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To what extent does self-reported physical activity impact children's wellbeing and mental health? Insights from school-aged children in Wales

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Abstract

There has been emphasis on the wellbeing of school-aged children amongst research, policy and practice in recent years, particularly during key developmental stages such as early childhood and adolescence. This study aimed to identify specific factors of self-reported physical activity that are associated with wellbeing and mental health among school-aged children in Wales. Using data from the Health and Attainment of Pupils in Primary Education in Wales (HAPPEN-Wales) cohort, this study analysed survey responses from 16,731 children aged 7–11 collected between 2016 and 2022. The HAPPEN survey includes self-reported measures of physical activity, physical literacy, sedentary behaviour, wellbeing, mental health, and local community environment. Wellbeing and mental health were assessed using the Good Childhood Index and the Me and My Feelings Questionnaire. Physical literacy was captured through questions on motivation, confidence, competence, and understanding of physical activity benefits. Additional data on environmental factors and socioeconomic status were also considered. Multiple regression and decision tree analyses were used to examine factors associated with overall wellbeing. Key factors associated with good wellbeing included being more physically active (Coef.:0.17 [95%CI: 0.05 to 0.29]), being less sedentary (Coef.: −0.16 [95%CI: −0.28 to −0.05]), feeling confident to take part in lots of physical activity (Coef.: 0.35 [95%CI: 0.16 to 0.55]), feeling good at lots of physical activity (Coef.: 0.30 [95%CI:0.14 to 0.46], having less knowledge around understanding (Coef.: −0.29 [95%CI: −0.57 to −0.07]), feeling safe (Coef.: 0.77 [95%CI: 0.66 to 0.89]), autonomous (Coef.: 0.57 [95%CI: 0.40 to 0.73]) and competent (Coef.: 0.51 [95%CI: 0.35 to 0.67]). The findings highlight the importance of providing opportunities for children to develop their confidence, competency and to feel like they have a choice in their lives. This may be done by providing safe, engaging, and varied physical activity opportunities in schools and communities to support children's overall wellbeing.

ethical use of sensitive data. Researchers who would like to access to this data can request access to the anonymised dataset via the SAIL Databank. SAIL operates a rigorous Information Governance Review Panel (IGRP) process to ensure that all data access requests comply with ethical and legal requirements. Researchers wishing to use the data can apply through SAIL, detailing their proposed study, and can securely analyse the data within the controlled environment of the SAIL Databank. More information on how to apply to use the data can be found here: https://saildatabank.com/data/apply-to-work-with-the-data/ or to contact SAIL directly: https://saildatabank.com/contact/

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Introduction

Wellbeing is defined as "the state of feeling healthy and happy" [1]. It is a multifaceted concept, typically encompassing positive psychological experiences [2], including mental health, happiness and life satisfaction [3], as well as physical and environmental factors [2] such as activity and opportunities. In recent years, there has been a focus in the United Kingdom (UK) policy landscape on the wellbeing of school-aged children [4]. Childhood, adolescence and early adulthood have all been marked as key time points in which wellbeing can be influenced [4,5]. Evidence suggests that play and physical activity could be a key promoter of wellbeing and good mental health in children and young people. This was highlighted during the pandemic where school closures and transmission measures reduced access for children to be able to play and socialise [6,7].

Understanding the relationship between wellbeing, mental health and physical activity, particularly at an early age, could help inform the design of policy and practice aiming to develop and protect opportunities for movement, play, activity, and education for young people. Physical literacy [PL] is thought to lay the foundations of engagement with sport and other physical activities [8]. It is defined as "*the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life*" [9]. PL has a role in developing core skills that not only relate to being physically active but also core characteristics of good wellbeing such as confidence [10]. Higher levels of PL are thought to contribute to sustained engagement with activity [11–14], which may, in turn, support better wellbeing outcomes due to the positive associations of physical and mental health with increased physical activity.

Schools are a key setting in which wellbeing and mental health can be impacted. In 2022, Wales began the rollout of a reformed national curriculum, moving away from "narrow" subject areas and a prescriptive curriculum to broader, more holistic Areas of Learning Experience and school-level curriculum design [15]. For example, schools can make strong connections between the Health and Wellbeing AoLE and the Literacy, Languages and Communication AoLE to address concerns regarding physical activity and diet [16]. Within the CfW it is recommended to provide 120 minutes of PE a week, though this is not statutory [17]. This is the same guidance given across the four nations, however, research in 2018 found that 69% of schools met this [18]. A recent report from Play Wales also noted a decline in self-directed, outdoor play [19]. The Active Healthy Kids [AHK] Report Card states that less than half of schools (45%) in Wales offer an afternoon break [20]. These observations paint a concerning picture for children's opportunities to be active within the school day, this is essential to consider given its proposed relationship with wellbeing, mental health, learning and attainment.

Given the well-reported links between physical activity, wellbeing and mental health, this study sets out to answer the question: *to what extent does self-reported physical activity (including active travel, feeling safe and perceptions of physical literacy) impact wellbeing and mental health in children aged 7–11*? Our hypothesis assumes that physical activity (and its determinants) will have a significant impact on

general wellbeing given existing research. This study uses data from Health and Attainment of Pupils in Primary EducatioN-Wales [HAPPEN-Wales] [21], a pan-Wales primary school cohort established by Swansea University in 2015 to explore the physical, social, emotional and mental health of children aged 7–11.

Materials and methods

HAPPEN-Wales [21] was established in 2014 by researchers at Swansea University and informed by research with head teachers from local primary schools [22,23]. It was co-produced to provide a more collaborative and cohesive approach to health and wellbeing in schools, bringing together schools, partners in health and research to make more targeted health and wellbeing plans based on individual school needs as voiced by their pupils [22,24]. HAPPEN has worked closely with school staff and pupils to develop the HAPPEN Survey; a self-report survey which is completed by primary school-aged children [aged 8–11, with expansion later to 7 years old] in education settings. The HAPPEN Survey captures a range of self-reported health behaviours including physical activity and sedentary behaviour, physical literacy, diet and dental health, wellbeing and mental health and the local community indicators. Schools receive an individual report of pupils' group-level health and wellbeing data compared to national averages enabling tailored curriculum design for their Curriculum for Wales (CfW) and the health and wellbeing Area of Learning Experience (AoLE).

Since September 2014, over 600 schools have been invited to share details of the survey [including study aims and a parent information sheet] with parents/guardians so that parents can opt their child out of the survey [21]. This opt-out method of recruiting participants was introduced in 2019 following the national roll-out in 2018, prior to this stage the network has been conducting more local and regional work in and around Swansea. This is informed via parent information sheets which are sent out prior to survey completion. All pupils in years 4, 5 and 6 can take part in the survey which is available in English and Welsh since September 2014 and is ongoing. The survey was co-developed alongside teachers, pupils, public health, and local authority teams. HAPPEN now includes a cohort of over 40,000 pupils across Wales. This aimed to ensure that a representative sample was recruited to reflect all children in Wales. The survey can be seen as supplementary file 1.

Ethics statement

This study was conducted with approval from Swansea University's Medical School Ethics Board. HAPPEN has had approval from the board since the project's inception in 2014 and ethical approval existed and was in place for the data collection period studied in this paper (Ref: 2017–0033) which runs from September 2017 to June 2023. HAPPEN continues to have ethical approval from Swansea University's Medical School Ethics Board (Ref: 7933) for ongoing research. Prior to 2019, parents and children provided written consent via consent forms. In 2019, this was amended to opt-out consent to overcome bias in the cohort. Parents can opt their child out of completing the survey by filling in the opt-out form which is received by the HAPPEN research team, the school is then notified and a record of this written opt-out is kept for records. Written consent from children is obtained at the start of the survey. This is informed via children's information sheets (which have been informed by teachers, parents and children) which are sent out prior to survey completion and are at the beginning of the survey. Prior to starting the survey, children must consent to having their data used for research purposes. If a child does not consent but chooses to complete the survey, their record is removed. This process has the approval of Swansea University's Medical School Ethics Board.

Data collection

The study uses data from 12th September 2017–23rd June 2023. This time frame encapsulates the national roll-out and six full academic years to provide a representative sample over a period.

This study aimed to ascertain the extent to which self-reported physical activity impacts wellbeing and mental health. The general wellbeing of children was measured by the validated Good Childhood Index [GCI] [25,26]. The Children's

Society note that it is a statistically robust measure of the main aspects of children's lives [26]. Questions ask children to score their happiness with their a) friends, b) family, c) school, d) health, and e) life out of 10 (low happiness = 1). For each component of the GCI, scores >=8 were assigned a 1 and <=7 a 0. To answer our question, we equated a total wellbeing score from this and a cumulative number was assigned based off the 5 GCI scores [highest score = 5].

Mental health was measured by the Me and My Feelings Questionnaire [MMF] [27,28]. The validated MMF measure [28] captures emotional and behavioural mental health difficulties. This measure has been embedded into the HAPPEN Survey and is recognised as valid and reliable in this age group. In this study, both domains were utilised to assess mental health. Responses to the 16-item MMF are scored as 0, 1, or 2, corresponding to 'Never', 'Sometimes', and 'Always' respectively. These scores are then aggregated to derive an overall score. For the Emotional Difficulties Subscale, scores of 10 and 11 indicate borderline difficulties, and scores of 12 and above indicate clinically significant difficulties; for the Behavioural Difficulties Subscale, scores of 6 indicate borderline difficulties, and scores of 7 and above indicate clinically significant difficulties. These thresholds have been defined by Deighton et al. (2013) [27] and are valid and reliable in identifying clinically significant difficulties. Further to this, a binary outcome was established where a score of 1 represents clinical scores and 0 represents scores below the aforementioned thresholds.

Physical activity and environmental survey items were included in the analysis. This included the ability to ride a bike without stabilisers [yes or no], the ability to swim 25 metres without armbands [yes or no], use an active travel method to and from school [yes or no], physical activity (getting out of breath) for 60 minutes every day in the previous week [yes or no], two hours of sedentary time every day in the previous week [yes or no], safety of local area [high or low], ability to make your own decisions [yes or no] and feeling confident you are doing well [yes or no]. Deprivation scores of the child's home were obtained from the Welsh Index of Multiple Deprivation (WIMD) [29]. WIMD is based on numerous indicators such as income, access to services, safety, housing, and education. Quintiles were used in analysis with 1 equating to the most deprived area and 5 to the least deprived. Self-reported physical literacy data was collected in HAPPEN via 4 questions with a Likert response [strongly agree, agree, disagree, strongly disagree]. These questions capture key constructs of motivation, confidence, competence and knowledge; *a] I want to take part in physical activity, b] I feel confident to take part in lots of different physical activities, c] I am good at lots of different physical activities, and d] I understand why taking part in physical activity is good for me.* For this study, a cumulative score for physical literacy was obtained by assigning a binary outcome of 1 to responses of agree and strongly agree and a 0 to responses of disagree and strongly disagree. The cumulative number of 1 response was combined to generate a PL score [highest score = 4]. The HAPPEN Survey itself has been tested for validity and internal consistency and is a reliable measure of general health and wellbeing outcomes in children aged 7–11 [30].

Analysis

Prior to beginning analysis, all data was anonymised, cleaned and coded by MJ. Data was accessed from 04/09/2023 for analysis. A linear regression model was used to explore the relationship between physical activity and components of physical activity (including environmental) on general wellbeing in the first instance. activity (including environmental) on general wellbeing in the first instance. All variables were treated according to their type (i.e., continuous, ordinal, or categorical) and indicator variables (e.g., 0,1) were used when necessary for categorical and ordinal variables. The research team then used logistical models to explore the relationship between physical activity and mental health. Once both models were produced, variables were removed in a stepwise manner, removing potential explanatory variables in order and testing for significance after each step. As well as this, a decision tree analysis was also conducted. This dual approach aimed to provide a comprehensive understanding of how physical activity impacts wellbeing.

Analysis was undertaken by three researchers between September 2023 and June 2024. AM devised the analysis plan and initially completed this in R. Researchers MSB and MJ replicated the analysis in SPSS. This was to ensure the reproducibility, reliability, and validity of the findings. A breakdown of variables used in the analysis can be seen as supplementary file 2.

Results

This study included a total of 16,731 participants, divided almost equally between boys (46.5%) and girls (49.2%), with a small percentage (4.2%) not specifying their gender. Participant characteristics are provided in Table 1. A significant proportion of the study population was from the most deprived quintiles, with 33.2% of boys and 34.1% of girls in the most deprived category, and a smaller representation from the least deprived quintiles. Most participants reported high overall wellbeing (the cumulative score of the GCI), with 49.6% of boys and 50.4% of girls in the high category. They also mostly reported good mental health with low numbers emotional and behavioural difficulties reported. Although girls reported higher emotional and boys reported higher behavioural.

Relationship between self-reported physical activity and overall wellbeing

The linear regression model (Table 2) indicated there are a number of predictors of good general wellbeing. Specifically, this included being more physically active (Coef.: 0.17 [95%CI: 0.05 to 0.29]), being less sedentary (Coef.: −0.16 [95%CI: −0.28 to −0.05]), feeling confident to take part in lots of physical activity (Coef.: 0.35 [95%CI: 0.16 to 0.55]), feeling good at lots of physical activity (Coef.: 0.30 [95%CI: 0.14 to 0.46], having less knowledge around why physical activity is good for you (Coef.: −0.29 [95%CI: −0.57 to −0.07]), feeling safe in your area (Coef.: 0.77 [95%CI: 0.66 to 0.89]), autonomous (Coef.: 0.57 [95%CI:0.40 to 0.73]) and competent (Coef.: 0.51 [95%CI: 0.35 to 0.67]).

Interestingly, gender and deprivation had no significant role to play in predicting general wellbeing for this age group. When removed in a stepwise manner, the most significant predictors were being less sedentary, feeling confident, feeling good, swimming (not being able to swim 25 m), feeling safe, feeling autonomous and feeling competent. Thus, suggesting that positive intrinsic feelings around being active are more important than specific indicators of physical activity participation.

Relationship between self-reported physical activity and mental health

Table 3 shows key predictors of lower emotional wellbeing (indicated by presenting clinical levels of emotional difficulties based on the cut-offs provided by the Me and My Feeling Questionnaire) included being more sedentary (Coef: 0.35 [95%CI: 0.09 to 0.61]), feeling less confident (Coef:. −0.60 [95%CI: −0.99 to −0.20]), feeling less safe in your area (Coef.: −0.99 [95%CI: −1.25 to −0.73), feeling less competent (Coef.: −0.58 [95%CI: −0.92 to −0.25]) and being a girl (Coef.: 0.49 [95%CI: 0.24 to 0.74]).

The stepwise removal of variables showed that confidence, safety, competence and gender are significant predictors of emotional difficulties and therefore, poorer mental health in this age group. These findings show that intrinsic motivators are of more value than specific indicators of physical activity participation and levels.

A similar picture is observed with behavioural difficulties (Table 4) with being more sedentary (Coef.: 0.31 [95%CI: 0.15 to 0.47]), feeling less safe (Coef.: −0.44 [95%CI: −0.60 to −0.27]), feeling less autonomous (−0.26 [95%CI: −0.47 to −0.05]), feeling less competent (Coef.: −0.31 [95%CI: −0.53 to −0.09]) also showing trends toward poorer mental health outcomes. Interestingly, for this measure of being more confident (Coef.: 0.31 [95%CI: 0.15 to 0.47]) was associated with less behavioural problems and being a boy (Coef.: −0.45 [95%CI: −0.62 to −0.28]) was associated with more behavioural problems. This was the first model in which deprivation was significant, lower deprivation was associated with a lower trend of having a behavioural difficulty (Coef:. −0.12 (95%CI: −0.19 to −0.05]).

Stepwise removal showed that higher sedentary time, less autonomy and gender (being a boy) were key predictors for high behavioural difficulties. This is the first wellbeing/mental health indicator in which physical activity participation is not associated with the outcome (e.g., PA does not improve or worsen behavioural difficulties).

Decision tree analysis

The decision tree analysis in Fig 1 investigates the clustering of factors predicting overall wellbeing among school children. The most important predictor of wellbeing is a sense of competence. Then among those who feel competent,

Table 1. Characteristics of participants (n = 16,731).

		Gender					
		Boy		Girl		Prefer Not To Say	
		#	%	#	%	#	%
Gender	Boy	7791	.	.	.	.	.
	Girl	.	.	8234	.	.	.
	PNTS	.	.	.	.	706	.
Deprivation (WIMD Quintile)	1 (Most)	2587	33.2%	2804	34.1%	277	39.2%
	2	2842	36.5%	3039	36.9%	296	41.9%
	3	1583	20.3%	1628	19.8%	116	16.4%
	4	295	3.8%	278	3.4%	9	1.3%
	5 (Least)	484	6.2%	485	5.9%	8	1.1%
Year Group	4	2189	28.2%	2266	27.6%	215	30.9%
	5	2672	34.4%	2858	34.8%	233	33.5%
	6	2911	37.5%	3081	37.6%	248	35.6%
Overall Wellbeing Score	0 (Low)	109	1.4%	177	2.1%	48	6.8%
	1	289	3.7%	371	4.5%	63	8.9%
	2	594	7.6%	667	8.1%	100	14.2%
	3	1055	13.5%	1037	12.6%	138	19.5%
	4	1879	24.1%	1831	22.2%	159	22.5%
	5	3865	49.6%	4151	50.4%	198	28.0%
Emotional Difficulties (Mental Health)	No	3308	85.7%	3573	81.5%	306	77.9%
	Yes	550	14.3%	811	18.5%	87	22.1%
Behavioural Difficulties (Mental Health)	No	3205	87.6%	3109	91.7%	263	87.1%
	Yes	453	12.4%	280	8.3%	39	12.9%
Been Active For Over 1 Hour Every Day Over A Week	No	13639	76.4%	15329	82.5%	1014	78.1%
	Yes	4211	23.6%	3250	17.5%	284	21.9%
Been Sedentary For Over 2 Hours Every Day Over A Week	No	10038	56.7%	11521	62.5%	669	52.4%
	Yes	7675	43.3%	6927	37.5%	607	47.6%
Want To Take Part In Lots of Physical Activities (PL)	No	1375	8.8%	1357	8.4%	190	14.9%
	Yes	14167	91.2%	14844	91.6%	1086	85.1%
Feel Confident To Take Part In Lots of Physical Activities (PL)	No	1985	12.9%	2254	14%	331	26.1%
	Yes	13399	87.1%	13832	86%	936	73.9%
I Am Good At Lots of Physical Activities (PL)	No	2438	15.9%	2826	17.6%	328	26%
	Yes	12906	84.1%	13213	82.4%	933	74%
I Understand Why Taking Part In Physical Activity Is Good For Me (PL)	No	1046	6.8%	778	4.9%	127	10.1%
	Yes	14275	93.2%	15263	95.1%	1132	89.9%
Ability To Swim 25m	No	2159	27.9%	2161	26.4%	219	31.2%
	Yes	5582	72.1%	6036	73.6%	484	68.8%
Ability To Ride A Bike	No	1011	13.1%	1057	12.9%	107	15.5%
	Yes	6702	86.9%	7122	87.1%	585	84.5%
Active Travel To School	No	4575	59.4%	5127	62.7%	439	62.5%
	Yes	3131	40.6%	3053	37.3%	263	37.5%
Active Travel From School	No	4334	56.7%	4783	59.1%	424	61.6%
	Yes	3305	43.3%	3312	40.9%	264	38.4%
Safe In Area	No	2103	27.4%	2343	28.9%	313	45.3%
	Yes	5578	72.6%	5766	71.1%	378	54.7%

(Continued)

Table 1. (Continued)

		Gender					
		Boy		Girl		Prefer Not To Say	
		#	%	#	%	#	%
Feel Autonomous	No	1097	14.2%	1089	13.3%	175	24.9%
	Yes	6638	85.8%	7098	86.7%	526	75.1%
Feel Competent	No	919	11.9%	1266	15.5%	177	25.3%
	Yes	6800	88.1%	6899	84.5%	522	74.7%

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Table 2. Activity based predictors of general wellbeing.

	Coef.	Std. Err.	Sig.	95% Conf. Interval	
Been Active For Over 1 Hour Every Day Over A Week*	**.17**	**.060**	**.003**	**.05**	**.29**
Been Sedentary For Over 2 Hours Every Day Over A Week*	**−.16**	**.057**	**.003**	**−.28**	**−.05**
Want To Take Part In Lots of Physical Activities (PL)	.15	.12	0.21	−.08	.39
Feel Confident To Take Part In Lots of Physical Activities (PL)*	**.35**	**.09**	**<.001**	**.16**	**.55**
I Am Good At Lots of Physical Activities (PL)*	**.30**	**.99**	**<.001**	**.14**	**.46**
I Understand Why Taking Part In Physical Activity Is Good For Me (PL)*	**−.29**	**.14**	**0.04**	**−.57**	**−.007**
Ability To Ride A Bike	−.01	.08	.86	−.18	.15
Ability To Swim 25m	−.13	.08	.86	−.18	.15
Active Travel To School	−.07	.07	.029	−.21	.06
Active Travel From School	−.07	.07	0.29	−.21	.06
Safe In Area*	**.77**	**.05**	**<.001**	**.66**	**.89**
Feel Autonomous*	**.57**	**.05**	**<.001**	**.66**	**.89**
Feel Competent*	**.51**	**.08**	**<.001**	**.35**	**.67**
Gender					
Girl	.02	.05	.63	−.07	.12
Prefer Not To Say	−.50	.46	.27	−1.41	.40
Deprivation	.02	.01	.09	−.004	.060

*denotes significance.

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autonomy is the next most important variable followed by participation in physical activities, particularly for those who also feel autonomous. However, low emotional wellbeing is an important negative factor that impacts overall wellbeing, especially for those who do not feel competent or autonomous. For those lacking competence or autonomy then confidence in physical activities can improve wellbeing.

Discussion

This study explores the key physical activity predictors of wellbeing and mental health in school-aged children in Wales using HAPPEN-Wales. It is well-documented that regular physical activity enhances mood, reduces anxiety and depression and improves wellbeing [3]. However, it remains unclear which attributed characteristics (i.e., active travel, riding a bike, feeling safe, perceptions of physical literacy) have a significant impact on general wellbeing. While previous research

Table 3. Self-reported physical activity-based predictors of emotional difficulties.

	Coef.	Std. Err.	Sig.	95% Conf. Interval	
Emotional Difficulties					
Been Active For Over 1 Hour Every Day Over A Week	−.02	.15	.90	−.32	.28
Been Sedentary For Over 2 Hours Every Day Over A Week*	**.35**	**.13**	**.009**	**.09**	**.61**
Want To Take Part In Lots of Physical Activities (PL)	.09	.26	.72	−.42	.60
Feel Confident To Take Part In Lots of Physical Activities (PL)*	**−.60**	**.20**	**.003**	**.99**	**−.20**
I Am Good At Lots of Physical Activities (PL)	−.35	.17	.04	−.69	−.01
I Understand Why Taking Part In Physical Activity Is Good For Me (PL)	−.37	.30	.21	−.97	.21
Ability To Ride A Bike	−25	.19	.18	−.63	.12
Ability To Swim 25m	.04	.16	.78	−.27	.36
Active Travel To School	.01	.17	.92	−.33	.36
Active Travel From School	−.10	.17	.54	−.45	.23
Safe In Area*	**−.99**	**.13**	**<.001**	**−1.25**	**−.73**
Feel Autonomous	−.30	.17	.08	−.65	.04
Feel Competent*	**−.58**	**.17**	**<.001**	**−.92**	**−.25**
Gender					
Girl*	**.49**	**.12**	**<.001**	**.24**	**.74**
Prefer Not To Say	.37	1.15	.74	−1.88	2.63
Deprivation	−.02	.04	.56	−.10	.05

* denotes significance.

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Table 4. Activity based predictors of behavioural difficulties.

	Coef.	Std. Err.	Sig.	95% Conf. Interval	
Behavioural Difficulties					
Been Active For Over 1 Hour Every Day Over A Week*	.07	.10	.45	−.12	.27
Been Sedentary For Over 2 Hours Every Day Over A Week*	**.31**	**.08**	**<.001**	**.15**	**.47**
Want To Take Part In Lots of Physical Activities (PL)	−.08	.15	.59	−.38	.22
Feel Confident To Take Part In Lots of Physical Activities (PL)*	**.03**	**.13**	**.77**	**−.22**	**.29**
I Am Good At Lots of Physical Activities (PL)	−.002	.11	.98	−.23	.22
I Understand Why Taking Part In Physical Activity Is Good For Me (PL)	−.15	.16	.37	−.48	.17
Ability To Ride A Bike	.06	.12	.59	−.17	.30
Ability To Swim 25m	.04	.09	.63	−.14	.23
Active Travel To School	.13	.12	.11	−.04	.43
Active Travel From School	−.24	.12	.04	−.47	−.27
Safe In Area*	**−.44**	**.08**	**<.001**	**−.60**	**−.27**
Feel Autonomous*	**−.26**	**.10**	**.01**	**−.47**	**−.05**
Feel Competent*	**−.31**	**.11**	**.005**	**−.53**	**−.09**
Gender					
Girl*	**−.45**	**.08**	**<.001**	**−.62**	**−.28**
Prefer Not To Say	−.25	.19	.19	−.64	.12
Deprivation*	**−12**	**.03**	**<.001**	**−.19**	**−.05**

* denotes significance.

https://doi.org/10.1371/journal.pone.0313970.t004

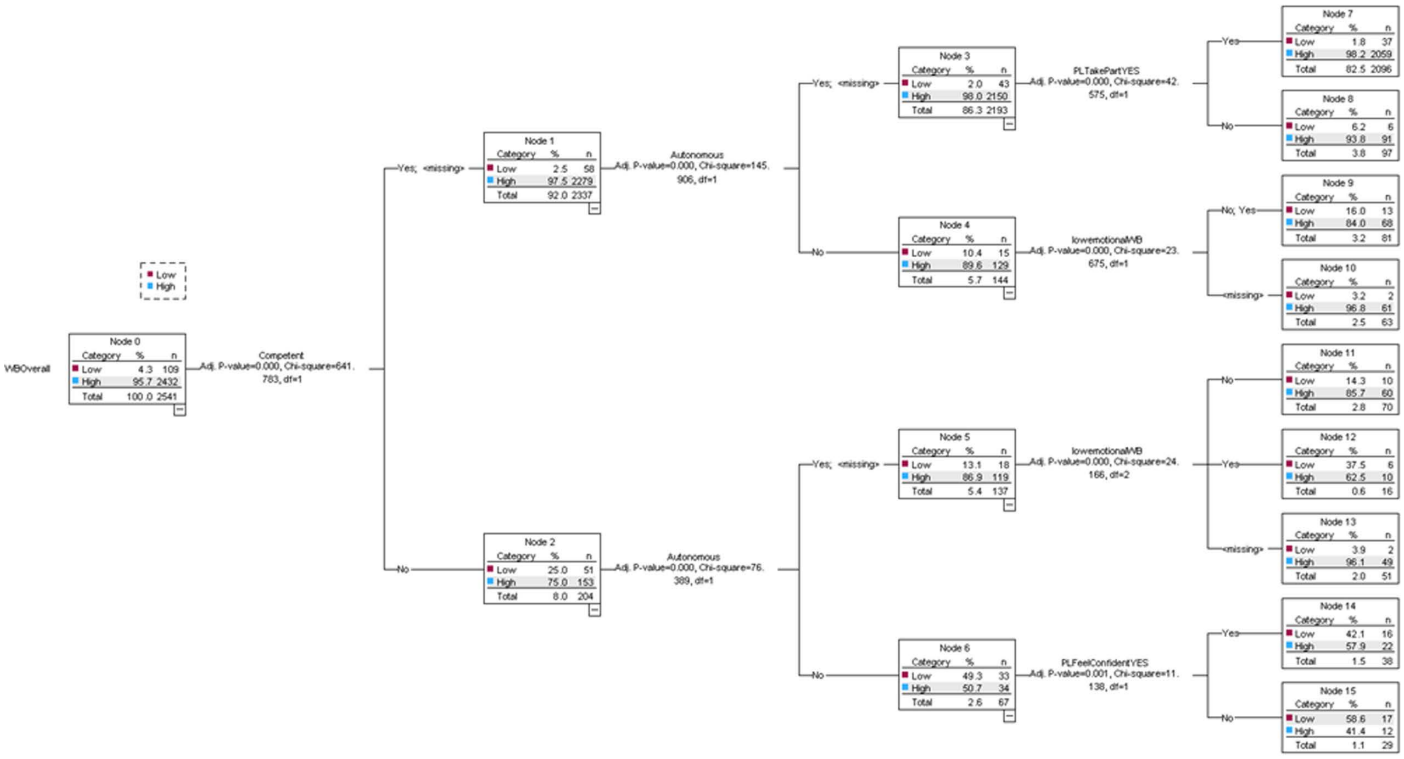

Fig 1. Decision Tree Analysis. Investigating the clustering of factors predicting overall wellbeing.

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has identified several correlations of wellbeing in children, this study contributes by emphasising the interplay between confidence, autonomy, and safety as key motivators for physical activity participation which in turn will improve general wellbeing.

Overall, analysis revealed that key predictors of good wellbeing and mental health are low sedentary time, high confidence, high autonomy, high safety and male gender. This is a key finding as it could help inform tailored interventions for young people to help reduce inequalities in wellbeing. Interestingly, this study highlights that intrinsic feelings around activity participation which are integral and that opportunities which protect and enhance confidence, autonomy and safety for girls and boys from a variety of backgrounds could be the solution to improve physical activity and, in turn, creating healthier and happier children and young people. These findings align with existing research findings on the predictors of wellbeing and mental health in young people; however, they emphasise the relationship between confidence, autonomy, and perceived safety as key factors influencing participation. This highlights the need for tailored interventions that not only promote activity but also create environments that foster these determinants, particularly for girls, who may experience greater barriers to engagement.

Overall wellbeing

The most significant indicators of good wellbeing were being less sedentary, feeling confident, feeling good, not being able to swim 25m, feeling safe, feeling autonomous and feeling competent. While self-reported physical activity time was positively associated with wellbeing, there were also a variety of intrinsic factors at play, showing that increasing the time to be active alone is not necessarily the solution needed. Our study strengthens this argument by providing empirical evidence that confidence, competence, and autonomy are strong predictors of wellbeing, these are key to nurture in children, giving

them opportunities to discover and develop these predictors, for example, providing children with more choices over activity provision in the school setting.

While regular physical activity in childhood is more likely to lead to move physically active adolescents and adults [31], it is important that children and young people are provided with a variety of opportunities to be active in every setting (school, home, after school), this study shows that these opportunities should improve a child's confidence. It is noteworthy that not being able to swim was associated with high wellbeing, advocating for less adult-led forms of activity provision. For example, research shows that walking can be an important activity [32,33], therefore employing ways in which this could be promoted would be significant. Evidence also reports positive impacts on children's PA levels, social engagement and emotional wellbeing from unstructured play. This is play which is self-directed with children doing what they wish, in their own way, in their own time [34].

Children and young people have consistently asked for more active opportunities. In schools, children have asked for more time, space and permission to be active and play [33,35] advocating for more opportunities to have less formal learning and more time to engage in play in a variety of ways with their friends. This trend has been observed throughout the years but has been highlighted by the pandemic where opportunities to play were limited. In comparison to interventions such as the Daily Mile [36], outdoor play can also ensure that more opportunities for PA are introduced into the school day and beyond.

The intrinsic benefits of child-led play and physical activity opportunities cannot be overlooked. It is these characteristics of confidence, competence and autonomy which have shown to be integral to good wellbeing. Previous research highlights that competence and confidence in physical activity contribute to lifelong engagement in PA. Our findings build on this by demonstrating how these factors interact with broader wellbeing determinants such as safety and autonomy. An underlying motivation for being active is the belief in being able to participate, reinforcing that fostering a sense of capability is crucial for long-term wellbeing benefits. This study demonstrated that wanting to take part in the activity, feeling confident to take part, feeling good at lots of activities, having autonomy and feeling competent to take part were key influences. Confidence and competence are also key components of PL [9] which can have a significant impact on wellbeing by providing the foundations for increased participation in physical activity. Research from Melby et al. (2022) [37] highlights that helping children develop PL is more beneficial for wellbeing than just trying to improve levels of PA in isolation, shifting the focus away from the intensity of activities to the quality and enjoyment of encouraging children to move. This study shows that this approach would help children who want to take part, feel confident to take part, feel competent to take part, feel good and have autonomy over their activity if the focus was on fun rather than time and effort.

This is important to note, particularly in Wales, where greater autonomy has been placed on schools within the CfW to influence health and wellbeing through school-level curriculum design [11], therefore providing opportunities to implement this ethos into the day-to-day of school-aged children. Guidance within the new curriculum regarding PA is broad and as a result, there are concerns regarding children and young people's opportunities to play and be active.

Autonomy allows individuals to feel that they can make their own choices. Choice has often been cited as an opportunity to improve physical activity for this age group, with prescriptive forms often seen as barriers due to their constraints on rules, times and resources. This study highlights that it is crucial to continue promoting a wider range of activities available for all children to support their wellbeing. It is important to note the key influences and ways in which we can continue to promote a wider choice of activity provision for this group. Thus, pupils and educational professionals should be involved in the design of such interventions based upon the wants and needs of children, factoring in structured and unstructured PA (play) and the creation of safe spaces.

Feeling safe in an area was the strongest positive predictor of overall wellbeing. This underpins the critical role that safe opportunities play in enhancing wellbeing. This reinforces previous research indicating that perceived safety is a fundamental determinant of children's ability to engage in PA. Safety has been highlighted by several studies as influential in supporting physical activity and wellbeing in general [3,32,33]. Our study extends this understanding by showing that

safety is not just a correlation of PA but a direct predictor of overall wellbeing, highlighting the need for interventions that improve perceptions of safety in local environments. Community characteristics such as crime rates, traffic and littering can all increase safety concerns. Parental influence and socio-economic status are also influential in safety perceptions, with more deprived children at risk of lower community safety (objectively or subjectively) and ultimately, reduced health and wellbeing [3,38,39]. While it is harder to externally control safety, it is worth noting that children who fall into this category are more likely to have lower wellbeing as demonstrated by this study's findings.

Mental health

Confidence, safety, competence and gender are significant predictors of emotional difficulties and higher sedentary time, less autonomy and gender (being a boy) were key predictors for high behavioural difficulties. These findings support research showing that PA can act as a protective factor for mental health, however, this study goes further by demonstrating that confidence and competence mediate this relationship, emphasising the mechanisms underlying PA's impact on wellbeing. The increased accessibility and use of screens has been shown to negatively impact wellbeing by contributing to higher levels of sedentary behaviour [40,41], therefore any provision that mitigates this is important. In schools, interventions such as the Daily Mile have been implemented as a social physical activity initiative that encourages children and young people to walk or run outdoors with their friends for 15 minutes each day [42]. However, whilst evidence suggests the benefits to children's PA levels, challenges include interventions like The Daily Mile replacing existing PA opportunities such as PE lessons or afternoon break times [43]. They also show evidence of improving PA but no evidence of the impact on wellbeing or longer-term follow-up impacts [43]. Shifting the focus away from the intensity of activities to the quality and enjoyment of encouraging children to move [37] could be a significant progression step in helping children be healthier and happier as demonstrated by the key predictors observed in this study.

Gender showed negative associations with mental health, indicating that girls (and individuals from more deprived areas) experience higher emotional difficulties and boys experiencing higher behavioural difficulties. This aligns with previous research on gender disparities in PA participation and mental health suggesting that interventions targeting these factors could help bridge the gender gap in PA engagement. These disparities may be due to a variety of factors, including different access, gender-specific expectations, resources and opportunities for PA. With girls significantly more likely to drop out of activity in their early teens, it is important that we uphold positive associations with PA and PL from an early age. Listening to what they want and need from PA opportunities could go some way to preventing this. This is also important to consider when tailoring interventions.

The decision tree analysis further cemented the factors influencing overall wellbeing. Our findings showed that feeling competent and safe significantly reduced emotional difficulties. Similarly, these factors, along with autonomy, correlated with lower behavioural difficulties. This contributes novel evidence to existing literature by quantitatively demonstrating the protective role of competence, safety, and autonomy in young people's mental health outcomes. These findings highlight the protective role of feeling capable, safe and autonomous for young people. These are important characteristics as capability and autonomy can be underpinned by PL and PA respectively. This underpins the need for co-designed interventions that enhance these intrinsic motivators, ensuring long-term benefits for both PA engagement and mental health.

Limitations

While we acknowledge that the use of a brief four-item measure of PL might be a limitation, in light of more complex measures available, this assessment was designed to capture key components of the construct concisely, allowing large-scale assessment with minimum burden. We also acknowledge that our analysis did not account for the nested nature of the data, as school-level identifiers were removed to comply with cross-team data-sharing policies and ensure anonymity. In future research, incorporating school-level effects would provide a more nuanced understanding of potential clustering

influences. This study and its findings are built on a cohort of Welsh school-aged children from 2015 to 2022. Therefore, it may not be appropriate to generalise findings, particularly those that relate to the Welsh context including specific legislation and the Curriculum for Wales. Furthermore, the sample is based on schools who chose to actively engage with HAPPEN. However, lessons can be learned from these policies. Future research should also explore a broader range of predictors and consider longitudinal studies to assess the long-term impact of interventions targeting PL and PA on overall wellbeing. The findings are cross sectional surveys and so it is not possible to give causal inference that being active leads to better wellbeing just that children who self-report lower sedentary levels report better wellbeing.

Conclusions

Childhood is a pivotal timepoint in which wellbeing can be influenced [4,5] and therefore, has important policy and practice implications. The key message is that improving time and amount of physical activity on its own is not enough for wellbeing and mental health benefits alone, belief in being able to participate and opportunities to do PA can enhance wellbeing by addressing confidence, competence and autonomy. These can also be tailored for specific demographic groups, particularly girls and those from deprived areas to help reduce inequalities. Higher wellbeing equates to better learning outcomes which is likely to impact academic attainment [4], therefore it serves school settings to provide for and listen to children and young people.

Given the findings of this study, there are key considerations which could be made to improve the wellbeing and mental health of young people:

1. Involve pupils, teachers and other key stakeholders in co-designing PA/PL interventions. This ensures that they are relevant and meet the needs of the children. This will go some way to giving young people autonomy over their activity and needs.
2. Provide a variety of PA opportunities within schools, such as PE lessons, break-time activities, and extracurricular clubs. This should include structured and unstructured play to cater to different interests and promote overall wellbeing.
3. Work with local authorities to improve community safety by addressing crime rates, traffic, and littering, which can significantly impact children's sense of safety and, subsequently, their wellbeing and mental health.

Helping children to have the confidence to feel that they are good at an activity, feeling safe and having autonomy is good for wellbeing. It is worth noting that play and physical activity can help with giving a sense of confidence and competence, but it might not be the only solution. Future work should look to explore other activities such as creative outlets.

Supporting information

S1 File. The HAPPEN survey 2023–2024. This is a copy of the HAPPEN Survey from 2023–2024.
(PDF)

S2 File. Variables used in analysis. Outlining the variables that were used in the analysis of this study.
(PDF)

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