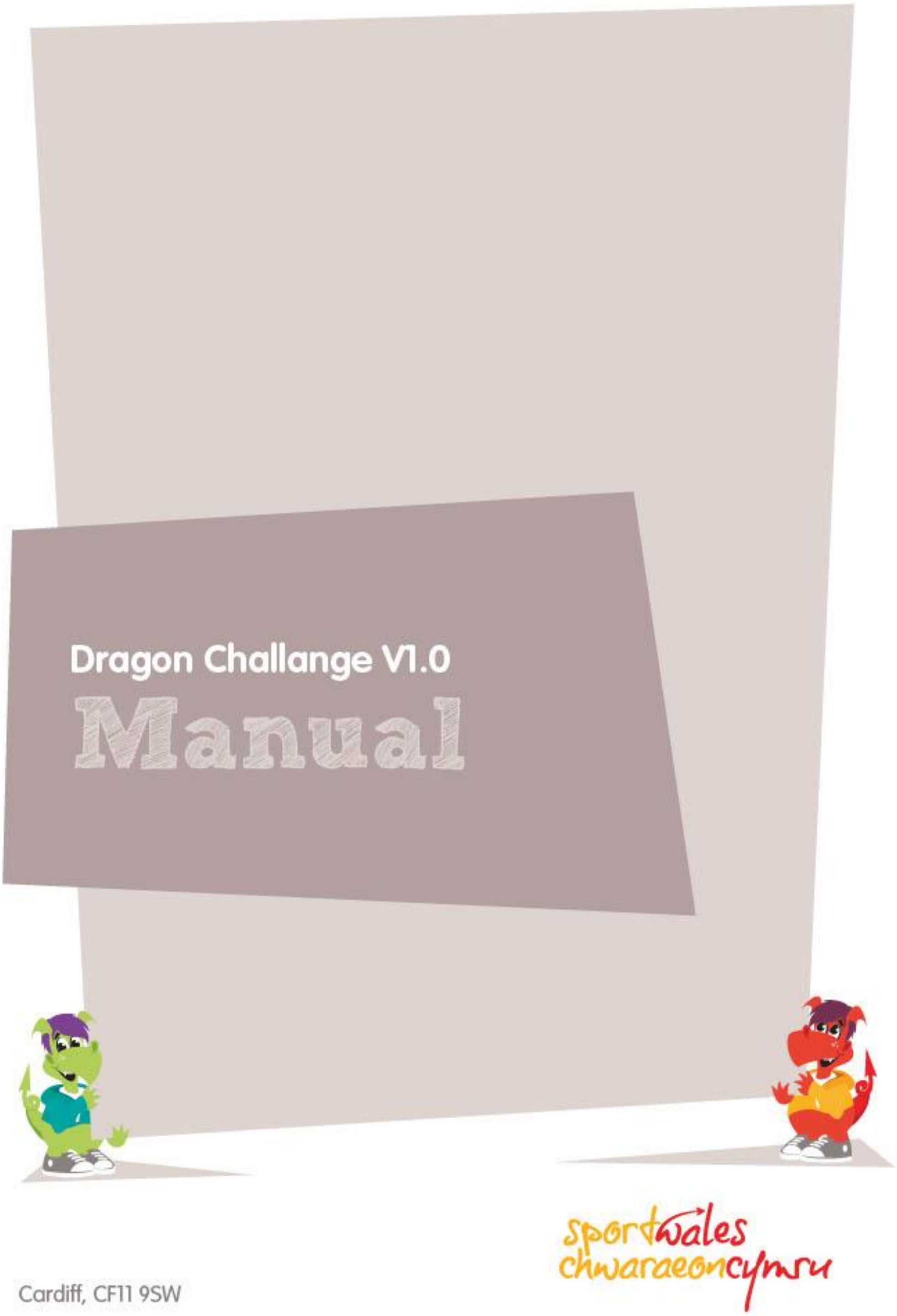
Scoring

The participants' score is the number of shuttles reached before they were unable to keep up with the recording. Record the last lap completed (not necessarily the lap stopped at).

Appendix 7 – Multistage Fitness Test Script

	Assessment Item – Multistage fitness test
What will you do?	You will be asked to run back and forth over a 20m distance in time with a bleep.
Why?	We want to know what your fitness level is. This type of activity puts more demands on your heart, lungs, legs and your ability to keep going. We know that this measure is related to your health.
What will it tell you?	You will run as far as you can and you will know how many 20m shuttles you can complete! If you do 20 shuttles, that means you have completed 400m. A healthy score for girls is 25, and a healthy score for boys is 33.
Is it competitive?	The most important thing about this task is that you do your best and work as hard as you can. We know how hard you are working. This is not a race!!!
How will you feel after it?	You should feel very tired initially and your heart rate and breathing will be must faster than usual, but you will recover quickly during your cool down period. If you want to join back in for fun or to help motivate a friend, you are very welcome to do that.
How can you help others?	Help motivate them if they want you to.
Hints for Instructors	This test has been criticised for not recording accurate results. This is due to low motivation levels of children and not setting the test up in a positive, cooperative atmosphere. When participants stop and get their breath back, they should join back in and help a friend. At the end of the MSFT, the person with the highest score should not be running alone.

APPENDIX V: DRAGON CHALLENGE MANUAL



This manual has been produced by Professor Gareth Stratton (Swansea University) and Dr Lawrence Foweather (Liverpool John Moores University) on behalf of Sport Wales.

How to reference this manual:

Stratton G, Foweather, L, Rotchell J, English J, Hughes H (2015). Dragon Challenge V1.0 Manual. Sport Wales.

Sport Wales
Sophia Gardens
Cardiff
CF11 9SW
Tel: 0300 300 3111 I Fax: 0300 300 3108 I Website: sportwales.org.uk I Email: info@sportwales.org.uk

Acknowledgements

The Dragon Challenge assessment tool was developed by Sport Wales in partnership with Swansea University, Liverpool John Moores University and Glyndwr University. This work would not have been possible without the significant contributions of numerous researchers (in particular, Dr Kelly MacKintosh and Dr Sue Taylor) and practitioners from across Wales, especially, Jan English and the Physical Literacy Programme for Schools team. We would also like to express our gratitude to the children and young people who participated in the development of the Dragon Challenge – thank you for your patience, energy and boundless enthusiasm!

LOTTERY FUNDED
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Contents

List of Tables

List of Figures

Background and Overview

The clock is ticking. The health and well-being of our nation is at crisis point and there has never been a more critical time to ensure children have a healthy, positive development. The Welsh Government has long recognised that the quantity and quality of physical activity and physical literacy, respectively, is paramount to shaping the health and well-being of children; Wales was the first country to legislate for Play (2002), the first to introduce an "Active Travel Act" to its statute books (2014) and the first to consider physical literacy as being as important as numeracy and literacy (2013). In parallel, Sport Wales have received significant funding from the Welsh Government to deliver a long term improvement in physical literacy and an increase in physical activity among children in schools in Wales, helping younger generations get hooked on sport for life and to adopt healthy lifestyles. Recently Sport Wales convened a Physical Literacy Expert group who have created a physical literacy framework to drive this work forward. Strategically programmes across Wales should contribute towards the framework (e.g. the Physical Literacy Programme for Schools). As such, there is growing interest from parents, teachers, sports coaches, health professionals and researchers regarding children's levels of physical literacy and in particular physical competence.

Understanding Physical Literacy

A child who is physically literate is able to move capably and confidently, read the physical environment, anticipate movement needs, and respond intelligently and imaginatively in a range of physically challenging situations (Whitehead, 2001). The development of physical literacy therefore gives children the motivation and confidence to maintain regular participation in physical activity throughout their life. Children are more likely to follow normal growth and development pathways and reduce risks to their health during adulthood if they are physically fit and active (Stratton et al, 2007; Department of Health, 2011). Furthermore, there is a growing body of evidence in the UK that reports a positive relationship between participation in physical activity and academic achievement (Booth et al., 2014).

What is Physical Competence?

Physical competence represents an important component of physical literacy and can be defined as a child's ability to use their bodies and physical skills. Physical competence therefore includes the acquisition of health-related components of fitness, such as aerobic fitness, strength and flexibility, and skill-related components of fitness like balance, agility, power, speed, reactions and coordination, as well as fundamental movement skills like catching, throwing and running.

Physical competence is gradually acquired through a complex process of brain and neuromuscular development. The development of physical competence occurs sequentially, progressing from reflexive movements in the first few months of life to the acquisition of a broad repertoire of sport- and context specific movements in middle to late childhood, adolescence and adulthood (Gallahue et al., 2011). When a child is learning to read they first learn words such as cat, sat, mat. Similarly as a child learns physical skills they learn skills such as how to run, jump, throw and balance. Children then string words together into sentences and read them. In the same way, physical skills are linked together to create movement and perform activities such as riding a bike, swimming or performing the long jump.

The Importance of Developing Physical Competence

Physical or motor development is considered to be an important dimension of child development and in the development of cognition (Piaget, 1952). From an early age, the capacity to move gives children the ability to explore and interact with their physical world.

Research suggests that children and adolescents who develop high motor competence are more likely to participate in physical activity (Foweather et al., 2014; Holfelder & Schott, 2014; Lubans et al., 2010). The development of physical skills also plays a significant role in giving children the confidence to be active (Babic et al., 2014). This creates a positive spiral of engagement in various physical activity behaviours that are inherently linked to cardiorespiratory fitness (Vlahov, Baghurst, & Mwavita, 2014), academic performance (Jaakkola, Hillman, Kalaja, & Liukkonen, 2015), and maintenance of a healthy weight (Rodrigues, Stodden, & Lopes, 2015).

Conversely, children who cannot demonstrate physical competence might not have the skills or confidence to be physically active and may therefore drop out of physical activity in later life (Stodden et al., 2008). Worryingly, the available evidence suggests there may be a "proficiency deficiency" (Cliff et al., 2012), although investment in physical education and school sport can support the development of physical skills (Foweather et al., 2008).

Assessment of Physical Competence

Given that the development of physical competence is important for both the health and wider development of children, there is a rationale for establishing the level of competence. At present there are a number of validated assessment tools that have been used to measure aspects of health and skill-related fitness, movement skills and physical activity. However, many of these tools require detailed analysis and expertise and are cost and time prohibitive. Further, current movement skill assessments were originally developed to identify children with physical developmental issues and involve the performance of skills in isolation, limiting their transferability and application to multi-skill and sport environments. It was therefore recognised that existing tools were unsuitable for population level measurement of physical competence in older children (aged 10-12).

Overview of the Dragon Challenge

Sport Wales, in partnership with Swansea University, Glyndwr University and Liverpool John Moores University, have carefully constructed a single practical assessment "Dragon Challenge V1.0" that aims to accurately and reliably assess the physical competence of children in years 6 to 7.

The Dragon Challenge assessment is a surveillance tool that was systematically developed through a number of iterations between 2013-14. Initially a professional review was conducted of other physical competency assessment tools. Subsequently, a pilot version of the Dragon Challenge was designed and tested. Then, with significant input from over 100 expert practitioners in physical education and sport from across Wales, the assessment tool was further developed and refined until Dragon Challenge Version 1.0 was finalised. It is expected that this version will be revised and updated according to the data and user feedback.

The Dragon Challenge is designed to be a dynamic and engaging assessment tool that provides a developmentally appropriate challenge of children's physical competence. The following sections outline the Dragon Challenge V1.0 and describe the tasks and preparatory procedures, the assessment process and criteria, as well as data management and the interpretation of results.

Description of the Dragon Challenge

Mapped to Multi-Skill and Multi-Sport Activity Cards

Purpose

- The purpose of the Dragon Challenge is to assess children's physical competence.

Target Population

- Dragon Challenge has been designed for children in school years 6 and 7 (aged 10-12 years).

Dragon Challenge Assessment Tasks

The Dragon Challenge assessment tasks are shown in Table 1, while the types of physical skills involved are shown in Table 2. Children complete 9 activities in a continuous circuit that assesses a number of stability (skills that involve balancing the body in one place or while in motion), locomotion (skills that involve moving the body in any direction from one point to another) and manipulative skills (skills that involve handling or controlling objects with the hand, foot or an implement). The circuit is completed in a timed trial that is designed to be fun, engaging and challenging.

The activities involve motor abilities such as agility, balance, coordination, strength, power, speed and reactions. The circuit requires spatial awareness (changes in direction and levels) and awareness of effort (changes in speed, force and flow) in relation to various objects, goals, and boundaries. Participants also utilise important cognitive attributes such as confidence, decision-making and reading the environment as they navigate through the tasks against the clock.

Table 1. Description of Dragon Challenge assessment tasks

Task	Description
1. Balance Bench	Walk the length of the narrow side of a bench beam, completing a 360 degree turn at mark before dismounting at the end of the bench.
2. Core Agility	Complete 4 body shape positions (dish - arch - dish - arch), rotating the body in both directions.
3. Wobble Spot	Complete 5 bean bag 'passes' around the body while balancing on the wobble spot on one leg.
4. Overarm Throw	Throw a tennis ball, using an overarm throw, at a target approximately 9 metres away.
5. Basketball Dribble	Using either hand, dribble a basketball around 4 coloured spots positioned in a 'z' formation.
6. Catch	Catch a tennis ball thrown underarm at a rebound net from any distance.
7. Jumping Patterns	Complete a jumping pattern sequence that includes a series of hops and jumps (2 footed jump over hurdle > 2 footed landing > 2 left hops > 2 right hops > 2 foot jump over hurdle > 2 footed landing).
8. T-Agility	Complete t-agility run, facing forwards throughout.
9. Accelerate-Sprint	10m acceleration to a sprint over finish line.

Table 2. Types of physical skills utilised during each Dragon Challenge assessment task

Task	Body Management	Locomotion	Manipulative
1. Balance Bench	●	○	
2. Core Agility	●		
3. Wobble Spot	●		●
4. Overarm Throw			●
5. Basketball Dribble		○	●
6. Catch	●	○	●
7. Jumping Patterns	●	●	
8. T-Agility		●	
9. Accelerate-Sprint		●	

● = primary skill category involved in task; ○ = secondary skill category involved in task

How long does the Dragon Challenge Assessment take?

Children typically take between 90 and 240 seconds to complete the Dragon Challenge. Groups of children can be assessed in a single session or multiple assessment days may be required for larger groups. A team of two assessors and one administrator can assess ten children in about 60 minutes. If testing is completed in a large sports hall with the necessary equipment and multiple assessors and administrators available, then a number of Dragon Challenge circuits can be set up to assess several children simultaneously.

Uses of the Dragon Challenge

The Dragon Challenge assessment has primarily been developed as a surveillance tool to assess patterns and trends in the levels of physical competence among children across Wales. Dragon Challenge data will also become a "Key Performance Indicator (KPI)" for Sport Wales "Every Child Hooked on Sport" and Physical Literacy strategies.

Preparing for the Dragon Challenge Assessment

This section discusses important matters that should be considered before administering the Dragon Challenge Assessment.

Video Resources

A series of training videos are available to familiarise instructors and assessors with the challenge and its constituent activities. Video material is presented in a real context and guidance on preparation, setting up, administering, assessment and scoring Dragon Challenge are available online. (Appendix A)

Training

Standardised procedures govern the administration and assessment of Dragon Challenge to ensure that the assessment is a reliable and valid measure of physical competence.

All assessors (examiners) of Dragon Challenge must have received training in assessment. Training is provided by Gold Standard Assessors who have been involved in the development of the Dragon Challenge and received intense training to implement assessments.

Each region has a lead Gold Standard Assessor who is supported by a team of support Gold Standard Assessors. These individuals act as leads, mentors, trainers and quality assurers on behalf of Sport Wales. The Lead Gold Assessors, their regions, and e-mail addresses are listed on the Sport Wales website **http://sport.wales/community-sport/education/dragon-multi-skills--sport.aspx**

Training is necessary to ensure that assessors have a clear understanding of the purpose, content and construction of the Dragon Challenge. Further, assessors should feel competent in procedures of administration and assessment, scoring and interpretation, and data management. Assessors should thoroughly practice giving and scoring each individual task and the full circuit until they feel confident in assessment.

Assessors are required to reach 85% agreement (3 disagreements per child) with the scores recorded by a Gold Assessor before assessing in a real situation. This agreement should be achieved using live or pre-recorded performances of sets of 10 children. Once acceptable agreement is reached assessors will be appropriately trained and will be assigned a unique identifier number by the Regional Lead Gold Assessor (see page 29).

Administrators of the Dragon Challenge should also receive basic training. This may include practicing administering the Dragon Challenge while being observed by an experienced administrator. Gold Standard Assessors will be able to provide information on training.

Child Data

Each child's Dragon Challenge assessment data needs to be input into an excel data sheet by the assessor(s) (see pages 27 to 30 for a detailed overview of data organisation and management). In preparation for the assessment, schools will need to provide pertinent information relating to individual child characteristics including:

- **Date of birth**
- **School year**
- **Sex**
- **Ethnicity**
- **Home postcode**
- **Free school meal status**
- **Learning difficulties or disabilities status**

Swansea and Edge Hill University academics in collaboration with Sport Wales will gain ethical approval for utilising data for further research and data linkage purposes. Data will be carefully protected and only used strategically for education and research purposes.

Space

It is important that a suitably adequate and safe space is available to conduct the Dragon Challenge assessment. The layout of the Dragon Challenge (see Figures 1a and 1b) has been designed to fit within the dimensions of a full size badminton court (13.4m x 6.1m); school gymnasiums and community sports centres are likely to have badminton court markings and sufficient space. Larger sports halls, with multiple badminton courts, can facilitate multiple concurrent child assessments.

Layout

A floor plan of the Dragon Challenge is illustrated in Figures 1a and 1b. The activities and equipment should be set up using the precise lay out and measurements given. The distances should be double-checked to ensure assessment conditions are identical. Layout and equipment should be reset following each child performance. Tape should be used to secure relevant pieces of equipment to the floor (e.g. spots, feet markers).

Equipment

The equipment required to run the Dragon Challenge is listed in Table 3. It is important that only the equipment listed is used and that guidelines relating to the air pressure of the basketball and wobble spot are adhered to; the assessment was standardised using this equipment and any change /improvisation may invalidate the results. Most of the equipment used can be found in primary or secondary schools or is available from Physical Literacy Programme for Schools teams. The availability of spare equipment such as balls and bean bags should also be considered. An iPad or other tablet is required and should be pre-loaded with the Dragon Challenge keynote/ppt. presentation slides that display the order of activities (see Appendix B and C).

Staffing

A team of two assessors and 1 administrator are required to run the Dragon Challenge. It is desirable that both males and females are represented on the team. At least one member of this team will need to give demonstrations. In groups, an additional member of staff (e.g. physical education teacher) will be needed to run activities to occupy children while they wait for their individual assessment. With additional staffing and space, multiple children can be assessed simultaneously.

Preparing Students

Children should prepare for the Dragon Challenge through participation in physical education, sport and extra-curricular activities. In line with changes to the curriculum, the children should not practise the Dragon Challenge with the specific intention of improving their scores or in fact "train" for the assessment. Children will need to be wearing appropriate footwear and clothing.

Health and Safety

Risk assessments and health and safety policies and procedures must be followed in accordance with standard practices in physical education. Adverse events that occur during the challenge should be recorded. It is requested that reports are anonymised and emailed to the regional lead gold assessor to ensure that the Dragon Challenge remains a safe measurement tool.

Table 3 Equipment required to deliver the Dragon Challenge V1.0

1 x 30 metre measuring tape
1 x 5 metre steel measuring tape
1 x Reel of coloured electrical/masking tape (2-3 inches wide)
1 x Rebound net (2m x 2m)
1 x Wooden bench (minimum length of beam: 2.5m; maximum width: 65mm)
1 x Large gym mat or 2 x standard gym mats (approx. dimensions: 2m x 2m)
1 x Fully inflated balance cushion (i.e., wobble spot)
1 x Bean bag
4 x Rubber floor spots
2 x Small plastic indoor hurdles (height: 30cm/12")
12 x Rubber 'feet' markers (6 x left foot, 6 x right foot)
2 x Small traffic cones
1 x Hula hoop
1 x Basketball (size 5; 0.5-0.6 bar; 7-9 PSI)
2 x Tennis balls
1 x iPad/tablet, fully charged and with Dragon Challenge presentations uploaded (Appendix B and C)

Figure 1a Floor Plan Layout

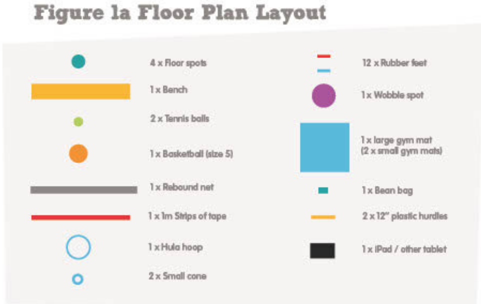
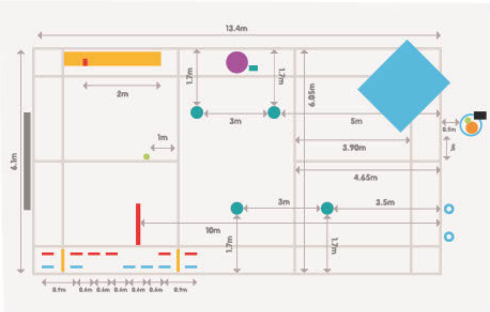


Figure 1b Floor Plan Layout



13

How to Administer the Dragon Challenge Assessment

This section provides directions for the administration of the Dragon Challenge. It is important that the Dragon Challenge is administered as specified so that a valid interpretation of a child's physical competence can be achieved and the results can be assessed across time. Therefore administrators should be trained in the live administration of Dragon Challenge. A range of video resources are available to support administrator training and development (see Appendix 3).

Step 1 - Preparation

- Possess a hard copy of this manual to be used as a reference
- Set up the Dragon Challenge using the equipment (Table 3) and floor plan (Figures 1a, b)
- List of children to be assessed
- Scoring sheets printed, including spare copies, and pens/pencils are available.
- Conduct a short briefing with assessors and administrators
  - Discuss how the assessment session will be managed, considering such factors as the number of children being assessed and the time available, which members of the team will be responsible for the introduction and demonstrations, as well as what other children will be doing during individual assessments
  - Review all the tasks and assessment criteria to ensure both assessors and administrators have full understanding of the Dragon Challenge procedures. This is particularly important if assessors/administrators lack experience.

Step 2 - Introduction

At the start of the session, make sure children have a clear side-on view of the Dragon Challenge layout. Children should then receive a verbal explanation of the Dragon Challenge, including what will be assessed, how they will be assessed and how the results will be used. Additional instructions and information relating to lesson/session management can also be given. See Box 1 for a suggested script that can be used for the introduction and explanation.

During your physical education lessons you have been taught to play many sports and activities that require you to use your physical skills. Today you will be completing the Dragon Challenge, which is an obstacle course that assesses some of these physical skills.

The Dragon Challenge is being completed by children all over Wales and involves skills like balance, agility, catching, throwing and jumping. You complete 9 different activities and you are assessed and timed by a teacher.

So Dragon Challenge is a balance between technique, accuracy and speed –you should try to complete the course as well as you can but also as quickly as you can. Getting the balance right is up to you; If you go too fast then you many not complete all the activities but if you go too slow then you may not get a good time. Sometime after you've finished the Dragon Challenge you will be given a score. This is your personal score and it will be used by teachers to improve your physical skills.

The Dragon Challenge is supposed to be fun so enjoy it and try your best!

Let's run through the activities so you know what to do!" (Move onto Step 3 – Demonstrations)

Box 1. Script for introducing the Dragon Challenge to children

14

Step 3 - Demonstration of Dragon Challenge

After the introduction, children then receive a practical demonstration of the Dragon Challenge activities. An assessor, administrator or specially recruited individual can demonstrate the activities. It is important that demonstrators perform each task accurately with sound technique. Demonstrations are important in ensuring that children understand the task requirements. However, they should not be used to teach or coach children.

During the demonstrations another member of the team (usually the same person that gave the introduction) provides a running commentary with precise instructions and directions. The script and actions for the demonstrations are given in Table 4 below. Demonstrations are given for individual activities before a full demonstration of Dragon Challenge from start to finish at maximum speed is provided. While the order of activities is standardised in the real assessments (see Table 1), for demonstration purposes a random order is given, with the 'random' iPad presentation being used (Appendices B & C).

Table 4 Actions and script for Dragon Challenge demonstrations

Activity	Actions	Scripts
Start - iPad	Begin standing stationary by the hoop containing the I-Pad	*children to gather round the iPad and hoop* "The Dragon Challenge uses an iPad to show you the activities that you need to do. This is what you see on the screen when you first see the iPad. You will start by the hoop and when you are ready, I will say 3-2-1-go." "What do you think you do next?" (answer: touch or swipe the screen) "Touching is usually more accurate than swiping" "Whatever picture you see on the screen will be the task you need to complete next" "What picture is shown here? So where is the next activity?" **Questions to check understanding:** "How do you know which activity to do next?" (answer: iPad and the picture) "What's the best way to see the next activity?" (touching the screen)
Balance Bench	Run to bench. Walks length of beam, completes full turn at 3/4 mark without falling off, dismounts at end zone. Repeat Return to iPad	"This activity is called balance bench. You get onto the bench, walk along, do a 360 degree turn and then get off the bench at the other end." "If you fall off the bench then you stop and return to the iPad." **Questions to check understanding:** "What do you do at the tape mark?" (answer: 360 degree turn) "Where do you get off the bench?" (at the end, not the side) "What happens if you fall off?" (run to iPad)
Core Agility	Run to mat. Completes 4 positions in correct order (dish on back - arch on front - dish on back - arch on front), rotating both ways Demonstrate dish only Demonstrate arch only Repeat in full Return to iPad	"This activity is called core agility. You need to run to the mat." "Dish on your back-arch-dish and then change direction back to arch." *administrator uses hand gestures to indicate which direction the body should be rotated* "What shape is this?" (answer – a dish) "What shape is this?" (answer – an arch) "Let's see it all again….what do you notice about their shoulders? Did they touch the floor?" (answer: off the floor throughout) **Questions to check understanding:** "What order do you do the shapes in?" (answer: dish-arch-dish-arch) "Show me a dish? Show me an arch?" *children perform shapes* "Do you start on your front or back?" (back)

15

Activity	Actions	Scripts
Wobble Spot	Run to wobble spot. Pick up bean bag. Get set. Completes 5 bean bag passes around body while balancing on wobble spot on one leg. Return to Ipad.	"This is called wobble spot. You need to balance on 1 foot, after picking up the bean bag." "Get yourself set, what do I mean by set?" (answer: balanced before starting) "Then pass the bean bag around your tummy 5 times." "1-2-3-4-5." *administrator counts aloud* "If you fall off, put your foot down or drop the bean bag, you stop and return to the iPad." **Questions to check understanding:** "How many times do you pass the bean bag?" (answer: 5) "What happens if you fall off after you have started?" (return to iPad)
Overarm Throw	Pick up tennis ball from hoop. Run and overarm throw, hitting the target (i.e. rebound net; no bounce). Repeat. Return to Ipad.	"It's overarm throw. You need to pick up the tennis ball and you will be throwing the ball overarm to hit the target." "You have to throw the ball before the T-point (badminton service box line)" "When you have thrown the ball leave it and return to the iPad" **Questions to check understanding:** "What type of throw is it?" (answer: overarm) Where do you need to throw the ball towards?" (rebound net) "Can it bounce before it hits the target?" (no) "Where is the line that you have to throw the ball before?" (T-point)
Basketball Dribble	Collect basketball from hoop. Dribble basketball around all spots and back to hoop using either hand (body & ball must move around outside of spots). Cannot catch ball/use two hands simultaneously. Repeat. Return to Ipad.	"Basketball dribble!" "Bounce the ball using your hand around the spots." "The first spot is to your left, you need to go in a zig-zag around the spots." "Then keep dribbling back down the middle and put the ball down in the hoop." "You need to make sure that your body and the ball move around the outside of the spots" "You can't catch the ball or put two hands on the ball at the same time." **Questions to check understanding:** "Can the ball bounce inside the spots if your body is on the outside?" (answer: no) "What do you do when you've finished the zig zag spots?" (dribble down middle back to hoop) "Am I allowed to use 2 hands at the same time?" (no)
Catch	Run forward and collect tennis ball from floor. Underarm throw tennis ball against the net and then catch (must be caught without a bounce). Return to iPad	"It's the catch! Run forward to the tennis ball on the floor." "Pick it up." "Underarm throw against the net and then catch" "You can go as close as you want to the net, but do your best to throw accurately and then catch the ball." If you don't catch the ball then leave it and return to the iPad. **Questions to check understanding:** "What type of throw do you use?" (answer: underarm) "How close can you go?" (as close as you like) "What do you do if you drop the ball or miss the catch?" (return to iPad)

16

Activity	Actions	Scripts
T-agility	Moves at half speed through all points of 'T' facing forwards (must enter both right & left court tramlines). Repeat at full speed. Return to iPad.	"T-run is marked on the (insert tape colour) line. Show me the shape of a "T"." *performs T-shape with arms* "You start moving forwards and then side-step into the tramline on the left then the tramline on the right." "You will always face forward and you need to move and change direction as fast as you can." **Questions to check understanding:** Which direction will you always be facing? (forwards) Where are the tramlines? *indicate where tramlines are* What speed should you change direction? (quickly as possible)
Jumping Patterns	Run to and complete jumping patterns sequence (2 footed jump over hurdle > 2 footed landing > 2 left hops > 2 right hops > 2 footed jump over hurdle > 2 footed landing). No contact with hurdles Repeat.	"This is called jumping patterns" Where do you think this is?" "You have to follow the same pattern as the feet on the floor." "Jump two feet over the hurdle to land on two feet" "Two hops on the left foot and then two on the right" "Jump two feet over the hurdle to land on two feet." "You need to make sure you follow the foot markers and don't touch the hurdles." **Questions to check understanding:** How do you know whether to hop or jump? (rubber foot markers) Can you touch the hurdles? (no)
Sprint	Runs through start gate & then through to finish line	"The sprint….run through the gate and then sprint as fast as you can over the line." "Go as fast as you can but slow down as soon as you cross the line!" **Questions to check understanding:** "How fast do you go?" (as fast as you can) "When do you start slowing down?" (as soon as you've crossed the line)
Full Demonstration	Demonstrate the full Dragon Challenge, from start to finish.	Cueing instructions are given in Step 5. Give children an opportunity to ask questions at the end.

Step 4 - Opportunities for Practice

While children do not have the opportunity to practice the full Dragon Challenge from start to finish, they should be provided with two practice trials for each individual task prior to assessment to assure that the child understands what to do. Following the demonstrations, children can be split into small groups, rotating around the activity stations to provide an opportunity for practice. When the child does not appear to understand the task, one additional demonstration can be given. No coaching tips or technical guidance should be given during practice opportunities.

17

Step 5 - During the Assessment

The administrator plays a critical role during the Dragon Challenge assessments. The administrator ensures that the stated protocols are adhered to and that consistent procedures are followed. In addition, the administrator also influences the motivational climate for the child performance. Dragon Challenge assessments should therefore be conducted using an inclusive approach in a positive, supportive environment to ensure children feel confident and enjoy the assessment process. This will help children feel engaged, motivated and committed to doing their best. General guidelines for administrators include:

- Ensure that the equipment and layout is correct prior to each child performance
- Introduce oneself to the child and ask their name
- Check that the child understands what they need to
- Help the child feel ready, relaxed and motivated to do their best
- Use the verbal cues given in Table 5 and note the additional directions in Table 6
- Keep in close proximity to the child during the Challenge, moving alongside them in a calming and relaxing manner (Do not race the child!)
- Use general encouragement and supportive language to promote sustained effort during the challenge (e.g. "keep going; try your best"; "don't worry", "never mind")
- Words of praise (e.g. "well done; excellent") should be reserved until after the assessment is completed.
- DO NOT "teach" or "coach" the child during the assessment.
- Congratulate the child upon completing the Dragon Challenge and say 'well done!'
- If any deviations occur during the assessment from the standard protocol, ensure these errors or deviations are noted on the child performance record.

Table 5 Actions and verbal cues given by the administrator during the assessment.

Step	Position	Scripts	*Actions*
1. Begin standing stationary by the hoop containing the iPad	iPad	"Ready…3-2-1-Go!"	
2. Immediately after child has touched iPad	iPad	"Balance bench"	*point to bench*
3. As they get on the bench	Bench	"Walk to the tape…"	*point to tape*
4. As they approach the ¾ mark on the bench	Bench	"Turn"	
5. As soon as they complete the turn	Bench	"Off the end"	*point to end of bench*
6. As soon as they leave the bench	Bench	"Back to the iPad"	*point towards the ipad*
7. As soon as they touch the iPad	iPad	"Core agility"	*point towards the mat*
8. Once the child is on the mat	Gym mat	"Dish on your back"	
9. As soon as they have attempted the dish	Gym mat	"Arch"	*gesture to turn*
10. As soon as they have attempted the arch	Gym mat	"Dish"	*gesture to turn*
11. As soon as they have attempted the dish	Gym mat	"Back to an arch"	
12. After they complete the arch	Gym mat	"Back to the iPad"	*point towards the ipad*

18

13. As soon as they touch the iPad	iPad	"Wobble spot"	*point towards the spot*
14. As they approach the wobble spot	Wobble spot	"Pick up the bean bag and get yourself set"	
15. As soon as they are set on the wobble spot	Wobble spot	"Go – 1, 2, 3, 4, 5"	
16. As soon as they leave the wobble spot	Wobble spot	"Back to the iPad"	*point towards the ipad*
17. As soon as they touch the iPad	iPad	"Overarm throw, tennis ball"	*point towards the tennis ball in the hoop*
18. As soon as they pick up the tennis ball	iPad	"Run up to the line and throw the ball at the target"	*point at the T-junction line*
19. Once the child has thrown the ball	iPad	"Leave the ball, back to the iPad"	*point towards the ipad*
20. As soon as they touch the iPad	iPad	"Basketball dribble"	*point towards the basketball in the hoop*
21. As soon as they pick up the basketball	Floor spots	"Around all the spots with the ball and your feet"	
22. As they are going around the final spot	Floor spots	"Dribble all the way back to the hoop"	
23. As soon as they touch the iPad	iPad	"Catch"	*point towards the tennis ball*
24. As soon as they start running towards the tennis ball	Tennis ball	"Underarm throw from wherever you like, make sure you can catch the ball"	
25. Once the child has either caught the ball or missed/dropped a catch	Tennis ball	"Back to the iPad" [& "leave the ball", if dropped/missed]	
26. As soon as they touch the iPad	iPad	"T-Run"	*point to bottom of T*
27. As they move up the middle	T-Agility	"Face forwards, quick as you can"	
28. As the child is approaching the T-junction	T-Agility	"All the way to the sides"	*point to tramlines*
29. Once they have changed direction for the second time	T-Agility	"Backwards to the start"	
30. As soon as they touch the iPad	iPad	"Jumping patterns"	*point to hurdles*
31. Once they land after the final hurdle	Jumping patterns	"Back to the iPad"	
32. As soon as they touch the iPad	iPad	"Sprint, through the gate"	*point to cone gate*
33. As they approach the cone gate	Sprint	"As fast as you can"	
34. Once they cross over the finish line	Sprint	"Well done, great effort!"	*clap hands, high five child*

19

Table 6 Additional directions for the administrator

Task	Additional Directions
iPad	Prior to starting each trial, ensure that the iPad is sufficiently charged and that the Dragon Challenge presentation is at the beginning.
Balance Bench	If the child falls off the bench at any time then end the task immediately.
Core Agility	Observe child's shoulders during task. If child's shoulders contact the floor at any time then administrator should signal to assessors by placing their hand on their shoulder.
Wobble Spot	Allow child to 'get set' before starting task. If non-support foot is put down on the floor or on the wobble spot after first beanbag pass then end the task immediately. Count the number of bean bag passes aloud. Observe the child during the task from the rear and indicate to the assessors if the child is resting their non-support leg on their support leg or foot, or on the wobble spot. Do not stop the task early if this is the case.
Basketball Dribble	If a child is clearly struggling to dribble then the administrator should use their judgement and end the task as soon as this is apparent.
Jumping Patterns	The administrator should try to ensure that they do not block the view of the assessors by running alongside the jumping pattern

20

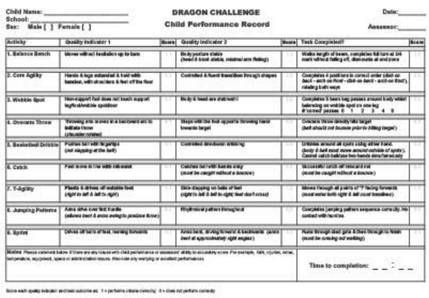
How to Record and Assess a Child's Dragon Challenge Performance

This section provides information in relation to how to record and assess a child's performance at the Dragon Challenge. As noted on page 13, all assessors of Dragon Challenge must have received training in assessment and be confident and competent in assessing children.

Child Performance Record

Child performance is scored in situ by trained assessors and recorded on the Child Performance Record form (Figure 2, also see Appendix D). This form is used to record pertinent information about the child (name, sex, and school), the date of the assessment, the assessor(s), the results, as well as noting any issues with the testing conditions that may be relevant for the interpretation of results. Assessors subsequently input Child Performance Record results into an excel file (See Data Management, page 26).

Figure 2 Child Performance Record Form


Child Name: ____________
School: ____________
Sex: Male [ ] Female [ ]

DRAGON CHALLENGE
Child Performance Record

Date: ______
Assessor: ______

Activity	Quality Indicator 1	Score	Quality Indicator 2	Score	Task Completed?	Score
1. Balance Bench	Moves without hesitation up to turn	[illegible]	Body posture stable [illegible]	[illegible]	[illegible]	[illegible]
2. Core Agility	[illegible]	[illegible]	Controlled & fluent transition through shapes	[illegible]	[illegible]	[illegible]
3. Wobble Spot	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 0 1 2 3 4 5	[illegible]
4. Overarm Throw	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5. Basketball Dribble	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6. Catch	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7. T-Agility	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8. Jumping Patterns	[illegible]	[illegible]	Rhythmical pattern throughout	[illegible]	[illegible]	[illegible]
9. Sprint	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Notes: [illegible]

Time to completion: _ _ : _ _

Assessment Criteria

Child performance at Dragon Challenge is assessed through:

- Time to completion
- Skill performance criteria (technique and outcome)
- The time and skill performance criteria are given equal weighting; children need to find the optimal balance between speed and accuracy, using the appropriate technique

Time to Completion

Using a stopwatch, time to completion is recorded (to nearest 0.1s) from the word 'Go' and stopped as soon as the child crosses the finish line. An assessor will use a stopwatch to record time. Time to completion is recorded on the child performance record (Figure 2).

Performance Criteria

Dragon challenge assessment criteria include indicators that measure both process and product characteristics of performance (See Table 7). Process characteristics address qualitative aspects of movement and have to do with how a child moves the body in performing a task (i.e. assesses movement form, quality and technique). Product characteristics have to do with the end product or outcome of the movement (e.g. 'throw hits target').

During the child performance, the assessors record whether the child meets the performance criteria. Assessors record a 1 if a child performs a criterion correctly or a 0 if not.

Table 7 Dragon Challenge assessment performance criteria

DC Task	Technical Criterion	Technical Criterion	Outcome Criterion
1. Balance Bench	1.1 Moves without hesitation up to turn	1.2 Body posture stable (head & trunk stable, minimal arm flailing)	1.3 Walks length of beam, completes full turn at 3/4 mark without falling off, dismounts at end zone
2. Core Agility	2.1 Hands & legs extended & held with tension, with shoulders & feet off the floor	2.2 Controlled & fluent transition through shapes	2.3 Completes 4 positions in correct order (dish on back - arch on front - dish on back - arch on front), rotating both ways
3. Wobble Spot	3.1 Non-support foot does not touch support leg/foot/ wobble spot/floor	3.2 Body & head are stable/still	3.3 Completes 5 bean bag passes around body while balancing on wobble spot on one leg # 'correct' passes 0 1 2 3 4 5
4. Overarm Throw	4.1 Throwing arm moves in a backward arc to initiate throw (shoulder rotates)	4.2 Steps with the foot opposite throwing hand towards target	4.3 Overarm throw directly hits target (ball should not bounce prior to hitting target)
5. Basketball Dribble	5.1 Pushes ball with fingertips (not slapping at the ball)	5.2 Controlled directional dribbling	5.3 Dribbles around all spots using either hand. (body & ball must move around outside of spots). Cannot catch ball/use two hands simultaneously
6. Catch	6.1 Feet move in line with rebound	6.2 Catches ball with hands only (must be caught without a bounce)	6.3 Successful catch off rebound net (must be caught without a bounce)
7. T-Agility	7.1 Plants & drives off outside foot (right to left & left to right)	7.2 Side-stepping on balls of feet (right to left & left to right; feet don't cross)	7.3 Moves through all points of 'T' facing forwards (must enter both right & left court tramlines)
8. Jumping Patterns	8.1 Arms drive over first hurdle (elbows bent & arms swing to produce force)	8.2 Rhythmical pattern throughout	8.3 Completes jumping pattern sequence correctly. No contact with hurdles
9. Sprint	9.1 Drives off balls of feet, leaning forwards	9.2 Arms bent, driving forward & backwards (arms bent at approx. right angles)	9.3 Runs through start gate & then through to finish (must be running not walking)

Calculating the Dragon Challenge Score

The Dragon Challenge composite score is calculated from the same trial as follows:

Technique (0 to 18) + Outcome (0 to 18) + Time (0 to 18) = Dragon Challange Total Score (0 to 54)

The time, technique and outcome scores are assigned equal weighting, as the more physically literate child will be able to find the optimal balance between speed and accuracy using the necessary technical quality. The obstacle course score is calculated in the same way for every child, regardless of the child's age and sex.

Calculating the Technique Score

There are 18 technique (or process) assessment criteria (see Table 8). Participants are awarded 1 point for each technique criteria successfully demonstrated. The 'technique' score therefore ranges from 0 to 18.

Calculating the Outcome Score

There are 9 performance 'outcome' (or product) assessment criteria (see Table 8). Participants are awarded 2 points for each successful performance outcome demonstrated (i.e., the number of criteria successfully demonstrated is doubled). The 'outcome' score therefore ranges from 0 to 18.

Calculating the Time Score

The time taken to complete the Dragon Challenge obstacle course, recorded in seconds, is converted to a score between 1 and 18 (see Table 9). Faster times are assigned a higher score.

Table 8 Scoring the Technique and Outcome Skill Performance Criteria

Skill	Technique (Process)			Outcome (Product)		
	DC Criteria #	Points per criteria	Scoring range	DC Criteria #	Points per Criteria	Scoring
Balance Bench	1.1, 1.2	1	0-2	1.3	2	0, 2
Core Agility	2.1, 2.2	1	0-2	2.3	2	0, 2
Wobble Spot	3.1, 3.2	1	0-2	3.3	2	0, 2
Overarm Throw	4.1, 4.2	1	0-2	4.3	2	0, 2
Basketball Dribble	5.1, 5.2	1	0-2	5.3	2	0, 2
Catch	6.1, 6.2	1	0-2	6.3	2	0, 2
T-Agility	7.1, 7.2	1	0-2	7.3	2	0, 2
Jumping patterns	8.1, 8.2	1	0-2	7.3	2	0, 2
Sprint	9.1, 9.2	1	0-2	7.3	2	0, 2

Table 9 Calculating and interpreting the Time Score Notes. a = platinum ranking, b = gold, c = silver, d = bronze

Time (mm:ss)	Time (s)	Score
<1:25	<84	18[a]
1:25 to 1:33	85 to 93	17[a]
1:34 to 1:42	94 to 102	16[a]
1:43 to 1:51	103 to 111	15[a]
1:52 to 2:00	112 to 120	14[a]
2:01 to 2:09	121 to 129	13[b]
2:10 to 2:18	130 to 138	12[b]
2:19 to 2:27	139 to 147	11[c]
2:28 to 2:36	148 to 156	10[c]
2:37 to 2:45	157 to 165	9[d]
2:46 to 2:54	166 to 174	8[d]
2:55 to 3:03	175 to 183	7[d]
3:04 to 3:12	184 to 192	6[d]
3:13 to 3:21	193 to 201	5[d]
3:22 to 3:30	202 to 210	4[d]
3:31 to 3:39	211 to 219	3[d]
3:40 to 3:49	220 to 228	2[d]
3:49 to 3:58	229 to 237	1[d]
>3:59	>238	0[d]

Interpreting the Dragon Challenge Results

Interpreting the Dragon Challenge Total Score

A child's Dragon Challenge total score can be interpreted by examining their performance in relation to other similar children. The score is interpreted the same way for every child, regardless of the child's age or sex.

Specific cut-points were generated for the total score using the 33rd, 66th, and 95th percentiles based on pilot data collected across Wales by gold assessors in Spring/Summer 2015. These percentile thresholds were selected to categorise 10-12 year old typically developing children into Bronze, Silver, Gold and Platinum awards, consistent with other Sport Wales programmes. In addition, * categories are included for bronze, silver and gold awards to indicate those children that are at the top of a level and working towards the next category. This banding system is shown in Table 10.

Table 10 Descriptive rating for Dragon Challenge total score for 10-12 year old children

Bronze	*	Silver	*	Gold	*	Platinum
<27	28, 29	30 to 34	35, 36	37 to 43	44, 45	46 to 54

Bronze Award

Children in the bronze category are in the bottom tertile for motor competence*. These children have low levels of motor competence compared to other children their age and their physical skills are still emerging and require significant improvement. These children need significant encouragement, support and opportunities for practice and instruction to develop their physical competence.

Silver Award

Children in the silver category fall within the middle tertile for motor competence*. These children have levels of motor competence that are similar to other children their age but their physical skills are still developing and require improvement. These children may benefit from opportunities for instruction and practice to refine their skills.

Gold Award

Children in the gold category fall within the upper tertile for motor competence*. These children have good levels of motor competence compared to other children their age and have acquired a broad range of physical skills. These children are doing well and should be encouraged to keep practising and exploring different sports and activities to advance and maintain their physical skills.

Platinum Award

Children in the platinum award fall within the top 5% of children*. These children have exceptional levels of motor competence compared to similar aged children and are proficient and accomplished at using their physical skills. These children are very talented and should be congratulated on their skills and encouraged to keep up the fantastic work!

*based on pilot data (n=584) collected across Wales in Spring/Summer 2015

Interpreting Time Scores

Judgements surrounding the speed in which a child completes the Dragon Challenge can be made by drawing comparisons to other children. As shown in Table 10, each time score is assigned a bronze, silver, gold or platinum ranking. The classification boundaries are at the 33rd, 66th and 95th percentile, consisted with those used for interpreting the overall score.

Interpreting Technique and Outcome Scores

Technique and outcome scores are criterion-referenced measures of performance and therefore scores are interpreted at the individual level only.

By reviewing the information from the child performance record, the practitioner can identify which skills the child needs to improve, and whether particular technique or outcome aspects of the skills need to be addressed (see Tables 2 and 7).

Practitioners should feedback the results to the child, discussing their strengths and weaknesses at different aspects of the Dragon Challenge and agreeing goals for improvement and particular skills to work on. The results can also be used by practitioners to plan and design developmentally-appropriate programmes.

Cautions in Interpreting Dragon Challenge Results Scores

The Dragon Challenge has been designed as a surveillance tool and is merely a single observation of a child's physical competence.

A child's score represents a performance at a given time, under a particular situation. Many factors can influence a child performance, including their motivation, confidence, nerves or other contextual factors.

Therefore, while the results of Dragon Challenge can make a useful a contribution to global judgements of physical competence, teachers and practitioners should not base their judgements exclusively on the results.

Data Management

This section discusses important matters concerning the recording and collation of Dragon Challenge results. Data management needs to be accurate and timely, and requires careful attention. The collation of results is important for subsequent analysis and monitoring, enabling detailed profiles of children's performances to be generated, for example at the regional or national levels, or within various sub-groups like males and females. Sport Wales will collate results at a national level and use these as a key performance indicator. This performance indicator will guide subsequent policy and strategy in physical literacy development.

Data Input

Two data files need to be kept. The first Excel file with a list of participant names and their assigned ID code (held locally), the second with their ID code and main data (this is submitted to a central database in the cloud – see below).

Each individual Child Performance Record (Figure 2) needs to be input into an excel file (Figure 3), which represents the main data sheet. The main data sheet includes over forty variables.

The first section of variables record information about the child (e.g. date of birth, sex), as well as the organisation of the assessment (date of assessment, assessors). The second section of variables records the scoring during the assessment tasks (e.g. against performance indicators). Table 11 gives an overview of the variables and the scoring method for each.

Figure 3 Main Excel Regional Data Sheet "DC Child Performance Record Regional Data

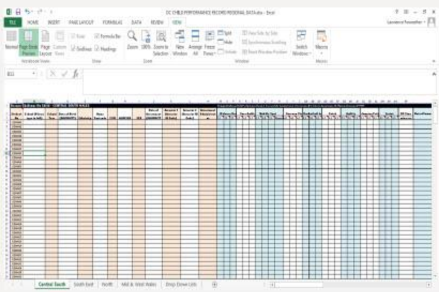


Table 11 Main data sheet: Explanation of variables and coding

Variable	Input	Missing data
Student No.	A 7-character unique child identifier number (page x)	n/a
School	Type school name in full	99999
School year*	"YEAR 6" or "YEAR 7"	99999
Date of birth	dd/mm/yy	99999
Ethnicity*	"White" or "Mixed" or "Asian / Asian British" or "Black / Black British" or " Chinese / Chinese British" or "Any Other"	99999
Home Post Code	Type in full using capitals, include space (e.g. CF12 1PG)	99999
Free School Meal*	"YES" or "NO"	99999
ALN (Additional Learning Needs) / SEN (Special Educational Needs)*	"No special provision" or "School action + Stat assess" or "School action +" or "School action" or "Statemented"	99999
Sex*	"MALE" or "FEMALE"	99999
Date of test	dd/mm/yy	99999
Assessor 1	A 10 character unique assessor identifier number (see page x)	99999
Assessor 2	A 10 character unique assessor identifier number (see page x)	99999
Administrator	Type full name or use assessor ID code (if applicable)	99999
Balance Bench 1.1	"1" (if criteria was present) or "0" (if criteria was absent)	99999
1.2	"1" or "0"	99999
1.3	"1" or "0"	99999
Core Agility 2.1	"1" (if criteria was present) or "0" (if criteria was absent)	99999
2.2	"1" or "0"	99999
2.3	"1" or "0"	99999
Wobble Spot 3.1	"1" (if criteria was present) or "0" (if criteria was absent)	99999
3.2	"1" or "0"	99999
3.3	"1" or "0"	99999
Overarm throw 4.1	"1" (if criteria was present) or "0" (if criteria was absent)	99999
4.2	"1" or "0"	99999
4.3	"1" or "0"	99999

Basketball dribble 5.1	"1" (if criteria was present) or "0" (if criteria was absent)	99999
5.2	"1" or "0"	99999
5.3	"1" or "0"	99999
Catch 6.1	"1" (if criteria was present) or "0" (if criteria was absent)	99999
6.2	"1" or "0"	99999
6.3	"1" or "0"	99999
T-Agility 7.1	"1" (if criteria was present) or "0" (if criteria was absent)	99999
7.2	"1" or "0"	99999
7.3	"1" or "0"	99999
Jumping Patterns 8.1	"1" (if criteria was present) or "0" (if criteria was absent)	99999
8.2	"1" or "0"	99999
8.3	"1" or "0"	99999
Sprint 9.1	"1" (if criteria was present) or "0" (if criteria was absent)	99999
9.2	"1" or "0"	99999
9.3	"1" or "0"	99999
Time	"mm:ss" (e.g. 02:01)	99999
Notes/Comments/ Issues with assessment		99999

***Drop down menu**

Unique Identifier Number: Children

Children should be assigned numbers in the order of their school register. However, when individual child data is transferred into the regional dataset, each student is given a unique regional identifier number. For example the first student from Mid- and West Wales will be recorded as WE00001, the second WE00002, third WE00003 and so on for the M H school, BUT numbers continue independent of school so D T school starts at 00061, 00062, 00063 and so on. This enables the data to be blinded by school for some parts of the analysis. Example of student numbers are illustrated in Table 12.

Table 12 Example of unique identifier numbers for children

Student No	School (Please type in full)	School Year
WE00001	M H School	YEAR 7
WE00002	M H School	YEAR 7
WE00060	M H School	YEAR 7
WE00061	D T School	YEAR 7
WE00062	D T School	YEAR 7
WE00063	D T School	YEAR 7

Unique Identifier Number: Assessors

After successfully completing training, each assessor is given a unique identifier number by the regional lead Gold Standard Assessor. This number is validated against a regional database of assessors to avoid duplication. The coding helps identify the assessor's region, gender and professional role. The method for generating a unique identifier number for assessors is shown in Table 13 below:

Table 13 Explanation of how to generate a unique identifier number for assessors

Character number	1	2	3	4	5	6	7	8	9	10
Component	Region 2 letters, indicating the region which the assessor will be operating within. (South East: SE) (Central South: SC) (Mid-West: MW) (North Wales: NW)		Gender 1 letter, indicating the assessor's gender. (Male: M) (Female: F)	Training 2 letters, calculated based on whether the individual is qualified to teach PE. (Physical Education Trained: PE) (Non-Physical Education Trained: NP)		Initials 2 letters, comprised of the assessors initials (first name, last name).		Number A three digit number, unique to each regional assessor.		
Example 1: Jon Evans PE teacher South East	S	E	M	P	E	J	E	0	0	1
Example 2: Leanne Jones Non-PE South East	S	E	F	N	P	L	J	0	0	2

Data Analysis

Data will be uploaded to a central cloud database held by Sport Wales and governed by Sport Wales and Swansea University. Data will then be analysed and trends identified. The results will then be used to adjust policy and strategy in relation to physical literacy development.

Quality Assurance

It is important that regular checks are made to assure the quality of the Dragon Challenge assessment process and to check for intra- and inter observer drift.

One out of every 10 children should have a repeat assessment. This can occur through sharing video data of a child performance with a gold assessor (after obtaining the necessary permissions) or through paired observations with a gold assessor during in situ live assessments. All quality assurance checks should be documented by the lead regional gold assessor and appropriate re-training given if required.

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APPENDICES

APPENDIX A – LIST OF VIDEO RESOURCES

Video Material to Support Delivery of Dragon Challenge V1.0

Title	Link
Dragon Challenge Promotional Video for Kids (English)	https://youtu.be/Ddr17NbqV5I
Dragon Challenge Promotional Video for Kids (Welsh)	https://youtu.be/DEs2kyLiaok
Dragon Challenge Equipment & Setup	https://youtu.be/bg8QUxs78qo
Dragon Challenge Introduction and Demonstration	https://youtu.be/3Pg_lHyAGxE
What is Dragon Challenge?	https://youtu.be/9XD-ejbfaE8
Children's Guide to the Dragon Challenge	https://youtu.be/ebLNCS7DTv0
The Role of Administrators /Assessors during the Dragon Challenge	https://youtu.be/POq5cu0PWGQ

APPENDIX B – DRAGON CHALLENGE 'ACTUAL' PRESENTATION OUTLINE

APPENDIX C – DRAGON CHALLENGE 'RANDOM' PRESENTATION OUTLINE

APPENDIX D – CHILD PERFORMANCE RECORD

Child Name: ____________________
School: ____________________
Sex: Male [ ] Female [ ]

DRAGON CHALLENGE
Child Performance Record

Date:_______
Assessor:_______

Activity	Quality Indicator 1	Score	Quality Indicator 2	Score	Task Completed?	Score
1. Balance Bench	Moves without hesitation up to turn		Body posture stable *(head & trunk stable, minimal arm flailing)*		Walks length of beam, completes full turn at 3/4 mark without falling off, dismounts at end zone	
2. Core Agility	Hands & legs extended & held with tension, with shoulders & feet off the floor		Controlled & fluent transition through shapes		Completes 4 positions in correct order (*dish on back - arch on front - dish on back - arch on front*), rotating both ways	
3. Wobble Spot	Non-support foot does not touch support leg/foot/wobble spot/floor		Body & head are stable/still		Completes 5 bean bag passes around body whilst balancing on wobble spot on one leg # 'correct' passes 0 1 2 3 4 5	
4. Overarm Throw	Throwing arm moves in a backward arc to initiate throw *(shoulder rotates)*		Steps with the foot opposite throwing hand towards target		Overarm throw directly hits target *(ball should not bounce prior to hitting target)*	
5. Basketball Dribble	Pushes ball with fingertips *(not slapping at the ball)*		Controlled directional dribbling		Dribbles around all spots using either hand. *(body & ball must move around outside of spots)*. Cannot catch ball/use two hands simultaneously	
6. Catch	Feet move in line with rebound		Catches ball with hands only *(must be caught without a bounce)*		Successful catch off rebound net *(must be caught without a bounce)*	
7. T-Agility	Plants & drives off outside foot *(right to left & left to right)*		Side-stepping on balls of feet *(right to left & left to right; feet don't cross)*		Moves through all points of 'T' facing forwards *(must enter both right & left court tramlines)*	
8. Jumping Patterns	Arms drive over first hurdle *(elbows bent & arms swing to produce force)*		Rhythmical pattern throughout		Completes jumping pattern sequence correctly. No contact with hurdles	
9. Sprint	Drives off balls of feet, leaning forwards		Arms bent, driving forward & backwards (arms *bent at approximately right angles*)		Runs through start gate & then through to finish *(must be running not walking)*	
Notes: Please comment below if there are any issues with child performance or assessors' ability to accurately score. For example, falls, injuries, noise, temperature, equipment, space or administration issues. Also note any worrying or excellent performances.					Time to completion: _ _ : _ _	

Score each quality indicator and task outcome as: 1 = performs criteria correctly; 0 = does not perform correctly

APPENDIX E – INFORMATION FOR PROFESSIONALS AND PARENTS/CARERS

Information for professionals (teachers/teaching assistants, Sports Development, Sport Ambassadors, coaches, dance teaches, etc.)

Dragon Challenge (DC) V1.0 is a tool designed to assess the physical competence of children in school years 5 through 7. DC V1.0 represents the culmination of Sport Wales, Swansea, Glyndwr and Liverpool John Moores Universities test development efforts, informed by the assessment of more than 1,000 children and with input from a representative group of over 100 researchers and practitioners involved in physical literacy development. DC V1.0 requires children to complete 9 physical activities in a continuous circuit. During this period children are scored for their quality of movement and whether they successfully complete the task. These scores are combined with "completion time" to calculate an overall DC V1.0 score. DC V1.0 will provide surveillance data that will be collated by age, gender, ethnic group, school, local authority, and region.

Information for carers/parents

Wales is leading the way in the development of children's "physical literacy."

Physical literacy is "the motivation, confidence, physical competence, knowledge and understanding that children and adults develop in order to maintain physical activity at an appropriate level throughout their life. The Dragon Challenge V1.0 has been developed to assess the physical competence part of your child's physical literacy. The Challenge involves your child attempting a circuit including 9 physical activities. These activities include balance, agility, throwing and catching, ball control and running skills. The Challenge should be completed in between 2 and 4 minutes. Your child will be observed and assessed during the circuit of activities by a trained assessor. The assessor may be a teacher, teaching assistant or qualified professional. After your child has completed the task s/he will be given an overall score. This score will be used to inform, teachers and professionals about how your child is developing physically and will be used to plan new physical education and sport activities at school and within the local community.

Notes

APPENDIX VI: HOMESPACE INTERVIEW GUIDE

HomeSPACE interview questions – PHASE 1 of Interviews

Four pre-identified themes will be used to guide the interviews; (1) perceptions of the children's PA and sedentary behaviour during the pandemic compared to before, (2) opportunities and challenges in keep their children active during the pandemic, (3) factors influencing PA and sedentary behaviour during the pandemic, (4) changes in the physical and social environment in response to the pandemic and perceptions of how they might be influencing PA and sedentary behaviour at home.

Children's perceptions of physical activity and sedentary behaviour and their influences at home

Usual Activities - Card Sort Activity (Children only)

- I'm going to ask you to talk about what you do on a usual weekday. Is that okay?
- There's a pack of cards in front of you - take a look at the cards and choose the 3 activities that you do most on a typical school day outside of school hours – so morning, afternoon and evening. Then we'll talk about them. Prompt: Start in the morning, afternoon, evening. Think about yesterday.
- Which activity do you do most? Where do you do this? Do you do it with others or by yourself? Do for all activities.
- Ask how and why this is different from before the COVID-19 restrictions, make sure to cover all questions (I.e., which activity do you do most, where do you do it, do you do it with other or by yourself)
- And what about a usual weekend day? Take the cards and select 3 cards based on a usual weekend day. Prompt: Start in the morning, through the day, and evening? Think about last Saturday.
- Which activity do you do most? Where do you do this? Do you do with others or by yourself? Do for all activities. Which do you like best?
- Ask how and why this is different from before the COVID-19 restrictions, make sure to cover all questions (I.e., which activity do you do most, where do you do it, do you do it with other or by yourself)

Factors influencing PA and sedentary behaviour (For child)

- What helps you to be more active at the moment?
- What makes you less active/ lazy (sitting playing video games, watching TV)? (Maybe separate for weekday and weekend days)

Parents perception of their children's physical activity and sedentary behaviour

- If you were to describe your child's level of physical activity at home at the home as low, medium or high, which one would you pick?
- Remind them that PA is "anything that gets the body moving-it can be in the form of structured exercise or it can be free play, running around the garden"
- Can you tell me more about why you picked x?
- Why do you think that?

- Compared to before the pandemic, are they less or more active? Why?
- What about screen time/screen viewing? Tell them that screen viewing includes time spent computers, laptops, games consoles, ipads, mobile phones, not just TV.
- If you were to describe your child's level of screen viewing on weekdays as low, medium or high, which one would you pick?
- Can you tell me more about why you picked 'X'? Why? (do you think that)
- What about weekend days? Would you describe their screen viewing on weekend days as low, medium or high?
- Can you tell me more about why you picked 'X? Why? (do you think that)
- Compared to before the COVID-19 restrictions, do they spend more or less time screen viewing? Why?

Factors influencing PA and sedentary behaviour (For parent)

- What are the main things that decide how active your child is at home? Think about individual, social and physical factors? (need to think of a way to word this so that parents understand)
- What affects the amount of time your children spend watching TV or using computer games when at home? Think about individual, social and physical factors?
- Any changes because of the covid-19 restrictions?

Opportunities and challenges in keeping your children active during the restrictions (Family)

- Is increasing your children's physical activity at home important to you?
- Currently (with Covid-19 restrictions), how achievable/possible is it? Why? in what way?
- Is managing your children's screen viewing at home important to you?
- Currently (with Covid-19 restrictions), how achievable/possible is it? Why? in what way?

Home tour (Family)

Now I'd like to talk with you about the different places in your house and yard that you use for different activities. I'd like to do this as a moving tour. What that means is I'll ask to think of places in your house and yard where he/she spends the most time. Then we'll go to those places and you can tell me all about the place and how you use that place. It's completely up to you where the tour goes. You are in charge. And we can come back here at any time. Does that sound okay?

Think of the three places in the house and yard where you spend the most time when you are awake. What are they? What about we start in the ___________ room?

For Each Room... (Family)

- Tell me about this area/room?
- What types of activities happen in here?
- How much time do you spend in here?
- Who are you usually with?

- What equipment do you have in here (prompt: media, play equipment, seating)? Is it easy to get to the equipment you have?
- Has anything changed in this room in response to the COVID-19 restrictions? Why? Talk about how it's influencing your child's PA/screen-viewing?
- Are there any other places that have changed in response to the COVID-19 restrictions that you would like to show me? Why? Talk about how it's influencing your child's PA/screen-viewing?

<u>HomeSPACE interview questions – PHASE 2 of Interviews</u>

<u>Introduction</u>

- Researcher to introduce self and thank participants for their time
- Ask to speak to all participants for a few minutes to outline the discussions
- Last time they were interviewed, the main focus was on the first lockdown in March 2020
- Today we want to split the discussion into two main timepoints the first being last summer when restrictions started to lift through the summer holidays to going back to school in September. And the second timepoint is when the restrictions came back in around October time through to March 2021.
- Remind participants that researcher will remind them which timepoint we are discussing.
- Reminder that if there is anything they don't want to discuss or answer anything they don't have to and we will be recording the session, haven't started yet will let them know when start. And if they don't understand something or want reminding of a question to just ask. No right or wrong answers, we just want to explore how your physical activity and sedentary behaviour (sitting down) changed as the restrictions changed.
- Start recording.
- Ask for a reminder of children's ages, who they live with including any pets.
- Ask when the children went back to school. Before summer holidays? After fire break? Before Easter this year?
- Has anyone in the house had to isolate?
- Ask to speak to participants individually.

<u>Child – Lifting of Restriction</u>

Refer back to if the child went back to school before the summer holidays.

- How did you feel knowing that the restrictions were lifting? And going back to school? Why did you feel like that?
- How did you find the summer holidays? What did you do?
- Did you go to any clubs over the summer? Holiday?
- Did you go back to after school clubs when you were allowed to?
- How did you feel about that? Did you have any motivation to go back to clubs?
- How did your friends feel and what did they do when the restrictions were lifts? Did they go back to clubs? Did you see them outside?
- How do you think your physical activity at home changed?

- Did you carry on going on walks etc?
- How do you think your screen time at home changed?
- Did you carry on gaming when you could?
- Did your friends?
- What was PE like when you went back to school?
- Did you go back to any community centres/leisure centres?
- Social/environmental factors to be physically active or spend time on a screen?
- Equipment at home?
- Did you play games at home as a younger child? Did you have equipment to do this? Did you go back to any of these games during lockdown to prevent boredom?

<u>Child – Lockdown Restrictions</u>

- October/November we went back into lockdown restrictions.
- How much did you know about the restrictions?
- How did you feel?
- How did you feel not going to school again?
- We sort of knew what was coming, were you looking forward to anything?
- What were you not looking forward to?
- Did you learn anything in the first lockdown that you used to help you in the second lockdown?
- Thinking about your routine and time at home, was anything the same as the first lockdown?
- Was anything different?
- First lockdown – PA was *researcher to read from first summary*, this changed when the restrictions were lifted, how would you say it changed again in the second lockdown? Higher or lower?
- SAME AS ABOVE FOR SED BEH/SCREENTIME. Higher/lower?
- Talked about things that made you want to be PA during lockdown did this change in the second lockdown? Did anything make you be physically active?
- Talked about things that made you want to spend time on a screen during the lockdown, did this change in the second lockdown? Anything make you want to spend more time on a screen?
- Christmas holidays
- How did you feel?
- How different to previous Christmas?
- Physical activity during Christmas? Sedentary Behaviour during Christmas?

<u>Parent - Lifting</u>

- How did you feel with the lifting of the restrictions?
- How do you think your child felt?
- Refer to when child went back to school.
- How were the summer holidays?
- Did you get away at all?

- Did the children go to any clubs?
- Did they manage to see friends a bit more often?
- Did you notice that they wanted to go out more than before the restrictions? How did their attitudes/motivation change?
- During lockdown PA was refer to previous interview how did that change when the restrictions lifted?
- During lockdown screen time was refer to previous interview how did that change when the restrictions lifted?
- We discussed factors that made them active during the lockdown, but what about when restrictions were lifted?
- Were there any factors that made them more active both outside of home and in the home?
- Were there any factors that made them spend more time on the screen?
- Did you keep any sort of routine?
- Did you change anything based on your experiences during the restrictions?
- Did you face any challenges around PA/Screen time when the restrictions were lifting?

<u>Parent – Lockdown</u>

- Oct/Nov we sort of knew what was coming next and we went back into lockdown.
- How did you feel?
- How did the children feel?
- What happened with home schooling?
- First lockdown – PA was *researcher to read from first summary*, this changed when the restrictions were lifted, how would you say it changed again in the second lockdown? Higher or lower?
- SAME AS ABOVE FOR SED BEH/SCREENTIME. Higher/lower?
- Talked about things that made you want to be PA during lockdown did this change in the second lockdown? Did anything make you be physically active? Weather not good!
- Talked about things that made you want to spend time on a screen during the lockdown, did this change in the second lockdown? Anything make you want to spend more time on a screen?
- Challenges around PA during this second lockdown?
- Challenges around screen time during the second lockdown?
- Routine?
- Did you stick to the restrictions as closely as the first lockdown?

<u>Conclusion</u>

- Last questions:
- How do you feel about the future?
- Looking forward to the future are there any changes that you would make based on the last 18 months?
- Researcher to thank participants for their time.

- Will send over consent form to allow for the interview to be used in our analysis.
- Be in touch again in September/October to hopefully discuss the "new normal".

<u>HomeSPACE interview questions – PHASE 3 of Interviews</u>

<u>Introduction</u>

- Researcher to introduce self and thank participants for their time.
- Ask to speak to all participants for a few minutes to outline the discussions.
- First time they were interviewed, the focus was on the first lockdown in March 2020 = July 2020.
- Interviewed again during summer 2021 to discuss the changes moving in and out of lockdown.
- Today we want to focus on what we call the "new normal" during the summer and into September through to now.
- Reminder that if there is anything they don't want to discuss or answer anything they don't have to and we will be recording the session, haven't started yet will let them know when start. And if they don't understand something or want reminding of a question to just ask. No right or wrong answers, we just want to explore how your physical activity and sedentary behaviour (sitting down) changed as the restrictions changed.
- Start recording.

<u>Children</u>

- Ask for age and reminder of who live with
- Spoke at start of July and were looking forward to the summer and going out with friends on bikes etc with almost all the restrictions being lifted. Can you remember what summer was like?
- School – September - what was it like going back to school? How did you feel? What was PE like? How did you get to school? Break/lunchtimes? After school clubs? Isolate from school?
- What do you do at home when you get home from school? Is this different to before the pandemic? Or during the pandemic?
- Weekends since September, what have they looked like?
- Did you start doing anything during lockdown that you have carried on doing now?
- Screen time? Gaming?
- Where do you do most of your physical activity?
- Play? Parks? Community Centres? Leisure Centres?
- Equipment?
- What now motivates you to be physically active?
- What makes you not want to do physical activity?
- Weather

- Before the pandemic what was important to you? Still important now?
- What were your views on physical activity before the pandemic? Are they still the same?
- What were your views on screentime before the pandemic? Are they still the same?

Parents

- Summer
- How do you think your child felt going back to school in September?
- What differences did they talk about? PE? Afterschool clubs? Activities when got home?
- Community Clubs?
- How would you compare their PA now compared to before Covid? Why do you think this is?
- How would you compare their screentime now to before Covid? Why do you think this is?
- What are the main differences in their PA/SB now compared to both during and before Covid?
- Last time we discussed factors that made them active. What would you say these are now?
- We also discussed factors that made them less active. What would you say these are now?
- At home and outside the home?
- Do you do anything now that you wouldn't have done if it weren't for Covid?
- We also discussed any challenges around PA/Screen time – what do these look like now?
- Main differences in your child's activities at home?
- Weather?
- Before the pandemic what was important to you? Still important now?
- Physical activity important?
- Screentime important?

Concluding Comments

- Last questions:
- How do you feel about the future?
- Looking forward to the future are there any changes that you would make based on your experiences with the pandemic?
- Researcher to thank participants for their time.

APPENDIX VII: CONSENT/ASSENT FORM EXAMPLES

Swansea University
Prifysgol Abertawe

Applied Sports Technology Exercise and Medicine Research Centre (A-STEM)
Sport and Health Portfolio, College of Engineering

SWAN-LINX

PARENT INFORMATION SHEET

(Version 3.0, Date: 01/11/2018)

Project Title:
Health, motor skills (physical competency), fitness and lifestyle of School Children in Wales

Contact Details:
Ms Amie Richards – 657783@swansea.ac.uk or 07910661959
Professor Gareth Stratton – G.Stratton@swansea.ac.uk
Dr Lowri Edwards – L.C.Edwards@swansea.ac.uk

Please read the information below carefully before deciding whether to consent for your child's participation.

1. Invitation Paragraph

The children in your child's class have been invited to take part in a new study that will look at the relationships between lifestyle behaviours, such as, sitting time, computer game play, fitness, sleep time, type of foods eaten and so forth. The data we collect from all of the children taking part in the study will help us assess different aspects of children's motor skills (physical competency), fitness and lifestyle.

2. What is the purpose of the study?

The purpose of this study is to investigate motor skills (physical competency), fitness and lifestyle in children. The study will also test an accelerometer which measures body movement. The data collected will be used in a postgraduate student's thesis and will assist in tracking children's health, physical activity and physical competency, to decide how best to help children become healthier and more involved in sport and physical activity in the future. The data collected will also be used to map results across Wales. This will help us to further analyse levels of health and fitness in children in terms of demographics.

3. Why has my child been chosen?

All of the children in your child's class, including your child, have been invited to take part in the Fitness Fun Day. During the day, if your child does not feel happy about anything that they are asked to do, they can stop at any time, without fear of penalty. If you need any more information about the study then please contact any member of the team on the details above.

4. What will happen to your child if they take part?

Your child will attend a Fitness Fun Day with the rest of their class. This will involve a half day of fun physical activities which will measure children's strength, speed, agility, endurance and flexibility. These activities include; 20m shuttle run (measures endurance), 10x5m sprint (measures speed and agility), handgrip (measures strength), sit and reach (measures flexibility), standing long jump (measures leg explosive power), and speed bounce (measures leg speed, agility and endurance). They will also take part in the Dragon Challenge V1.0; this Challenge assesses many fundamental movement skills. During the Dragon Challenge, your child and their class will perform 9 discrete tasks in a circuit that require single or combinations of motor skills in order to achieve a goal. These tasks involve running, jumping over hurdles, balancing, core agility/flexibility, ball throwing, ball catching and ball bouncing.

During the physical activities, some of the children may be asked to wear the SlamTracker accelerometer. This device will measure how fast your child moves forwards and backwards, side to side and up and down. Your child will also have weight, height and sitting height measurements recorded, taken by a member of the research team listed. Measures of body weight are taken privately in a separate room or behind a screen, there will always be other children in the room or next to the screen but they will not be party to the results or be able to view the measures and no results are shared with the rest of the class, however, your child will not have to have them taken if they do not want to. All activities will be no harder than your child would do during school PE lessons. Finally, during the Fitness Fun Day session or at your child's school, your child will also be asked complete a questionnaire, about their health, physical activity and lifestyle, which will take about 30 minutes. There will be members of the research team and teachers present to assist your child in filling them in. All the activities during the Fitness Fun Day are aimed for the children's enjoyment and not as a competition. With your permission, a video camera will also be used to capture some of the activities the children are performing.

5. What are the possible disadvantages of taking part?

Taking part in the Fitness Fun Day and Dragon Challenge activities poses no greater risk than a child participating in school physical education lessons. However, in the unlikely event that a child feels unwell, there will be people monitoring the children during all parts of the fitness fun day and dragon challenge activities, and the children's teachers will remain present at all times. A qualified first aider will always be present during the Fitness Fun Day (including Dragon Challenge).

6. What are the possible benefits of taking part?

The Fitness Fun Day will be an active and very enjoyable day for the children and they will get to take part in a variety of different activities that they might not have taken part in before. They will be able to find out about their skills and fitness in relation to health and well-being. Further we want children to engage with their results. Therefore school data will be anonymised and made available to the school for educational purposes.

7. Will my child taking part in the study be kept confidential?

All the data we collect from your child will be kept private and confidential; the children's names will be changed to numbers. Any hard copies of the questionnaires and fitness fun day data will be kept in a secure office and computer files with any personal information will be password protected. The data obtained will only be looked at by responsible individuals of the research team from Swansea University, City & County of Swansea/ Bridgend County Borough Council and the PLPS team (Sport Wales), or from regulatory authorities where it is relevant to your child's participation in the research. To enable us to track changes in heath over time we will also keep the secure data available for future linkage with other sets of data collected in the future such as GP visits or educational results for example.

8. What if I have any questions?

If you have any questions about what is written above or anything to do with the study please don't hesitate to contact me or anyone from the research team (see contact details above). If after the study you are concerned about how any aspect of the research was conducted please contact the Chair of the College Ethics Committee, Professor Mike McNamee (m.j.mcnamee@swansea.ac.uk).

Applied Sports Technology Exercise and Medicine Research Centre (A-STEM)
Sport and Health Portfolio, College of Engineering

(Version 3.0, Date: 01/11/2018)

Project Title:
Health, motor skills (physical competency), fitness and lifestyle of School Children in Wales

PLEASE RETURN THIS FORM TO SCHOOL TO CONSENT FOR YOUR CHILD TO TAKE PART IN THE PROJECT.

Contact Details:
Ms Amie Richards – 657783@swansea.ac.uk or 07910661959
Professor Gareth Stratton – G.Stratton@swansea.ac.uk
Dr Lowri Edwards – L.C.Edwards@swansea.ac.uk

<u>Please INITIAL each box below</u>

1. I confirm that I have read and understood the information sheet dated 01/11/2018 (Version number 3.0) for the above study and have had the opportunity to ask questions. ☐
2. I am happy for my child to participate in the Fitness Fun Day, and wear the SlamTracker accelerometer. ☐
3. I understand that my child's participation is voluntary and that I am free to withdraw my child at any time, without giving any reason, without their medical care or legal rights being affected. ☐
4. I understand that sections of the data obtained may be looked at by responsible individuals from the Swansea University or from regulatory authorities where it is relevant to the children's taking part in research ☐
5. I am happy for any data collected in this study to be used in future health related studies where data collected will be linked to health outcomes and educational records. ☐
6. I am happy for the activities to be video recorded for academic use ONLY. ☐

I agree to allow my child to take part in the above study.

____________________	__________	________________
Name of Participant (child)	Date	Signature
____________________	__________	________________
Name of Parent/Guardian	Date	Signature
____________________	__________	________________
Researcher	Date	Signature

Swansea University
Prifysgol Abertawe

Applied Sports Technology Exercise and Medicine Research Centre (A-STEM)
Sport and Health Portfolio, College of Engineering

SWAN-LINX

(Version 3.0, Date: 01/11/2018)

Project Title:
Health, motor skills (physical competency), fitness and lifestyle of School Children in Wales

Contact Details:
Ms Amie Richards – 657783@swansea.ac.uk or 07910661959
Professor Gareth Stratton – G.Stratton@swansea.ac.uk
Dr Lowri Edwards – L.C.Edwards@swansea.ac.uk

1. Invitation Paragraph
The children in your school have been invited to take part in a new study that will look at the relationships between lifestyle behaviours, such as, sitting time, computer game play, fitness, sleep time, type of foods eaten and so forth. Other schools are also taking part in the study. They will be asked to take part in a Fitness Fun Day, where they will complete the Dragon Challenge, and a series of physical activities and a questionnaire. The data we collect will help us assess different aspects of children's motor skills (physical competency), fitness and lifestyle. Please consider whether you are able to commit to the requirements stated below before signing the consent form.

2. What is the purpose of the study?
The purpose of this study is to investigate the health, motor skills (physical competence), fitness, lifestyle of children from selected schools. The study will also test an accelerometer which measures body movement. The data collected will be used in a postgraduate student's thesis and will assist in tracking children's health, physical activity and physical competency, to decide how best to help children become healthier and more involved in sport and physical activity in the future. The data collected will also be used to map results across Wales. This will help us to further analyse levels of health and fitness in children in terms of demographics.

3. Why have I been chosen?
The children in your school have been invited take part in the Fitness Fun Day as they attend school in Wales. During the day if any of the children do not feel happy about anything they are asked to do, they can stop at any time, without fear of penalty. If you need any more information about the study then please contact any member of the team on the details above.

4. What will happen to the children if they take part?
Your pupils will attend a Fitness Fun Day; this will involve a half day of fun physical activities which will measure the children's strength, speed, agility, endurance and flexibility. These activities include; 20m Multi Stage shuttle runs (measures endurance), 10x5m sprint (measures speed and agility), handgrip (measures strength), sit and reach (measures flexibility), standing long jump (measures leg explosive power), and speed bounce (measures leg speed, agility and endurance). They will also take part in the Dragon Challenge V1.0; this Challenge assesses many fundamental movement skills. During the Dragon

Challenge, the children will perform 9 discrete tasks in a circuit that require single or combinations of motor skills in order to achieve a goal. These tasks involve running, jumping over hurdles, balancing, core agility/flexibility, ball throwing, ball catching and ball bouncing.

During these physical activities, some of the children may be asked to wear a sensor called a SlamTracker accelerometer. This device will measure how fast the child moves forwards and backwards, side to side and up and down, and will only be worn during some activities. The activities will be no harder than what a child would do during school PE lessons. The children will also have weight, height and sitting height measurements recorded, take by a member of the research team listed. Measures of body weight are taken privately in a separate room or behind a screen, there will always be other children in the room or next to the screen but they will not be party to the results or be able to view the measures and no results are shared with the rest of the class. Children can choose not to have their anthropometric measurements taken if they do not want to be measured. We have followed this approach with around 70000 children in Liverpool since 1996. Finally, during the Fitness Fun Day session, the children will also be asked complete a questionnaire, about their health, physical activity and lifestyle, which will take about 30 minutes. There will be members of the research team and teachers present to assist the children in filling them in. All the activities during the Fitness Fun Day are aimed for the children's enjoyment and not as a competition. With your permission, a video camera will also be used to capture some of the activities the children are performing.

5. What are the possible disadvantages of taking part?

Taking part in the Fitness Fun Day and Dragon Challenge activities poses no greater risk than a child would face during physical education lessons in school. However, in the unlikely event that a child feels unwell, there will be people monitoring the children during all parts of the fitness fun day and dragon challenge activities, and the children's teachers will remain present at all times. A qualified first aider will always be present during the fitness fun day (including Dragon Challenge).

6. What are the possible benefits of taking part?

The Fitness Fun Day will be an active and very enjoyable day for the children and they will get to take part in a variety of different activities that they might not have taken part in before. They will be able to find out about their skills and fitness in relation to health and well-being. Further we want children to engage with their results. Therefore school data will be anonymised and made available to the school for educational purposes.

7. Will my taking part in the study be kept confidential?

All the data we collect from the children will be kept private and confidential; the children's names will be changed to numbers. Any hard copies of the questionnaires and fun day data will be kept in a secure office and computer files with any personal information will be password protected. The data obtained will only be looked at by responsible individuals of the research team from Swansea University and the City & County of Swansea/ Bridgend County Borough Council and the PLPS team (Sport Wales), or from regulatory authorities where it is relevant to the children's participation in the research. To enable us to track changes in heath over time we will also keep the secure data available for future linkage with other sets of data collected in the future such as GP visits or educational results for example.

8. What if I have any questions?

If you have any questions about what I have written above or anything to do with the study please don't hesitate to contact me or anyone from the research team as detailed above. If after the study you are concerned about how any aspect of the research was conducted please contact the Chair of the College Ethics Committee, Professor Mike McNamee (m.j.mcnamee@swansea.ac.uk)

Swansea University
Prifysgol Abertawe

Applied Sports Technology Exercise and Medicine Research Centre (A-STEM)
Sport and Health Portfolio, College of Engineering

(Version 3.0, Date: 01/11/2018)

Project Title:
Health, motor skills (physical competency), fitness and lifestyle of School Children in Wales

Contact Details:
Ms Amie Richards – 657783@swansea.ac.uk or 07910661959
Professor Gareth Stratton – G.Stratton@swansea.ac.uk
Dr Lowri Edwards – L.C.Edwards@swansea.ac.uk

Please INITIAL each box below

1. I confirm that I have read and understood the information sheet dated 01/11/2018 (Version number 3.0) for the above study and have had the opportunity to ask questions. ☐
2. I understand that the children's participation is voluntary and that I am free to withdraw my pupils at any time, without giving any reason, without their medical care or legal rights being affected. ☐
3. I understand that sections of the data obtained may be looked at by responsible individuals from the Swansea University or from regulatory authorities where it is relevant to the children's taking part in research. ☐
4. I am happy for any data collected in this study to be used in future health related studies where data collected will be linked to health outcomes and educational records. ☐
5. I am happy for the activities to be video recorded for academic use ONLY. ☐

I agree to allow the pupils in my school to take part in the above study.

Name of School	Date	Signature
Name of Headteacher	Date	Signature
Researcher	Date	Signature

Swansea University
Prifysgol Abertawe

Applied Sports Technology Exercise and Medicine Research Centre (A-STEM)
Sport and Health Portfolio, College of Engineering

SWAN-LINX

PARTICIPANT INFORMATION SHEET

(Version 3.0, Date: 01/11/2018)

Project Title:
Health, motor skills (physical competency), fitness and lifestyle of School Children in Wales

Contact Details:
Ms Amie Richards – 657783@swansea.ac.uk or 07910661959
Professor Gareth Stratton – G.Stratton@swansea.ac.uk
Dr Lowri Edwards – L.C.Edwards@swansea.ac.uk

You have been invited to take part in a Swansea University study. You have been chosen because you are between the ages of 8-13 years old and go to a school in Wales.

In this study you have the chance to take part in a fitness fun day, the Dragon Challenge, and complete a questionnaire about your health and lifestyle and about how physically active you are. Physical activity is any movement that requires your body to work harder than it does whilst sitting, or resting. The fitness fun day will involve lots of fun physical activities that you may not have tried before which should be really enjoyable. These activities will include a 20m shuttle run to see how long you can run for, a shuttle sprint to see how quick you can run back and forth, gripping with your hands to find out your strength, sit and reach to find out how flexible you are, standing long jump to see how far you can jump, and speed bounce to see how many times you can jump in 30 seconds. The Dragon Challenge involves running, jumping over hurdles, balancing, core agility/flexibility, ball throwing, ball catching and ball bouncing. These are done in a circuit and should be really fun.

You may also get asked to wear our BRAND NEW devices, and use the NEWEST technology to measure how fast you move forwards and backwards, side to side and up and down. This will be worn on your wrist and ankle during some of the physical activities. You may also be video recorded during some of the physical activities. This will help us see how well you have done.

You will not be forced to do any of the activities and can stop at any time without fear of penalty or having to worry about being in trouble.

If you have any questions please ask. **THANK YOU.**

Swansea University
Prifysgol Abertawe

Applied Sports Technology Exercise and Medicine Research Centre (A-STEM)
Sport and Health Portfolio, College of Engineering

(Version 3.0, Date: 01/11/2018)

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Professor Gareth Stratton – G.Stratton@swansea.ac.uk
Dr Lowri Edwards – L.C.Edwards@swansea.ac.uk

	Please look at the following statements and put your initials if you agree. Example Sarah Jones: SJ	
	I have read the Participant Information Sheet	☐
	I understand what I will be doing if I take part	☐
	I have had a chance to think about taking part	☐
	I have had a chance to ask any questions	☐
	I agree that my data can be used in a research report and that I will not be named so no-one will know it was my information	☐
	I understand that all of the information will be kept private and only shared with the research team	☐
	I am happy to try to do the activities that the Swan-Linx Team wants me to do during the fitness fun day, and complete the questionnaire.	☐
	I am happy to take part in this study	☐

Name of Participant	Date	Signature
Researcher	Date	Signature

APPENDIX VIII: HOMESPACE PROJECT PHASES OUTLINE

HomeSPACE Project			
Phase 1 Nov-2017 to Jul-2018	Phase 2 Jun-2020 to Aug-2020	Phase 3 Mar-2021 to Jun-2021	Phase 4 Sept-2021 to Jan-2022
Total Children = 213	Total Children = 143	Total Children = 124	Total Children = 108
• Home Social Environment Audit • Home Physical Environment Audit • Device-Based Physical Activity Measures • CHAT Data • Demographic Data • Weather Data (Retrospectively)			
In This Thesis			
No Data Used	Interviews about Lockdown 1	Interviews about Easing of Restrictions and Lockdown 2	Interviews about “The New Normal”
N/A	N=41 invited N=20 took part	N=20 invited N=14 took part	N=20 invited N=9 took part

APPENDIX IX: CONFERENCE ABSTRACTS

Richards, A.B., Stratton, G. Are those who can swim, cycle and play sport fitter than those than don't? United Kingdom & Ireland Motor Competence Network Meeting, Liverpool, UK. January 2019. Oral Presentation.

Title: Are children who swim, cycle and play sport fitter than those that don't?

Authors: Amie Richards & Professor Gareth Stratton
Affiliations: A-STEM Research Centre, Swansea University

Introduction: Children's fitness is woefully low and declining at a faster rate than obesity is increasing (Sandercock, Ogunleye & Voss, 2015). Swimming and cycling are popular activities for promoting fitness among children (Swim England, 2017; Garrard, Rissel & Bauman, 2012), with 50% wanting to swim and 36% to cycle more often respectively (Sport Wales, 2017). We aimed to establish whether different components of fitness were greater in boys and girls who could cycle, swim and play sport compared to those who do not.

Method: A cross sectional study to explore six components of fitness in children (n=375, aged 10.54 years±0.58, 57% boys). Participants took part in a Fitness Fun Day to assess fitness in: 20m multi-stage fitness test, sit and reach test, standing broad jump, grip strength, 10x5m shuttle run, speed bounce and anthropometrics (height, weight, sitting height). Participants completed an online survey to self-report sport club participation, whether they could ride a bike and swim 25m. Postcode data was collected to analyse the Welsh index of multiple deprivation (WIMD). MANCOVA were conducted to look for differences in fitness controlling for body mass index (BMI) and WIMD.

Results: There was a significant difference between children who could and could not ride a bike from the 20m multi-stage fitness test and BMI ($p<0.05$) and the 10x5m shuttle run ($p<0.01$). There were significant differences in the children's speed bounce scores if they could or could not swim 25m ($p<0.05$). Separate analysis corrected for number of sports clubs the children attend and significant differences ($p<0.05$) were found between those who could and could not ride a bike in the multi-stage fitness stage, 10x5m shuttle run and BMI.

Conclusion: Riding a bike appears to be a better measure of fitness than being able to swim 25m. However, schools and community groups should continue to promote both swimming and cycling for enjoyment, safety and health.

Richards, A.B., Klos, L., Swindell, N., Griffiths, L.G., DeMartelaer, K., Edwards, L., Brophy, S., Stratton, G. The influence of swimming & cycling abilities on the fitness of 9–11-year-old boys and girls, International Motor Development Research Consortium, Virtual (South Carolina, USA). September 2020. Oral Presentation.

THE INFLUENCE OF SWIMMING & CYCLING ABILITIES ON THE FITNESS OF 9-11 YEAR OLD BOYS AND GIRLS

*Amie B Richards[1], Leon Klos[2], Dr Nils Swindell[1], Dr Lucy Griffiths[3], Professor Kristine DeMartelaer[4], Dr Lowri Edwards[5], Professor Sinead Brophy[3] & Professor Gareth Stratton[1]

[1]Swansea University, Applied Sports Technology Exercise and Medicine (A-STEM) Research Centre, Swansea, Wales, UK; [redacted]@swansea.ac.uk
[2] Karlsruhe Institute of Technology, Institute of Sports and Sports Science, Karlsruhe, Germany
[3]Swansea University, College of Medicine, Swansea, Wales, UK
[4]Vrije Universiteit Brussel, Faculty of Physical Education and Physiotherapy, Brussels, Belgium
[5]Cardiff Metropolitan University, School of Sport and Health Sciences (Sport), Wales, UK.

Objective: To examine the associations between swimming and cycling abilities and fitness levels in 9-11-year-old boys and girls. **Method**: A cross-sectional study involving 2161 children (50.7% boys; aged 10.52 ± 0.6 years) from 33 schools, participated in the SwanLinx and BridgeLinx health, fitness, and lifestyle programmes between 2013 and 2019. These programmes collected health and fitness data; namely body composition, cardiorespiratory fitness, muscular strength, flexibility, power, speed, and coordination using standard measures from the EuroFit physical fitness test battery. Data relating to swimming and cycling abilities, together with sports club attendance, lifestyle and wellbeing, were collected using an online survey. Multivariate multilevel regressions were used to examine the associations between swimming and cycling abilities and fitness levels, together with gender interactions. **Results**: Intraclass correlations (ICC) showed that schools accounted for between 5.8% and 13.6% of the variance. The ability to swim and cycle was significantly ($p<0.05$) associated with all components of fitness when accounting for decimal age, body composition, deprivation, gender, "Linx" programme and sports club attendance. In the final model, there were significant interactions between swimming, cycling and gender and cardiorespiratory fitness for both gender by swim ($p=0.001$) and gender by cycle ($p=0.014$); while the gender by cycle interaction significantly predicted grip strength ($p=0.002$). **Implications:** The ability to swim and cycle are important 'milestones' in the journey of motor development and are associated with higher levels of motor fitness. Swimming and cycling should be promoted in children's lifecourse to allow for an optimal development of motor skills, fitness, and health.

Richards, A.B., Minou, M., Sheldrick, M.P., Swindell, N., Griffiths, L.J., Hudson, J., Stratton, G. A socioecological perspective of how physical education & home-schooling impacted physical activity and sedentary behaviour during the COVID-19 restrictions – The HomeSPACE Project, 32nd Pediatric Work Physiology Conference, Virtual (Swansea, UK). September 2021. Oral Presentation.

A Socioecological Interpretation Of How Physical Education & Homeschooling Impacted Physical Activity And Sedentary Behaviour During The Covid-19 Restrictions – The Homespace Project

Richards, A.B.,[1*] Minou, M.,[1] Sheldrick, M.P.,[1] Swindell, N.,[1] Griffiths, L.J.,[2] Hudson, J.[1] & Stratton, G.[1]
[1]Applied Sports Technology Exercise and Medicine (A-STEM) Research Centre, Swansea University, Swansea, Wales, UK; *[redacted]@swansea.ac.uk
[2]Population Data Science, Swansea University Medical School, Swansea, Swansea, Wales, UK

INTRODUCTION: The Covid-19 pandemic forced schools to close to limit the spread of the virus, meaning children were being home schooled, spending a considerable amount of time in their home environment. The HomeSPACE Project previously identified associations between the home physical environment and children's home-based physical activity and sitting time (Sheldrick et al, 2019). This study explored how and why home schooling and PE influenced physical activity and sedentary levels within the home environment.

METHODS: Twenty semi-structured interviews (20 parents & 23 children) were conducted, and discussions were guided around children's physical activity and sedentary behaviour in the home environment during the first national lockdown of the pandemic. Data were coded using thematic analysis on NVivo. Concepts from the socioecological model were used to analyse the data.

RESULTS: The interviews indicated that various factors influenced the children's engagement in home schooling and PE, having a subsequent impact on their physical activity and sedentary behaviour at home. These factors included: i) individual-level factors (e.g., attitudes towards school and PE); ii) interpersonal-level factors (e.g., parental support and peer influence); iii) organisation-level factors (e.g., school policies, sports club engagement), iv) community-level factors (e.g., equipment and environment), and finally; v) policy-level factors (e.g., lockdown restrictions, curriculum policy).

CONCLUSIONS: Results showed that despite national policy making PE a compulsory part of the curriculum, this may not have been adhered to as temporary national regulations enforced schools to close. This study implies that the previous findings of PE being a less prioritised subject, may well also be true for home schooling. Parents and children reported that home schooling increased their screen time as the majority of learning was taking place on an online platform, increasing their sedentary behaviour. Schools should plan to decrease children's screen time and increase their physical activity in the event of future school closures.

Richards, A.B., Beaney, M., Barker, H., Williams, E., Tyler, R., Griffiths, L.G., Stratton, G. Does children's motor competence differ between ethnicities & gender: A cross sectional evaluation, International Motor Development Research Consortium, Virtual (Greece). September 2021. Poster Presentation.

DOES CHILDREN'S MOTOR COMPETENCE DIFFER BETWEEN ETHNICITIES & GENDER: A CROSS SECTIONAL EVALUATION

Amie B. Richards[1*], Megan Beaney[1], Harriet G. Barker[1], Emily Williams[1], Richard Tyler[2], Lucy J Griffiths[3] & Gareth Stratton[1]

[1]Swansea University, Applied Sports Technology Exercise and Medicine (A-STEM) Research Centre, Swansea, Wales, UK; *[redacted]@swansea.ac.uk
[2]Edge Hill University, Sport & Physical Activity, Lancashire, England, UK
[3]Population Data Science, Swansea University Medical School, Swansea, Swansea, Wales, UK

The aim of this study was to examine differences in children's motor competency levels based on their ethnicity and gender. A cross-sectional study involving 4145 children (50% boys; aged 11.36 ± 0.58 years) from schools across Wales participated in the Dragon Challenge assessment of motor competence. The Dragon Challenge is a valid and dynamic motor competence assessment, comprising of nine individual tasks, measuring stability, locomotion and object control skills. Children were assessed by qualified individuals and given an overall score which considered process, product and time. Demographic data such as gender, ethnicity and date of birth was also obtained. When controlling for decimal age and free school meal status, significant differences were found between ethnicities for overall score ($p=0.000$) and process and product score ($p=0.000$). Post-hoc tests confirmed that the differences in these scores were between White/White British and Asian/Asian British children. There were also significant differences between ethnicities in 7 out of the 18 process score categories ($p<0.05$) but only 1 out of the 9 product scores ($p = 0.002$). Gender differences were present in total score ($p = 0.000$) and process and product score ($p = 0.000$); also, in 9 out of 18 process scores (0<0.05) and 4 out of 9 product scores ($p<0.05$). Gender and ethnicity interactions were significant in overall score ($p = 0.027$), three process scores and two product scores (<0.05). There were no significant differences in neither gender nor ethnicity for time scores ($p>0.05$). Building on previous research the results suggest that those children from an Asian background will have significantly poorer motor competence than those from White ethnic groups. The identified differences further support the need to bridge the gap in health inequalities between both ethnicities and genders. Having higher levels of motor competence will allow for an optimal development of motor skills, fitness, and subsequently health.

Richards, A.B.; Mackintosh, K.A.; Swindell, N.; Ward, M.; Marchant, E.; James, M.; Edwards, L.C.; Tyler, R.; Blain, D.; Wainwright, N.; Nicholls, S.; Mannello, M.; Morgan, K.; Evans, T.; Stratton, G. WALES 2021 Active Healthy Kids (AHK) Report Card: The Fourth Pandemic of Childhood Inactivity, International Society of Physical Activity and Health Conference, Abu Dhabi, United Arab Emirates. October 2022. Poster Presentation.

THE FOURTH PANDEMIC OF CHILDHOOD INACTIVITY

Amie B. Richards[1]*; Kelly A. Mackintosh[1]; Nils Swindell[1]; Malcolm Ward[1]; Emily Marchant[2]; Michaela James[2]; Lowri C. Edwards[3]; Richard Tyler[4]; Dylan Blain[5]; Nalda Wainwright[5]; Sarah Nicholls[6]; Marianne Mannello[7]; Kelly Morgan[8]; Tim Evans[9]; Gareth Stratton[1]

[1] Applied Sports, Technology, Exercise and Medicine (A-STEM) Research Centre, Swansea University, Swansea, SA1 8EN, Wales, UK;
[2] Population Data Science, Medical School, Singleton Campus, Swansea University, Wales, SA2 8PP;
[3] Cardiff School of Sport and Health Sciences, Cardiff Metropolitan University, Wales, UK;
[4] Health Research Institute and Movement Behaviours, Nutrition, Health, Development, and Wellbeing Research Group, Department of Sport and Physical Activity, Edge Hill University, St Helens Road, Ormskirk, UK;
[5] Institute of Management and Health, University of Wales Trinity Saint David, Carmarthen Campus, Carmarthen, SA31 3EP;
[6] Department of Business, School of Management, Swansea University, Bay Campus, Fabian Way, Swansea, SA1 8EN, Wales, UK;
[7] Play Wales, Park House, Greyfriars Road, Cardiff, CF10 3AF, Wales, UK;
[8] DECIPHer, School of Social Sciences, Cardiff University, SPARK, Maindy Road, Cardiff, CF24 4HQ, Wales, UK;
[9] Sport Wales, Sport Wales National Centre, Sophia Gardens, Cardiff, CF11 9SW, Wales, UK

The pandemic of childhood physical inactivity in Wales continues. While the Welsh Assembly made 20 recommendations to address this issue in 2019, children and young people's (CYP) physical activity remains low, despite the contributions that sufficient physical activity can have on health outcomes. The fourth Active Healthy Kids (AHK) Wales Report Card has examined physical activity in CYP using data that was collected pre-COVID-19. Grades were produced for eleven quality indicators by synthesising the best available evidence and expert consensus from the Research Working Group (RWG). Grades were assigned as follows: Overall PA - F; Organised Sport and PA - C; Active Play - C+; Active Transportation - C-; Sedentary Behaviours - F; Physical Fitness - C-; Family and Peer Influences - D+; School - B-; Community and the Built Environment - C; National Government and Policy - C; and Physical Literacy - C-. The pandemic of inactivity continues as all but three grades have remained the same or decreased, (Active Play increased from a C- to a C+; Active Transportation D+ to C-; and Family and Peers D to D+). This is the first iteration of the Report Card that includes grades for all indicators and results paint a worrying picture for CYP's health and wellbeing in Wales. Key recommendations to improve the grades include prioritising the views of CYP, protecting playtime, increasing access to active spaces and places, and not conflating physical activity with obesity. This Report Card should be utilised by policy makers and practitioners to increase physical activity opportunities and reduce inequalities for CYP in Wales, with the aim of slowing the pandemic of physical inactivity and its immediate consequences on children's ability to thrive. The implications of COVID-19 on quality indicator grades are yet to be explored by the AHK-Wales RWG.

APPENDIX X: POSTER PRESENTATIONS

DOES CHILDREN'S MOTOR COMPETENCE DIFFER BETWEEN ETHNICITIES AND GENDER: A CROSS SECTIONAL EVALUATION

Amie B Richards*, Megan Beaney, Harriet G Barker, Emily Williams, Richard Tyler, Lucy J Griffiths & Gareth Stratton
*Swansea University, Applied Sports Technology Exercise and Medicine (A-STEM) Research Centre, Swansea, Wales, UK.

Introduction

- Motor Competence (MC) reflects an individual's capabilities across locomotor, object control & stability skills (Gallahue & Ozmun, 2012) & is a precursor to physical activity (Stodden et al, 2008).
- MC levels and trends have been monitored & assessed through a variety of instruments and techniques (Cools et al, 2008).
- The Dragon Challenge (DC) is used to assess children's MC with both process & product scores in a dynamic, circuit-based environment, with 9 tasks; it has acceptable validity (Tyler et al, 2019).
- Few studies have explored ethnicity and MC.
- Adeyemi-Walker et al, (2020) highlighted differences between ethnicities & gender, finding that black and white children had significantly higher MC than Asian children. They also found that total MC scores were significantly higher in boys than girls.

Aim

The aim of this study was to examine differences in children's motor competency levels based on their ethnicity and gender.

Task	
1. Balance Bench	6. Catch
2. Core Agility	7. Jumping Patterns
3. Wobble Spot	8. T-Agility
4. Overarm Throw	9. Accelerate-Sprint
5. Basketball Dribble	

Figure 1. The tasks performed during the DC

Methods

- 4555 children from 63 schools from across Wales took part in the DC.
- 3986 (Aged 11.36 ± 0.58 years, 49.6% boys) were eligible to be used in this analysis.
- The procedures used in the DC have been previously reported (Tyler et al, 2019).
- Children's age, ethnicity, free school meal status (FSM) & special educational or additional learning needs (SEN/ALN).
- The variability between schools showed an ICC of between 2% and 14%. A multilevel model was used to investigate whether there were differences between ethnicities and gender for each task of the DC.

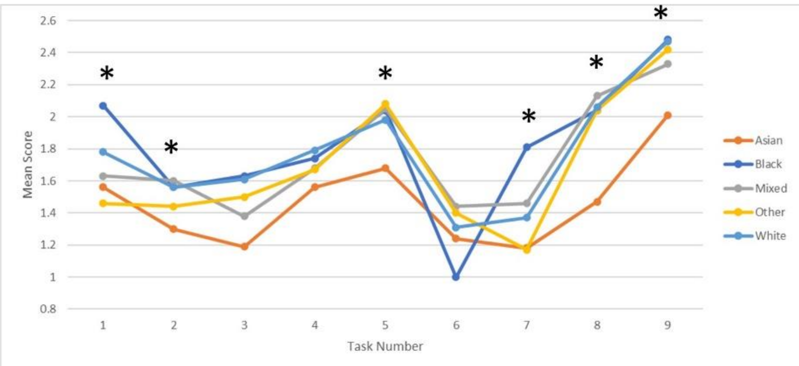

Figure 2. Mean scores for each task of the DC by ethnicity - *denotes a significant difference p<0.05.

Results

Ethnicity

- There were significant differences between ethnicities in tasks: 1, 2, 5, 7, 8 & 9 (p<0.05).
- White children scored significantly higher than Asian children in all significant tasks apart from task 7, where black children who performed significantly better than their Asian peers.
- In tasks 8 & 9, both locomotor based, Asian children performed significantly worse than all other ethnicities.

Gender

- Significant differences were found in all tasks apart from task 3, the wobble spot.
- Girls significantly outperformed boys in tasks 1, 2 & 8.

Discussion & Conclusion

Differences in ethnicity match that of previous research - Asian children have significantly worse MC than white, black, mixed & other ethnicities.

MC is significantly poorer in Asian children across Wales. Interventions are needed to bridge the gap between ethnicities & therefore reduce health inequalities.

Swansea University Prifysgol Abertawe

kess 2

Cronfa Gymdeithasol Ewrop European Social Fund

Amie B Richards
A-STEM, Swansea University
Email: 657783@swansea.ac.uk
Twitter: @AmieRichards
Phone: +44 7910 661 959

THE FOURTH PANDEMIC OF CHILDHOOD INACTIVITY IN WALES
ACTIVE HEALTHY KIDS WALES REPORT CARD 2021

AIM: To provide a greater understanding of children and young people's physical activity across Wales

BACKGROUND

There are ~664,000 children aged 0 – 18 years in Wales[1] and only 51% who are aged 3-17 years meet the recommended levels of physical activity (PA) for at least 60 minutes every day of the week, decreasing to between 13% and 17% for 11-16 year olds[2]. Poor levels of PA have negative implications on both physical[3] and mental health[4]. Therefore, increasing PA can lead to better health outcomes and to a more active population, reducing burdens on healthcare and the economy. To increase PA levels, there needs to be a good understanding of trends and current levels which this Report Card aimed to provide.

METHODS

The AHK-Wales Research Working Group (RWG) produced grades on children and young people's PA using pre-COVID-19 data. The methods used throughout were aligned to AHK Global Alliance (AHKGA) guidelines. Briefly, data was collated and synthesised from 11 sources and aligned to the AHKGA benchmarks. A standardised grading rubric, ranging from A+ (94-100% of children met the criteria) to F (<20% met the criteria) was used to provide a grade for each indicator.

QUALITY INDICATOR	GRADE
Overall Physical Activity 17% of 11-16 year olds and 22% of 8-11 year olds were active for at least 60 minutes across all seven days of the week.	F
Organised Sport Participation Between 44% and 51% of 7-17 year olds participated in sport on three or more occasions per week.	C
Active Play 42% of 5-17 year olds played outside most days and 33% reported playing outside a few days each week.	C+
Active Transportation On average 34% of 11 to 16 year olds used active transport to travel to school. 73% aged 4-18 years used active travel to places where they play.	C-
Sedentary Behaviours 86% of 11-16 year olds spent two or more hours sitting during weekdays. 32% of children aged 8-11 years watched TV/screens for two hours or more every day.	F
Physical Fitness When comparing to European Normative Values children in Wales were in the 40th percentile for both cardiorespiratory fitness and muscular fitness.	C-

QUALITY INDICATOR	GRADE
Family and Peers 46% of adults were happy with children playing out. 10% of adults had volunteered in sport in the past 12 months, whilst 53% of adults met the MVPA guidelines.	D+
School All but one benchmark scored between 45% and 94%. Between 1% and 6% of children were offered the recommended 120 minutes of PE per week.	B-
Community and Environment 88% of children were happy with their area whilst only 38% could walk to a PA facility.	C
Government Policies specific to PA promotion have expired and been replaced by an obesity policy.	C
Physical Literacy Four components were graded: physical competence 34%; confidence 69%; motivation 65% and PA 19%.	C-

CONCLUSIONS

The AHK-Wales 2021 Report Card raised concerns for children and young people's health and well-being in Wales. It is the first Report Card from Wales that has been able to provide a grade for all indicators with none marked as inconclusive which emphasises the greater volume of data available since 2018. This has allowed for a more comprehensive understanding of children and young people's PA.

WHAT NEXT?

- The results should be used to improve children and young people's PA levels and decrease physical activity inequalities highlighted in the Report Card
- Inform the decision making of policy makers
- Production of a COVID-19 Report Card

AUTHORS: Amie B Richards, Kelly A Mackintosh, Nils Swindell, Malcolm Ward, Emily Marchant, Michaela James, Lowri C Edwards, Richard Tyler, Dylan Blain, Nalda Wainwright, Sarah Nicholls, Marianne Mannello, Kelly Morgan, Tim Evans and Gareth Stratton.

INSTITUTIONS: Applied Sports, Technology, Exercise and Medicine (A-STEM) Research Centre, Swansea University, Swansea SA1 8EN, UK; Population Data Science, Medical School, Singleton Campus, Swansea University, Swansea SA2 8PP, UK; Cardiff School of Sport and Health Sciences, Cardiff Metropolitan University, Cardiff CF23 6XD, UK; Health Research Institute and Movement Behaviours, Nutrition, Health, Development, and Wellbeing Research Group, Department of Sport and Physical Activity, Edge Hill University, Ormskirk L39 4QP, UK; Institute of Management and Health, Carmarthen Campus, University of Wales Trinity Saint David, Carmarthen SA31 3EP, UK; Department of Business, School of Management, Bay Campus, Swansea University, Swansea SA1 8EN, UK; Play Wales, Park House, Greyfriars Road, Cardiff CF10 3AF, UK; DECIPHer, School of Social Sciences, Cardiff University, SPARK, Cardiff CF24 4HQ, UK; Sport Wales, Sport Wales National Centre, Sophia Gardens, Cardiff CF11 9SW, UK;

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thewaterloofoundation

kess 2
Ysgoloriaethau Sgiliau Economi Gwybodaeth
Knowledge Economy Skills Scholarships

Cronfa Gymdeithasol Ewrop
European Social Fund

ISPAH Congress 2022
9th International Society For Physical Activity & Health Congress
23-26 October 2022 | Abu Dhabi, UAE

APPENDIX XI: LIST OF ADDITIONAL PUBLICATIONS

Swindell, N., Wachira, L.J., Okoth, V., Kagunda, S., Owino, G., Ochola, S., Brophy, S., Summers, H., **Richards, A.B**., Fairclough, S.J., Onywera, V., & Stratton, G. (2022). Prevalence and correlates of compliance with 24-h movement guidelines among children from urban and rural Kenya—The Kenya-LINX project. *Plos ONE*, 17(12), e0279751. https://doi.org/10.1371/journal.pone.0279751

Sheldrick, M. P. R., Swindell, N., **Richards, A.B**., Fairclough, S.J., & Stratton, G. (2022). Homes became the “everything space” during COVID-19: impact of changes to the home environment on children’s physical activity and sitting. *International Journal of Behavioral Nutrition and Physical Activity,* 19(1), 1-15. https://doi.org/10.1186/s12966-022-01346-5

Aubert, S., Barnes, J. D., Demchenko, I., Hawthorne, M., Abdeta, C., Abi Nader, P., Adsuar Sala, J. C., Aguilar-Farias, N., Aznar, S., Bakalár, P., Bhawra, J., Brazo-Sayavera, J., Bringas, M., Cagas, J. Y., Carlin, A., Chang, C., Chen, B., Christiansen, L. B., Christie, C. J., De Roia, G. F., Delisle Nyström, C., Demetriou, Y., Djordjic, V., Emeljanovas, A., Findling Endy, L., Gába, A., Galaviz, K. I., González, S. A., Hesketh, K. D., Huang, W. Y., Hubona, O., Jeon, J. Y., Jurakić, D., Jürimäe, J., Katapally, T. R., Katewongsa, P., Katzmarzyk, P. T., Kim, Y., Lambert, E. V., Lee, E., Levi, S., Lobo, P., Löf, M., Loney, T., López-Gil, J. F., López-Taylor, J., Mäestu, E., Mahendra, A., Makaza, D., Mallari, M. F. T., Manyanga, T., Masanovic, B., Morrison, S. A., Mota, J., Müller-Riemenschneider, F., Muñoz Bermejo, L., Murphy, M. H., Naidoo, R., Nguyen, P., Paudel, S., Pedišić, Ž., Pérez-Gómez, J., Reilly, J. J., Reimers, A. K., **Richards, A. B**., Santos Silva, D. A., Saonuam, P., Sarmiento, O. L., Sember, V., Shahril, M. R., Smith, M., Standage, M., Stratton, G., Subedi, N., Tammelin, T. H., Tanaka, C., Tesler, R., Thivel, D., Tladi, D. M., Tlučáková, L., Vanderloo, L. M., Williams, A., Wong, S. H. S., Wu, C., Zembura, P., & Tremblay, M. S. (2022). Global Matrix 4.0 Physical Activity Report Card Grades for Children and Adolescents: Results and Analyses From 57 Countries. *Journal of Physical Activity and Health, 19*(11). https://doi.org/10.1123/jpah.2022-0456

APPENDIX XII: STUDY 2 – ONE PAGE OVERVIEW

Associations Between Swimming & Cycling Abilities And Fitness In 9-11 Year Old Boys And Girls

2258 children from 33 primary schools from across Wales participated in the Swan/BridgeLinx health, fitness and lifestyle programmes between 2013 – 2019. Health & fitness data were collected on: body composition, cardiorespiratory fitness, muscular strength, flexibility, power, and speed. Whether they could ride a bike and swim 25m unaided was also recorded.

Controlling for age, BMI, deprivation, gender & sports club attendance these were the key results:

- If children could swim and cycle every component of fitness was higher than those who couldn't.
- Boys outperformed girls in all components of fitness apart from flexibility.
- Swimming & cycling had a bigger impact on boys cardiorespiratory fitness more so than girls.
- Cycling had a bigger impact on boys strength and power more so than girls.

Practical Implications

Swimming and cycling are important 'milestones' in the journey of motor development and are associated with higher levels of fitness. These activities should be promoted to allow for an optimal development of motor skills, fitness, and health.

Swimming & cycling should be encouraged at a young age to increase fitness and also opportunities to be physically active.

Balance bike initiatives are a great start.

FREE SWIMMING/SCHOOL SWIMMING

Swimming and cycling are important 'milestones' in the journey of motor development and are associated with higher levels of fitness. These activities should be promoted to allow for an optimal development of motor skills, fitness, and health.