Research paper

Risk of suicide following school persistent absence and exclusion: an electronic cohort study in Wales, UK 2012–2019

Margaret Ifeoma Diogu, Sze Chim Lee, Marcos Del Pozo-Banos, Olivier Y. Rouquette, Ann John [*]

Population Data Science, Swansea University Medical School, Singleton Park, Swansea SA2 8PP, UK

ABSTRACT

Background: Evidence of the negative impact of school absence and exclusion on children and young people's life trajectories has been growing but relevant population-based studies including suicide adjusted for history of mental health conditions are scarce. We aimed to examine the associations between suicide and school absence and exclusion.
Methods: We linked routinely collected electronic education and health data for pupils in Wales, UK during 2012/13-2018/19 school years. We identified pupils who were persistently absent or excluded from school and followed them up to identify suicide deaths to 31/12/2021. Firth logistic regression was used to evaluate adjusted odd ratios (aORs) of suicide mortality.
Results: Respectively, 8.6 % and 4.3 % of pupils (*N* = 584,394) had records of persistent absence and exclusion from school. 123 pupils died by suicide in the cohort (21.0 per 100,000 persons). Adjusted odds ratios for suicide were 2.3 (95 % CI: 1.5–3.7) following exclusion but non-significant for persistent absence (1.0; 95 % CI: 0.6–1.7). Other indicators for suicide were male sex, age $\geq$ 10 years, history of self-harm, high levels mental health comorbidity, autistic spectrum disorders and drug use.
Limitations: Relatively low numbers of suicide deaths reduced statistical power. There was no stratification of absence and exclusions into categories based on their nature or causes.
Conclusions: Long-term strategies to support those excluded from school, addressing their social, emotional and medical, needs should be implemented given their heightened risk of future suicide. Attendance data, routinely collected by schools, has potential to be developed as an indicator of unmet need.

1. Introduction

Suicide is the fourth most common cause of death for children and young people (CYP) aged between 15 and19 years old globally and is an important public health concern (World Health Organization, 2021). Rates of suicide for the CYP aged 15–19 and 20–24 increased respectively from 4.0 to 6.4 and from 8.6 to 11.0 per 100,000 UK population from 2011 to 2021 (Office for National Statistics, 2022). Previous self-harm is one of the strongest risk factors for suicide, but several socio-demographic, bio-psycho-social, and environmental risk factors have

also been identified (Hawton et al., 2012; Marchant et al., 2017). They include male sex, low socioeconomic status, pre-existing mental health issues particularly depression, substance misuse, impulsivity, genetic factors (Docherty et al., 2020; Mullins et al., 2022), exposure to suicidal behaviours, childhood adversity (Hawton and van Heeringen, 2009; Turecki and Brent, 2016), and availability/access to the means of suicide (Hawton, 2007).

School is a crucial environment for the social and emotional development of CYP and can foster connection in a community outside of their families (Kidger et al., 2012). Poor school attendance not only

---

disrupts learning but also hampers this development. It may result in loneliness, social isolation and a lack of belongingness, and the consequences are long-term (Samaritans Cymru, 2019; Shaw et al., 2021). School absence (absence from school for any reason, authorised or unauthorised, such as sickness, refusal, truancy) and exclusion (absence from school due to a decision made by the school) are the two categories of attendance problems experienced by school-age pupils (Epstein et al., 2018; Heyne et al., 2019; John et al., 2022). Reasons underlying school absence/exclusion are multifaceted ranging from physical health issues to personal or parental mental health issues, bullying, abuse and behaviours (Epstein et al., 2020; Ford et al., 2018; Paget et al., 2018). A recent study linking school attendance and clinical data for the Wales population demonstrated that pupils (aged 7–16 years) who had neurodevelopmental disorders, mental health conditions or who self-harmed before the age of 24 were more likely to be absent or excluded from school. There was a strong association between poor attendance and self-harm (John et al., 2022). Similarly, a recent systematic review and meta-analysis showed that risks of suicidal ideation and self-harm was increased by 1.2 and 1.4 respectively in pupils who were absent from school (Epstein et al., 2020).

Accumulating evidence suggests that pupils who experience persistent absence or exclusion have poor connectedness, experiences, and negative attitudes towards school (Epstein et al., 2018). Their future trajectories in life are affected with absence/exclusion associated with poor educational attainment (Department for Education, 2016; Smerillo et al., 2018), unemployment, poverty, violence, injury, substance misuse and several mental health problems in adulthood (Egger et al., 2003; Epstein et al., 2018; Kearney, 2008).

An association between absence and exclusion and suicide has been demonstrated in the literature but studies are small, focused solely on males and do not adjust for mental health conditions. A 30-year follow-up study of males in a 1953 Swedish birth cohort showed risk of suicide was increased for males absent from school for reasons other than illness and participants reported feelings of loneliness and social isolation which were seen as indicators of poor school integration (Rojas and Stenberg, 2010). An England and Wales study reported the crude suicide rate of a small sample of male pupils who had been excluded from school ($N = 215$) was >17 times higher than children of the same age not excluded (Pritchard and King, 2000). A more recent thematic review of 34 CYP (10–17 years) in Wales who died by suicide between 2013 and 2017 highlighted poor attendance and/or exclusion in over a third of those included (John et al., 2019).

In order to address the lack of current quantitative population level evidence on suicide following school absence/exclusion, we aimed to examine this risk for pupils in Wales during the 2012/13–2018/19 school years. We linked population-based routinely collected data on education, socio-demographics, primary and secondary healthcare, and death registration to extract school attendance and exclusions, clinical diagnoses, and mortality statistics at a person level. We hypothesised that school absence and exclusion are associated with elevated risks of suicide after adjusting for covariates. We also explored exposure-response relationship for suicide and absence/exclusion.

2. Methods

2.1. Ethical approval

Ethical approval was granted from the Secure Anonymised Information Linkage (SAIL) (www.saildatabank.com) Information Governance Review Panel, an independent body consisting of a range of government, regulatory, and professional agencies (approval number 0667).

2.2. Study design, participants and settings

This study was a population-based, retrospective, electronic cohort study. We extracted data from the population of about 3.2 million in Wales, UK. We included pupils enrolled in state-funded schools during the 2012/13–2018/19 school years (between 1st September 2012, and 31st August 2019) aged 4–16 years (16 years being the school leaving age in the UK) from the Education Wales dataset (EDUW) who had primary and secondary care linked data. We included pupils with no conflicting data in the EDUW that pointed to a many-to-one correspondence between the anonymised linkage field and the internal pupil identification number (Fig. 1). A pupil's cohort entry date was the year of the latest date of first appearance in the linked EDUW dataset or the 1st September 2012 while cohort exit was the year of the earliest date leaving the EDUW dataset or 31st August 2019. The cohort duration for each pupil was the years between entry and exit which included those with one year of Wales residency. The follow-up time was the earliest date of suicide outcome before or on 31st December 2021, moving out of Wales or death and the observation period for each pupil was from the cohort entry to the maximum follow-up time for suicide outcomes.

2.3. Data source and procedure

We extracted and linked individual-level data via the Adolescent Mental Health Data Platform (ADP), an international data platform that supports mental health research in children and young people (https://adolescentmentalhealth.uk/Platform). Which included using datasets from the SAIL Databank(www.saildatabank.com), a trusted research environment of routinely collected health and education datasets for the population of Wales anonymised for research purposes.

Data linkage between database were performed by matching unique anonymised linkage field identifier (ALF) across datasets. This was conducted via the National Health Service Wales Informatics Service. We included individuals whose data were either deterministically linked or probabilistically linked with matching score of ≥ 0.9 (Ford et al., 2009; Lyons et al., 2009).

To create the cohort of school pupils, we used the EDUW dataset in SAIL then linked the EDUW dataset to the following datasets: the General Practice Database (primary care), Outpatient Appointments Dataset (outpatient hospital appointments) the Patient Episode Database for Wales (inpatient hospital admissions), the emergency department dataset (accident and emergency department attendances), Welsh Demographic Service and the Annual District Death Extract (ADDE) obtained from the Office for National Statistics (ONS) (Fig. 1). See description in Suppl. Table 1.
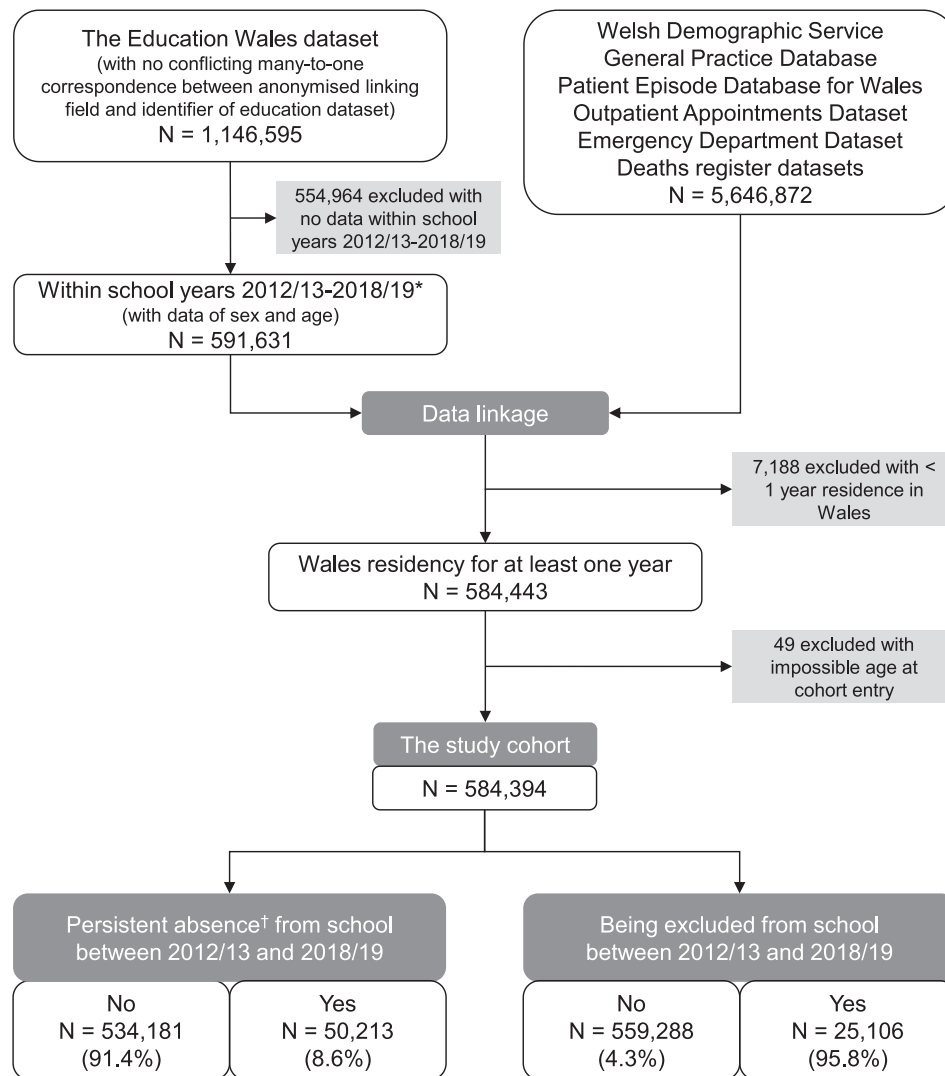
2.4. Measures

2.4.1. Outcome

We identified individuals who died by suicide from the ADDE dataset via previously used (John et al., 2020) International Classification of Diseases version 10 (ICD-10) codes for underlying cause of death, documented in the medical certificate of cause of death. Detailed code lists are available in the HDRUK Gateway (https://phenotypes.healthdatagateway.org). Suicide was defined as individuals who died by intentional self-harm (if aged over 10 years) and undetermined intent (if aged over 15 years) (Office for National Statistics, 2018). Some deaths that were classified as accidental poisoning or hanging were classified as suicide after clinical review (detailed codes lists are described in the concept library) and these possible suicide deaths were included in a sensitivity analysis (Gunnell et al., 2013).

2.4.2. Exposures and other covariates

2.4.2.1. Persistent absence. The definition of persistent absence varies across locations and time. We used the Welsh government's definition relevant at the time: a pupil absent for at least 20 % of eligible sessions (Welsh Government, 2020a). For each pupil, we calculated the

Fig. 1. Study flow diagram of the cohort of pupil.

percentage of missed sessions (authorised and unauthorised absences) for each school year and identified any persistent absences using the 20 % threshold (Department for Education, 2019). We then derived a binary variable for each pupil to indicate any persistent absence over the cohort's duration. To explore exposure-response relation, we summed the number of school years where persistent absence was flagged and calculated the proportion of years of having persistent absence over the duration in cohort. We created a three-level ordinal variable: no report of persistent absence (0 %), up to half (0–50 %) or more than half (50–100 %) of the duration in cohort having records of persistent absence.

2.4.2.2. Exclusion. We identified pupils who were excluded (either permanently or fixed-time exclusion) from schools in each school year and derived a binary variable for being excluded during the cohort duration in keeping with previous research (John et al., 2022). We assessed exposure-response relation following a similar methodology to absence.

2.4.2.3. Other covariates. We included sex (male and female) and age at

cohort entry, (<10 years, 10–15 years, and 16+ years) as categorical variables for demographics. We also categorised age at date of death or the end of follow-up period as three groups (<15 years, 15–17 years, and 18+ years) for suicide outcomes only. These age groupings were based on the ONS suicide criteria (Office for National Statistics, 2018). To assess level of area deprivation, we used the Welsh Index of Multiple Deprivation (WIMD) 2014 (Welsh Government, 2014). WIMD scores were assessed from multiple different domains of deprivation including income and unemployment for each Lower layer Super output Area divided into quintiles to define the least (Q1) and most deprived (Q5) area. A five-level ordinal variable (1–5) was derived for each pupil (John et al., 2022) by calculating weighted average of available WIMD quintiles over the observation period and rounded to integers.

We also extracted data of pupils' status on special education need (SEN) and free school meal (FSM) as separate binary variables (John et al., 2022). SEN refers to pupils with learning problems or disabilities (Welsh Assembly Government, 2010) while FSM is a benefit awarded to children where their parents or carers are in receipt of state benefits or income support (Department for Education, 2018). For each pupil, we extracted use of health services related to self-harm, neurodiversity

(attention deficit hyperactivity disorder, ADHD, autism spectrum disorder, ASD), and various mental health conditions (during the observation period based on previously used and validated lists of ICD-10 codes, Read codes (version 2) and attendance groups for ED (see descriptions in the https://phenotypes.healthdatagateway.org) from primary and secondary care datasets. Mental health conditions included conduct disorder, learning difficulties, eating disorders, depression, anxiety, severe mental illnesses (including schizophrenia, bipolar disorder, and other psychotic disorders), alcohol misuse and drugs misuse). Ten respective binary variables were derived to indicate the presence of each of these conditions within the observation period. Pupils' mental health comorbidity was summarised with a four-level ordinal variable (0, 1, 2, 3+). A summary of the study variables is available in Suppl. Table 2.

2.5. Statistical analysis

We used structured query language (SQL DB2) for data extraction and conducted statistical analyses using Stata version 17.0. Statistical significance was at $p = 0.05$ and we estimated 95 % confidence intervals (CIs) for proportions using Wilson score (Newcombe, 1998). Cross-tabulations were tested using chi-square test of association and strength of associations were assessed using Cramer's V. We summarised cohort characteristics as descriptive statistics and computed the proportion of persistent absence, exclusion and suicide deaths stratified by characteristics. Exposure-response relations for cross-tabulations of persistent absence/exclusion (as categorical variables) and suicide were examined using the Mantel-Haenszel test for trend.

Risk of suicide was evaluated using Firth logistic regression to avoid small sample bias due to perfect separation and rarity of outcomes using conventional maximum likelihood estimation (Firth, 1993; Heinze and Schemper, 2002). We performed both unadjusted and adjusted analyses to evaluate the effect size (as odds ratios and adjusted odds ratios, ORs and aORs, with 95 % CIs) of risk factors on suicide including persistent absence and exclusion (both as binary variables), receipt of SEN and FSM, self-harm, mental health comorbidity and other covariates (Suppl. Table 2). Ordinal variables of absence/exclusion were used in a separate analysis to assess exposure-response relations.

A supplementary analysis was performed by replicating the main analysis with the mental health comorbidity variable replaced by ten binary variables for individual mental health conditions. We used a less restricted definition of suicide which included certain accidental conclusions as outcomes in a sensitivity analysis.

For all adjusted models, we reported model fit statistics including Akaike's information criterion (Akaike, 1974), Bayesian information criterion (Schwarz, 1978), Nagelkerke's R^2 (Nagelkerke, 1991) and area under the Receiver operating characteristic curve (Hanley and McNeil, 1982). Variance inflation factors (VIF) threshold of three was used to assess multicollinearity issue for each model (Miles and Shevlin, 2001).

3. Results

3.1. Cohort characteristics

We identified 1,146,595 school pupils from the EDWU dataset in SAIL (Fig. 1). 591,631 of those appeared between 2012/13 and 2018/19 (1st September 2012-31st August 2019) and were linked to the demographic and health datasets. The final study cohort consisted of 584,394 eligible pupils with at least one year of residency in Wales, providing about 2.5 million person years between 2012/13 and 2018/19. Characteristics of the cohort are summarised in Table 1. The cohort contained approximately equal proportions of males (51.1 %) and females (48.9 %) with a mean age of cohort entry to EDUW of 8.7 years (standard deviation: 3.5 years). A slightly higher proportion of pupils resided in more socioeconomic deprived areas (Q3 and Q4) compared to less deprived areas (Q1 and Q2). Data for over one-quarter of pupils

Table 1
Cohort characteristics.

Characteristics	Category	Persons	(%)
	Total	584,394	(100.0)
Sex	Male	298,395	(51.1)
	Female	285,999	(48.9)
Age group	<10 years	364,559	(62.4)
(at cohort entry)	10–15 years	201,779	(34.5)
	16 years	18,056	(3.1)
Area deprivation	Q1	86,995	(14.9)
(WIMD Quintile, Q5: most	Q2	109,492	(18.7)
deprived)	Q3	131,207	(22.5)
	Q4	138,914	(23.8)
	Q5	117,786	(20.2)
Persistent absence and Exclusion	Ever persistent absence[a,b]	50,213	(8.6)
	Ever excluded[a]	25,106	(4.3)
Received free school meal[a]	No	435,183	(74.5)
(FSM)	Yes	145,240	(24.9)
	Unknown	3971	(0.7)
Received special education needs	No	391,597	(67.0)
(SEN)[a]	Yes	192,797	(33.0)
Mental health comorbidity[c]	0	468,626	(80.2)
	1	77,195	(13.2)
	2	27,985	(4.8)
	3+	10,588	(1.8)
Lifetime self-harm and mental health conditions	Self-harm	21,782	(3.7)
	ADHD[d]	12,772	(2.2)
	ASD[e]	10,823	(1.9)
	Conduct disorders	6378	(1.1)
	Learning difficulties	6098	(1.0)
	Eating disorders	7934	(1.4)
	Depression	54,867	(9.4)
	Anxiety	51,624	(8.8)
	Severe mental illness	1484	(0.3)
	Alcohol misuse	8403	(1.4)
	Drugs misuse	8712	(1.5)
Duration in cohort (years)	1	79,994	(13.7)
	2	77,648	(13.3)
	3	74,060	(12.7)
	4	70,358	(12.0)
	5	67,105	(11.5)
	6	66,358	(11.4)
	7	148,871	(25.5)
School year[f,g,h]	2012/13	354,539	(14.1)
	2013/14	354,266	(14.1)
	2014/15	354,735	(14.1)
	2015/16	356,817	(14.2)
	2016/17	360,471	(14.4)
	2017/18	363,750	(14.5)
	2018/19	365,845	(14.6)

[a] Measured within the duration in cohort.
[b] Defined as having at least one school year with school absence for at least 20 % of the mode number of half-day sessions that schools were open to pupils.
[c] Derived from the sum of any lifetime mental health conditions.
[d] Attention deficit hyperactivity disorder.
[e] Autism spectrum disorder.
[f] School year starts from 1st September to 31st August.
[g] A pupil can be in the cohort for more than one school year.
[h] Denominator of the %: total number of person-years (2,510,423) in the cohort.

(25.5 %) covered the whole duration in the cohort (seven school years).

3.2. School absence and exclusion by characteristics

Table 2 shows 50,213 (8.6 %; 95 % CI: 8.5 %–8.7 %) and 25,106 (4.3 %; 95 % CI: 4.2 %–4.3 %) out of 584,394 pupils with records of persistent absence and school exclusion respectively within the duration in cohort (Permanent exclusion occurred in 475 pupils (0.1 % of the study cohort)). 25,106 individual pupils who were ever excluded had 80,615 exclusions and 489 of these exclusions were permanent (0.6 %). Annual exclusion rates (per 1000 pupils) were 0.1–0.3 for permanent

Table 2
School absence/exclusion by characteristics.

Characteristics	Category	Total	Persistent absence		Ever excluded	
			Persons	% (95 % CI)	Persons	% (95 % CI)
	Total	584,394	50,213	8.6 (8.5–8.7)	25,106	4.3 (4.2–4.3)
Sex	Male	298,395	25,455	8.5 (8.4–8.6)	18,077	6.1 (6.0–6.1)
	Female	285,999	24,758	8.7 (8.6–8.8)	7029	2.5 (2.4–2.5)
Age group	<10 years	364,559	24,251	6.7 (6.6–6.7)	8052	2.2 (2.2–2.3)
(at cohort entry)	10–15 years	201,779	24,253	12.0 (11.9–12.2)	16,170	8.0 (7.9–8.1)
	16 years	18,056	1709	9.5 (9.0–9.9)	884	4.9 (4.6–5.2)
Area deprivation	Q1	86,995	2569	3.0 (2.8–3.1)	1288	1.5 (1.4–1.6)
(WIMD Quintile, Q5: most deprived)	Q2	109,492	5709	5.2 (5.1–5.3)	2695	2.5 (2.4–2.6)
	Q3	131,207	10,061	7.7 (7.5–7.8)	4852	3.7 (3.6–3.8)
	Q4	138,914	15,711	11.3 (11.1–11.5)	8018	5.8 (5.7–5.9)
	Q5	117,786	16,163	13.7 (13.5–13.9)	8253	7.0 (6.9–7.2)
Persistent absence and Exclusion	Ever persistent absence	50,213	–	–	9111	18.1 (17.8–18.5)
	Ever excluded	25,106	9111	36.3 (35.7–36.9)	–	–
Received (FSM)	No	435,183	20,645	4.7 (4.7–4.8)	12,076	2.8 (2.7–2.8)
	Yes	145,240	28,787	19.8 (19.6–21.6)	12,905	8.9 (8.7–9.4)
	Unknown	3971	781	19.7 (18.4–25.9)	125	3.1 (2.6–3.8)
Received SEN	No	391,597	21,246	5.4 (5.4–5.5)	7900	2.0 (2.0–2.1)
	Yes	192,797	28,967	15.0 (14.9–15.2)	17,206	8.9 (8.8–9.1)
Mental health comorbidity	0	468,626	28,667	6.1 (6.0–6.2)	13,223	2.8 (2.8–2.9)
	1	77,195	11,528	14.9 (14.7–15.2)	6184	8.0 (7.8–8.2)
	2	27,985	6486	23.2 (22.7–23.7)	3384	12.1 (11.7–12.5)
	3+	10,588	3532	33.4 (32.5–34.3)	2315	21.9 (21.1–22.7)
Lifetime self-harm and mental health conditions	Self-harm	21,782	6089	28.0 (27.4–28.6)	3905	17.9 (17.4–18.4)
	ADHD	12,772	2710	21.2 (20.5–21.9)	3067	24.0 (23.3–24.8)
	ASD	10,823	2194	20.3 (19.5–21.2)	1029	9.5 (8.9–16.1)
	Conduct disorders	6378	1854	29.1 (27.9–36.2)	1409	22.1 (21.1–23.1)
	Learning difficulties	6098	1063	17.4 (16.5–18.4)	448	7.3 (6.7–8.1)
	Eating disorders	7934	1259	15.9 (15.1–16.7)	438	5.5 (5.0–6.1)
	Depression	54,867	11,864	21.6 (21.2–22.8)	6094	11.1 (10.8–11.4)
	Anxiety	51,624	10,281	19.9 (19.5–27.3)	4143	8.0 (7.8–8.3)
	Severe mental illness	1484	483	32.5 (30.1–35.8)	321	21.6 (19.6–23.8)
	Alcohol misuse	8403	2147	25.6 (24.6–26.5)	1727	20.6 (19.7–21.4)
	Drugs misuse	8712	2861	32.8 (31.9–33.8)	2480	28.5 (27.5–29.4)
Duration in cohort (years)	1	79,994	5322	6.7 (6.5–6.8)	1976	2.5 (2.4–2.6)
	2	77,648	6009	7.7 (7.6–7.9)	2781	3.6 (3.5–3.7)
	3	74,060	6007	8.1 (7.9–8.3)	3136	4.2 (4.1–4.4)
	4	70,358	6070	8.6 (8.4–8.8)	3364	4.8 (4.6–4.9)
	5	67,105	5856	8.7 (8.5–8.9)	3133	4.7 (4.5–4.8)
	6	66,358	6191	9.3 (9.1–9.6)	3343	5.0 (4.9–5.2)
	7	148,871	14,758	9.9 (9.7–16.1)	7373	5.0 (4.8–5.1)
School year[a]	2012/13	354,539	15,485	4.4 (4.3–4.4)	5239	1.5 (1.4–1.5)
	2013/14	354,266	11,681	3.3 (3.2–3.4)	4679	1.3 (1.3–1.4)
	2014/15	354,735	9928	2.8 (2.7–2.9)	4401	1.2 (1.2–1.3)
	2015/16	356,817	9541	2.7 (2.6–2.7)	4515	1.3 (1.2–1.3)
	2016/17	360,471	9666	2.7 (2.6–2.7)	4399	1.2 (1.2–1.3)
	2017/18	363,750	10,885	3.0 (2.9–3.4)	5020	1.4 (1.3–1.4)
	2018/19	365,845	11,664	3.2 (3.1–3.2)	5402	1.5 (1.4–1.5)

[a] A pupil can be in the cohort, be persistently absence and/or excluded for more than one school year.

and 29.3–37.2 for fixed-term exclusions from 2012/13–2018/19.

Characteristics of pupils persistently absent or excluded from school are depicted in Table 2, which showed annual prevalence of persistent absence and exclusion were 2.7 %–4.4 % and 1.2 %–1.5 % respectively. There was no significant difference by sex in persistent absence (male: 8.5 % vs. female: 8.7 %) but males were significantly more likely to be excluded (male 6.1 % vs. female 2.5 %). Older pupils, aged, between 10 and 15 years at cohort entry, were significantly more likely to have persistent absence and be excluded from school. Absence and exclusion were significantly more likely to occur in pupils who resided in more deprived areas. Of the 66,208 pupils who either had a record of persistent absence or exclusion from school, 13.8 % of them (*n* = 9111) had records of both indicating some pupils who have been excluded from school have also been absent. There were strong positive associations among absence/exclusion, receiving FSM and requiring SEN status compared to other studied factors. Pupils with health service contacts for self-harm and mental health conditions were significantly more likely to have persistent absence and exclusion from school. 21.6 % Depression and 28.6 % self-harm were strongly associated with persistent absence while 28.5 % of pupils who used drugs and 24 % ADHD had

the strongest associations with exclusion. Higher mental health comorbidity was also significantly associated with persistent absence and exclusion. See Suppl. Table 3 for summary statistics on cross tabulation.

3.3. Suicide following school absence, exclusion, and other factors

Up to 31st December 2021, 123 pupils died by suicide within our cohort (out of 584,394 pupils, rate = 21.0 per 100,000 persons; 95 % CI = 17.6–25.2) with age of suicide between 15 and 25 years (Table 3). Suicide was significantly positively associated with persistent absence (47.8 vs.18.5 per 100,000 persons) and exclusion (127.5 vs. 16.3 per 100,000 persons) See Suppl. Tables 4 & 5 for cross-tabulation. However, neither receipt of FSM nor SEN was significantly associated with higher suicide rates. Suicide was more likely to occur in males and older age pupils while there was no significant association between suicide and deprivation. Self-harm and higher mental health comorbidity significantly increased suicide rate except for learning difficulties and eating disorders. The association between suicide and drugs misuse was the strongest among these conditions.

When using ordinal variables for persistent absence and exclusion,

Table 3
Suicide by characteristics.

Characteristics	Category	Persons	Number of Suicide	Suicide rate[a] (95 % CI)
	Total	584,394	123	21.0 (17.6–25.2)
Persistent absence (Binary)	No persistent absence	534,181	99	18.5 (15.1–22.7)
	Ever persistent absence	50,213	24	47.8 (31.3–72.3)
Persistent absence (Categorical: % of years in cohort)	0 % (no persistent absence)	534,181	99	18.5 (15.1–22.7)
	(0–50 %)	36,644	13	35.5 (19.7–62.4)
	(50–100 %)	13,569	11	81.1 (42.6–149.8)
Exclusion (Binary)	Not excluded	559,288	91	16.3 (13.2–20.1)
	Ever Excluded	25,106	32	127.5 (88.7–182.2)
Exclusion (Categorical: % of years in cohort)	0 % (not excluded)	559,288	91	16.3 (13.2–20.1)
	(0–50 %)	20,862	25	119.8 (79.3–179.7)
	(50–100 %)	4244	7	164.9 (72.3–355.9)
Sex	Male	298,395	98	32.8 (26.8–40.2)
	Female	285,999	25	8.7 (5.8–13.1)
Age group	<15 yrs	221,043	0	0.0 (0.0–0.0)
(at death or end of follow-up)	15–17 yrs	105,484	33	31.3 (21.9–44.5)
	18+ yrs	257,867	90	34.9 (28.2–43.1)
Area deprivation	Q1	86,995	16	18.4 (10.9–30.6)
(WIMD Quintile, Q5: most deprived)	Q2	109,492	21	19.2 (12.2–29.9)
	Q3	131,207	31	23.6 (16.3–34.0)
	Q4	138,914	33	23.8 (16.6–33.8)
	Q5	117,786	22	18.7 (12.0–28.8)
Received FSM	No	435,183	90	20.7 (16.7–25.5)
	Yes	145,240	<50	-[b]
	Unknown	3971	<5	-[b]
Received SEN	No	391,597	75	19.2 (15.2–24.1)
	Yes	192,797	48	24.9 (18.6–33.3)
Mental health comorbidity	0	468,626	55	11.7 (8.9–15.4)
	1	77,195	25	32.4 (21.4–48.6)
	2	27,985	22	78.6 (50.5–121.2)
	3+	10,588	21	198.3 (126.0–308.7)
History of self-harm and mental health conditions	Self-harm	21,782	49	225.0 (168.2–299.9)
	ADHD	12,772	9	70.5 (34.4–139.0)
	ASD	10,823	8	73.9 (34.4–151.9)
	Conduct disorders	6378	7	109.8 (48.1–236.9)
	Learning difficulties	6098	<5	-[b]
	Eating disorders	7934	<5	-[b]
	Depression	54,867	47	85.7 (63.6–114.9)
	Anxiety	51,624	22	42.6 (27.4–65.7)
	Severe mental illness	1484	6	404.3 (164.5–925.1)
	Alcohol misuse	8403	10	119.0 (60.5–226.6)
	Drugs misuse	8712	30	344.4 (236.6–497.9)

[a] Expressed as number of suicides per 100,000 persons.
[b] Rate not disclosed due to small numbers or secondary disclosure of small numbers.

we observed increasing trends of suicides with increasing percentages of numbers of school years (from at 0 %, up to 50 % to up to 100 %) with reports of both persistent absence and exclusion (Figs. 2, 3A–B). Mantel-Haenszel test showed significant linear associations between suicide and absence [$\chi2$ (1) = 26.3, $p < 0.001$] and exclusion [$\chi2$ (1) = 140.8, p < 0.001].

We used Firth logistic regression to estimate suicide risk with persistent absence, exclusion, and other risk factors. In unadjusted analyses, we observed consistent associations of suicide with all independent variables (Suppl. Table 6). In the adjusted analysis (Fig. 3A, Suppl. Table 6), effect size of exclusion remained significantly higher than one (aOR = 2.3; 95 % CI: 1.5–3.7) whereas persistent absence did not (aOR = 1.0; 95 % CI: 0.6–1). Other variables with effect size robustly higher than one included female sex, age groups ≥10 compared children aged <10 years at cohort entry, history of self-harm, and having mental health comorbidity ≥2. Similar to the results from the unadjusted models, higher level of deprivation, receipt of FSM and SEN were not significantly associated with higher suicide risk in the adjusted analysis.

When the persistent absence and exclusion variables were ordinal (Fig. 3B, Suppl. Table 6), aORs for persistent absence remained non-significantly different from one. For exclusion, aOR remained significantly larger than one in the middle category (>0 to 50 %: aOR = 2.9;

95 % CI:1.7–4.8) but not the highest category (>50 to 100 %: aOR = 1.5; 95 % CI: 0.7–5.3). aORs for other variables were similar to those in the model where absence/exclusion variables were binary.

3.4. Supplementary and sensitivity analyses

We performed a supplementary analysis to estimate adjusted suicide risk associated with individual mental health conditions (Suppl. Table 7). ASD (aOR = 2.3; 95 % CI: 1.1–4.9) and drug misuse (aOR = 2.7; 95 % CI: 1.6–4.6) were significantly associated with suicide in the adjusted models. aORs for all other predictors including persistent absence and exclusion were very similar to the main analysis. As a sensitivity analysis, we additionally identified 31 possible suicide deaths from the cohort (Suppl. Table 4) and replicated the main analysis. All results were similar with the main analysis with the exception that aOR of having two mental health comorbidities was no longer significantly higher than one (Suppl. Tables 8–9).

VIFs for independent variables in all corresponding adjusted regressions ranged from 1.0 to 1.3, below the threshold of three, indicating no multicollinearity in our adjusted models.
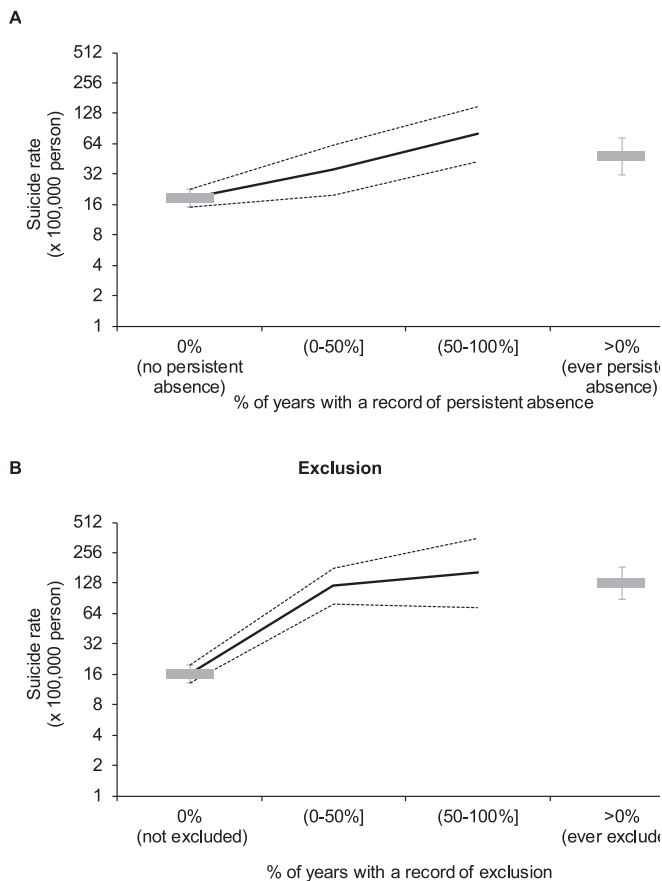
A

B

Fig. 2. Rates of suicide (in log scale) for pupils against % of school years out of duration in cohort (as ordinal categories) having a report of persistent absence (A) and (B) exclusion from school between 2012/13 and 2018/19 school year. Persistent absence/exclusion as binary variables are also shown (grey bars) for reference. Dotted lines and error bars: 95 % confidence intervals (CIs).

4. Discussion

We examined risk of suicide following school absence and exclusion by linking population-level routinely collected education, health data and mortality data at an individual level for pupils in Wales over seven school years (2012–2019). We assessed death by suicide up to December 2021 and controlled for absence, exclusion, sociodemographic and clinical risk factors. We found that pupils who were excluded from school are 2.3 times more likely to die by suicide than those who were not, after adjusting for other risk factors. This finding suggests that the elevated risk of suicide associated with exclusion is independent of other risk factors such as history of self-harm and existing mental health issues. The association between suicide and persistent absence was significant in unadjusted analyses but not significant when adjusted for both absence and exclusion.

School exclusion often leads to continuing social exclusion in adulthood (Madia et al., 2022), limiting individuals' participation in economic and social activities (Chakravarty and D'Ambrosio, 2006). School exclusion leading to social exclusion (Yur'Yev et al., 2013) with isolation (Motillon-Toudic et al., 2022) and loneliness (McClelland et al., 2020) may contribute to the elevated suicide risk, in addition to other known risks factors. However, we cannot rule out indirect effects of school exclusion on suicide through repeated self-harm and development or exacerbation of mental health issues before death. It is also possible that associations between early onset of mental health issues and suicide are established through bi-directional relationship between school exclusion and mental health status (Ford et al., 2018), or more complex associations that involve other risk factors (John et al., 2022).

To better understand the intricate mechanisms between school exclusion, mental health issues and other risk factors in relation to suicide mortality, larger-scale longitudinal studies with extended observation periods and precise timing of exclusions and absence are needed.

Our finding of no significant relationship between suicide and persistent absence is not in keeping with existing literature which suggests elevated suicide ideation, self-harm and suicide risk among absent students (Epstein et al., 2020; Rojas and Stenberg, 2010). Our adjusted models also showed no-significant association between absence and suicide regardless of the proportion of school years with reports of persistent absence. The difference in results may stem from variations in research methodologies and outcomes among studies. However, our study indicates a stronger association between suicide and school exclusion compared to absence. School absence can involve voluntary or authorised absence due to illness, family bereavement or religious obligations (Welsh Government, 2020a). While we support distinguishing between absence and exclusion (Epstein et al., 2020), our results suggest that characteristics associated with future suicide risk are shared between them. Future research should explore both measures exclusively to clarify these associations.

A higher risk of suicide was associated with pupils being excluded for less than half of the school years compared to being excluded for more than half of the school years. In the adjusted models, we did not show significant association between absence and suicide regardless of the proportion of school years with reports of persistent absence. We suggest that recognition, diagnosis, and educational policies may help mitigate the risk for at risk pupils (Ford et al., 2018). These findings strengthen the assumption that characteristics like male sex, older age, self-harm history and mental health conditions tend to be shared among students more likely to face exclusion and later die by suicide (Ford et al., 2018; Hawton et al., 2012; Paget et al., 2018). However, further investigations with lager sample sizes and more outcomes events are needed for the exposure-response relations.

In the 2012/13–2018/19 period, about 9 % of the pupils had persistent absence, while about 4 % were excluded from schools. In keeping with others, boys had a higher risk of exclusion, while the risk of persistent absence did not significantly differ between sexes (John et al., 2022). The annual prevalence of persistent absence (2.7 %–4.4 %) closely aligns with national statistics (2.5 %–4.2 %) for the same years (Welsh Government, 2020a). Similarly, annual rates of permanent (0.1–0.3 per 1000 pupils) and fixed-term exclusions (29.3–37.2 per 1000 pupils) are also comparable with related statistics (Welsh Government, 2020b), with permanent exclusion (0.2–0.5 per 1000 pupils) and fixed-term exclusion (28.3–40.8 per 1000 pupils). The distributions of persistent absence and exclusion across sex, age groups, level of area deprivation, FSM and SEN status, self-harm and mental health groups are also very consistent with previous studies (Ford et al., 2018; John et al., 2022; Paget et al., 2018) and government statistics (Welsh Government, 2020a, 2020b).

4.1. Strengths and limitations

This is a robust and unique study that linked suicide mortality data with routinely collected education and health data for over 580,000 school age pupils in Wales from 2012/13 to 2018/19. By data linkage, we could simultaneously assess sociodemographic, educational, and clinical determinants for the risk of suicide in school-age pupils. We not only conducted a joint analysis of absence and exclusion with other known risk factors for suicide, but also explored the exposure-response relationships between suicide and absence/exclusion.

However, a significant limitation of this study is the limited number of suicide deaths, which affected the validity and statistical power of our findings. This restricted our ability to further stratify sub-groups of absences and exclusions by types or reasons. Pupils permanently excluded from school and not integrated may have a more pronounced impact on their future. The small number of suicide deaths also hindered the use of
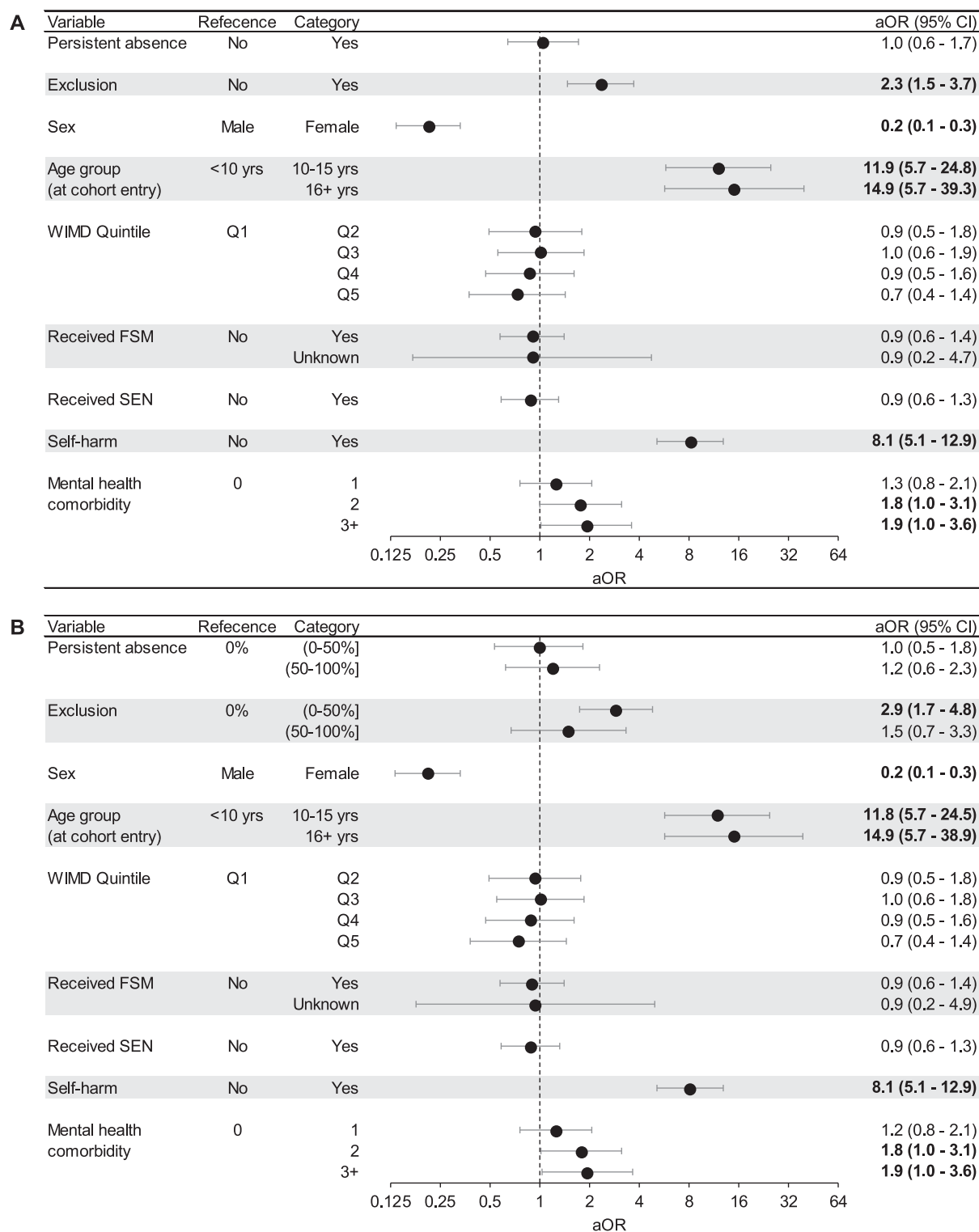
A

Variable	Refecence	Category		aOR (95% CI)
Persistent absence	No	Yes		1.0 (0.6 - 1.7)
Exclusion	No	Yes		**2.3 (1.5 - 3.7)**
Sex	Male	Female		**0.2 (0.1 - 0.3)**
Age group (at cohort entry)	<10 yrs	10-15 yrs		**11.9 (5.7 - 24.8)**
		16+ yrs		**14.9 (5.7 - 39.3)**
WIMD Quintile	Q1	Q2		0.9 (0.5 - 1.8)
		Q3		1.0 (0.6 - 1.9)
		Q4		0.9 (0.5 - 1.6)
		Q5		0.7 (0.4 - 1.4)
Received FSM	No	Yes		0.9 (0.6 - 1.4)
		Unknown		0.9 (0.2 - 4.7)
Received SEN	No	Yes		0.9 (0.6 - 1.3)
Self-harm	No	Yes		**8.1 (5.1 - 12.9)**
Mental health comorbidity	0	1		1.3 (0.8 - 2.1)
		2		**1.8 (1.0 - 3.1)**
		3+		**1.9 (1.0 - 3.6)**

0.125 0.25 0.5 1 2 4 8 16 32 64
aOR

B

Variable	Refecence	Category		aOR (95% CI)
Persistent absence	0%	(0-50%]		1.0 (0.5 - 1.8)
		(50-100%]		1.2 (0.6 - 2.3)
Exclusion	0%	(0-50%]		**2.9 (1.7 - 4.8)**
		(50-100%]		1.5 (0.7 - 3.3)
Sex	Male	Female		**0.2 (0.1 - 0.3)**
Age group (at cohort entry)	<10 yrs	10-15 yrs		**11.8 (5.7 - 24.5)**
		16+ yrs		**14.9 (5.7 - 38.9)**
WIMD Quintile	Q1	Q2		0.9 (0.5 - 1.8)
		Q3		1.0 (0.6 - 1.8)
		Q4		0.9 (0.5 - 1.6)
		Q5		0.7 (0.4 - 1.4)
Received FSM	No	Yes		0.9 (0.6 - 1.4)
		Unknown		0.9 (0.2 - 4.9)
Received SEN	No	Yes		0.9 (0.6 - 1.3)
Self-harm	No	Yes		**8.1 (5.1 - 12.9)**
Mental health comorbidity	0	1		1.2 (0.8 - 2.1)
		2		**1.8 (1.0 - 3.1)**
		3+		**1.9 (1.0 - 3.6)**

0.125 0.25 0.5 1 2 4 8 16 32 64
aOR

Fig. 3. Adjusted odds ratios (aORs) for the risk of suicide following persistent absence/exclusion from school as binary (A) and ordinal variable (B) together with other risk factors. Bold values: aORs significantly different from one. Error bars: 95 % CIs.

more sophisticated methods, such as splines, for exploring exposure-response relationships. Additionally, the small number of deaths prevented us from demonstrating socioeconomic inequality in suicide (Hawton et al., 2012), although it may also be influenced by the distribution of deprivation in our cohort, which skewed towards more deprived areas. Such findings have been replicated in a previous study using the same dataset (John et al., 2022). Nevertheless, we were able to

replicate socioeconomic inequality of absence/exclusion as demonstrated by others.

To increase the number of outcomes events for analysis, we extended the follow up period to end of 2021, encompassing the COVID-19 pandemic (The UK government, 2020). Preliminary data did not show significant increase in suicide rates among young people in England and Wales during the initial months of the pandemic outbreak (Pirkis et al.,

2022). However, the pandemic disrupted school activities resulting in fluctuation school absence and exclusion rates during 20,019/20–2020/21 (between March 2020 and April 2021) (Welsh Government, 2021) compared to pre-pandemic figures, with an increase of absence (Welsh Government, 2022a) and decrease of exclusion (Welsh Government, 2022b). Thus, the extent to which the pandemic affected pupils school lives and future outcomes remained uncertain. Attempts to shorten the follow up period to before 2020 resulted in a considerable decrease in the number of suicide deaths, rendering the analyses untenable.

Other limitations stem from the use of routinely collected data for research. We may underestimate self-harm and other mental health conditions, particularly where pupils do not seek healthcare, have undetectable symptoms, or experience misclassification of their conditions, availability of only annual aggregated data for school absences and exclusions (John et al., 2022) also limited our ability to establish temporality between these events and other important covariates such as mental health conditions. Furthermore, our school attendance data covered only seven school years with pupils entering the cohort at different ages and providing different years of data coverage. Approximately a quarter of pupils provided data for all seven years in our cohort. The data coverage for the primary care database was incomplete for the study period, with data collection for emergency attendance commencing 2009.

4.2. Implications for policy and practice

This study underscores the significant impact of school exclusion together with other risk factors, such as self-harm and mental health issues on future suicide risk for school-age pupils. We recognise the potential impact of school absence on pupils' outcomes, given the overlapping characteristics between school absence and exclusion. These findings should inform schools and professionals who work with CYP to be aware of these risk factors when offering support and strategies for reducing school absence and exclusion, improving mental health and wellbeing, and preventing suicide. Policies like penalty notices for caregivers of persistently absent pupils and attendance incentives were introduced in Wales (Welsh Assembly Government, 2011), but they do not address the psychosocial aspects of poor attendance. Focusing on understanding and intervening for individuals' children may be more effective, taking a whole school approach, minimising exclusions and integrating with child and adolescent mental health services such as school in-reach services is required. Policy makers and practitioners are increasingly prioritizing, understanding the reasons behind pupil disengagement and well-being. Shifting away from strict discipline and behaviour management (Power and Taylor, 2021).

However, efforts are required to reduce the negative consequences of exclusion on pupils, as support for at-risk pupils varies widely across schools (Power and Taylor, 2021). Pupils may be effectively excluded from usual learning environments but remain on school registers. These hidden forms of exclusion will remain undocumented (Power and Taylor, 2021, 2020). The impact on isolated pupils is uncertain as their learning experience differs from their peers. More research is needed to uncover hidden school exclusions and its potential consequences on students' futures.

Preventive measures should also be implemented that are aimed at factors associated with exclusion, including inequality, poverty, disability, and exposure to adverse childhood experiences (Samaritans Cymru, 2019). At school level, certain routine practices and initiatives, e.g., dress-up days, school trips and social events that may leave disadvantaged CYP feeling embarrassed/isolated due to lack of inclusivity should be minimised. Mandatory education to pupils and training of teachers on mental health has been advocated to increase awareness and understanding of pupils' emotions and stress.

This study is particularly relevant given the increase in absence from both primary (Estyn, 2024) and secondary school (Welsh Government, 2023a) after the COVID-19 pandemic, and the ongoing Welsh

educational policies and curricular reform (Welsh Parliament Senedd Research, 2022). Besides pupils' health issues, unmet additional learning needs, and refusal to go to school (Welsh Government, 2023b), reasons for post-pandemic school absence include change in parents' attitudes towards schooling, parenting, and pupils' mental health in school setting, increasing mistrust between family and school, and the cost-of-living crisis (Burtonshaw and Dorrell, 2023). Nonetheless, this study crucially underscores the potential negative impact of school absence/exclusion which may not be only on academic performance (Ingram et al., 2023), but also on pupils' psychosocial outcomes.

The study also highlights the potential of linking school attendance and education data to identify at risk groups early and inform intervention strategies for CYP. Further research can explore the mechanisms linking absence, exclusion, self-harm, mental health, and suicide for effective intervention timing. Longitudinal studies can assess the relationship between school factors, adult life factors and suicide evaluating school attendance improvement programme's effectiveness in suicide prevention.

5. Conclusion

By linking data of school-aged population in Wales, this study showed that pupils who were excluded from school, male, having history of self-harm, higher number of mental health comorbidity, histories of ASD and drug misuse were more likely to die by suicide. Our findings suggest that exclusion and other forms of school attendance problems should be considered as important indicators of future risk of suicide and strategies of suicide prevention in CYP should target more comprehensive assessments and early intervention to reduce school attendance problems.

CRediT authorship contribution statement

Margaret Ifeoma Diogu: Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Sze Chim Lee:** Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Marcos Del Pozo-Banos:** Formal analysis, Writing – review & editing. **Olivier Y. Rouquette:** Formal analysis, Writing – review & editing. **Ann John:** Conceptualization, Supervision, Writing – original draft, Writing – review & editing.

Declaration of competing interest

Acknowledgements

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jad.2025.119394.

Data availability

The data used in this study are available in the SAIL Databank at Swansea University (Swansea, UK) via the Adolescent Mental Health Data Platform, but, as restrictions apply, they are not publicly available. All proposals to use SAIL data are subject to review by an independent Information Governance Review Panel. Before any data can be accessed, approval must be given by the Information Governance Review Panel. The Information Governance Review Panel carefully considers each project to ensure proper and appropriate use of SAIL data. When access has been granted, it is gained through a privacy-protecting safe haven and remote access system referred to as the SAIL Gateway. SAIL have established an application process to be followed by anyone who would like to access data via SAIL, details of which can be found at https://www.saildatabank.com/applicationprocess. Derived data supporting the findings of this study are available from the corresponding author (AJ) on request at a.john@swansea.ac.uk.

References

Akaike, H., 1974. A new look at the statistical model identification. IEEE Trans Automat Contr 19, 716–723. https://doi.org/10.1109/TAC.1974.1100705.

Burtonshaw, S., Dorrell, E., 2023. Listening to, and learning from, parents in the attendance crisis. https://thelink.slough.gov.uk/news/attendance-report-listening-learning-parents-attendance-crisis (accessed 10.21.22).

Chakravarty, S.R., D'Ambrosio, C., 2006. The measurement of social exclusion. Rev. Income Wealth 52, 377–398. https://doi.org/10.1111/j.1475-4991.2006.00195.x.

Department for Education, 2016. The link between absence and attainment at KS2 and KS4 2013/14 academic year. https://www.gov.uk/government/publications/absence-and-attainment-at-key-stages-2-and-4-2013-to-2014 (accessed 10.22.22).

Department for Education, 2018. Free school meals: guidance for local authorities, maintained schools, academies and free schools. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700139/Free_school_meals_guidance_Apr18.pdf (accessed 10.22.22).

Department for Education, 2019. A guide to absence statistics https://dera.ioe.ac.uk/id/eprint/33072/1/Guide_to_absence_statistics_21032019.pdf (accessed 10.21.22).

Docherty, A.R., Shabalin, A.A., DiBlasi, E., Monson, E., Mullins, N., Adkins, D.E., Bacanu, S.-A., Bakian, A.V., Crowell, S., Chen, D., Darlington, T.M., Callor, W.B., Christensen, E.D., Gray, D., Keeshin, B., Klein, M., Anderson, J.S., Jerominski, L., Hayward, C., Porteous, D.J., McIntosh, A., Li, Q., Coon, H., 2020. Genome-wide association study of suicide death and polygenic prediction of clinical antecedents. Am. J. Psychiatry 177, 917–927. https://doi.org/10.1176/appi.ajp.2020.19101025.

Egger, H.L., Costello, E.J., Angold, A., 2003. School refusal and psychiatric disorders: a community study. J. Am. Acad. Child Adolesc. Psychiatry 42, 797–807. https://doi.org/10.1097/01.CHI.0000046865.56865.79.

Epstein, S., Roberts, E., Sedgwick, R., Finning, K., Ford, T., Dutta, R., Downs, J., 2018. Poor school attendance and exclusion: a systematic review protocol on educational risk factors for self-harm and suicidal behaviours. BMJ Open 8, e023953. https://doi.org/10.1136/bmjopen-2018-023953.

Epstein, S., Roberts, E., Sedgwick, R., Polling, C., Finning, K., Ford, T., Dutta, R., Downs, J., 2020. School absenteeism as a risk factor for self-harm and suicidal ideation in children and adolescents: a systematic review and meta-analysis. Eur. Child Adolesc. Psychiatry 29, 1175–1194. https://doi.org/10.1007/s00787-019-01327-3.

Estyn, 2024. HMCI Annual Report 2022–2023. Cardiff, UK.

Firth, D., 1993. Bias reduction of maximum likelihood estimates. Biometrika 80, 27–38. https://doi.org/10.1093/biomet/80.1.27.

Ford, D.V., Jones, K.H., Verplancke, J., Lyons, R.A., John, G., Brown, G., Brooks, C.J., Thompson, S., Bodger, O., Couch, T., Leake, K., 2009. The SAIL databank: building a national architecture for e-health research and evaluation. BMC Health Serv. Res. 9, 157. https://doi.org/10.1186/1472-6963-9-157.

Ford, T., Parker, C., Salim, J., Goodman, R., Logan, S., Henley, W., 2018. The relationship between exclusion from school and mental health: a secondary analysis of the British child and adolescent mental health surveys 2004 and 2007. Psychol. Med. 48, 629–641. https://doi.org/10.1017/S003329171700215X.

Gunnell, D., Bennewith, O., Simkin, S., Cooper, J., Klineberg, E., Rodway, C., Sutton, L., Steeg, S., Wells, C., Hawton, K., Kapur, N., 2013. Time trends in coroners' use of different verdicts for possible suicides and their impact on officially reported incidence of suicide in England: 1990–2005. Psychol. Med. 43, 1415–1422. https://doi.org/10.1017/S0033291712002401.

Hanley, J.A., McNeil, B.J., 1982. The meaning and use of the area under a receiver operating characteristic (ROC) curve. Radiology 143, 29–36. https://doi.org/10.1148/radiology.143.1.7063747.

Hawton, K., 2007. Restricting access to methods of suicide. Crisis 28, 4–9. https://doi.org/10.1027/0227-5910.28.S1.4.

Hawton, K., van Heeringen, K., 2009. Suicide. Lancet. https://doi.org/10.1016/S0140-6736(09)60372-X.

Hawton, K., Saunders, K.E.A., O'Connor, R.C., 2012. Self-harm and suicide in adolescents. Lancet 379, 2373–2382. https://doi.org/10.1016/S0140-6736(12)60322-5.

Heinze, G., Schemper, M., 2002. A solution to the problem of separation in logistic regression. Stat. Med. 21, 2409–2419. https://doi.org/10.1002/sim.1047.

Heyne, D., Gren-Landell, M., Melvin, G., Gentle-Genitty, C., 2019. Differentiation between school attendance problems: why and how? Cogn. Behav. Pract. 26, 8–34. https://doi.org/10.1016/j.cbpra.2018.03.006.

Ingram, J., Stiff, J., Cadwallader, S., Gabriel, L., Kayton, H., 2023. PISA 2022: National Report for Wales. England, Oxford.

John, A., Reilly, R., Price, L., Okolie, C., Heatman, B., 2019. Thematic review of deaths of children and young people through probable suicide, 2013–2017 https://phw.nhs.wales/news/averting-tragedy-suicide-prevention-in-welsh-children-and-young-people/thematic-review-of-deaths-of-children-and-young-people-through-probable-suicide-2013-2017-main-report/ (accessed 10.26.22).

John, A., DelPozo-Banos, M., Gunnell, D., Dennis, M., Scourfield, J., Ford, D.V., Kapur, N., Lloyd, K., 2020. Contacts with primary and secondary healthcare prior to suicide: case–control whole-population-based study using person-level linked routine data in Wales, UK, 2000–2017. Br. J. Psychiatry 217, 717–724. https://doi.org/10.1192/bjp.2020.137.

John, A., Friedmann, Y., DelPozo-Banos, M., Frizzati, A., Ford, T., Thapar, A., 2022. Association of school absence and exclusion with recorded neurodevelopmental disorders, mental disorders, or self-harm: a nationwide, retrospective, electronic cohort study of children and young people in Wales, UK. Lancet Psychiatry 9, 23–34. https://doi.org/10.1016/S2215-0366(21)00367-9.

Kearney, C.A., 2008. School absenteeism and school refusal behavior in youth: a contemporary review. Clin. Psychol. Rev. 28, 451–471. https://doi.org/10.1016/j.cpr.2007.07.012.

Kidger, J., Heron, J., Lewis, G., Evans, J., Gunnell, D., 2012. Adolescent self-harm and suicidal thoughts in the ALSPAC cohort: a self-report survey in England. BMC Psychiatry 12, 69. https://doi.org/10.1186/1471-244X-12-69.

Lyons, R.A., Jones, K.H., John, G., Brooks, C.J., Verplancke, J.-P., Ford, D.V., Brown, G., Leake, K., 2009. The SAIL databank: linking multiple health and social care datasets. BMC Med. Inform. Decis. Mak. 9, 3. https://doi.org/10.1186/1472-6947-9-3.

Madia, J.E., Obsuth, I., Thompson, I., Daniels, H., Murray, A.L., 2022. Long-term labour market and economic consequences of school exclusions in England: evidence from two counterfactual approaches. Br. J. Educ. Psychol. 92, 801–816. https://doi.org/10.1111/bjep.12487.

Marchant, A., Hawton, K., Stewart, A., Montgomery, P., Singaravelu, V., Lloyd, K., Purdy, N., Daine, K., John, A., 2017. A systematic review of the relationship between internet use, self-harm and suicidal behaviour in young people: The good, the bad and the unknown. PloS One 12, e0181722.

McClelland, H., Evans, J.J., Nowland, R., Ferguson, E., O'Connor, R.C., 2020. Loneliness as a predictor of suicidal ideation and behaviour: a systematic review and meta-analysis of prospective studies. J. Affect. Disord. 274, 880–896. https://doi.org/10.1016/j.jad.2020.05.004.

Miles, J., Shevlin, M., 2001. Applying regression and correlation: a guide for students and researchers. Sage.

Motillon-Toudic, C., Walter, M., Séguin, M., Carrier, J.-D., Berrouiguet, S., Lemey, C., 2022. Social isolation and suicide risk: literature review and perspectives. Eur. Psychiatry 65, e65. https://doi.org/10.1192/j.eurpsy.2022.2320.

Mullins, N., Kang, J., Campos, A.I., Coleman, J.R.I., Edwards, A.C., Galfalvy, H., Levey, D.F., Lori, A., Shabalin, A., Starnawska, A., Su, M.H., Watson, H.J., Adams, M., Awasthi, S., Gandal, M., Hafferty, J.D., Hishimoto, A., Kim, M., Okazaki, S., Otsuka, I., Ripke, S., Ware, E.B., Bergen, A.W., Berrettini, W.H., Bohus, M., Brandt, H., Chang, X., Chen, W.J., Chen, H.C., Crawford, S., Crow, S., DiBlasi, E., Duriez, P., Fernández-Aranda, F., Fichter, M.M., Gallinger, S., Glatt, S.J., Gorwood, P., Guo, Y., Hakonarson, H., Halmi, K.A., Hwu, H.G., Jain, S., Jamain, S., Jiménez-Murcia, S., Johnson, C., Kaplan, A.S., Kaye, W.H., Keel, P.K., Kennedy, J.L., Klump, K.L., Li, D., Liao, S.C., Lieb, K., Lilenfeld, L., Liu, C.M., Magistretti, P.J., Marshall, C.R., Mitchell, J.E., Monson, E.T., Myers, R.M., Pinto, D., Powers, A., Ramoz, N., Roepke, S., Rozanov, V., Scherer, S.W., Schmahl, C., Sokolowski, M., Strober, M., Thornton, L.M., Treasure, J., Tsuang, M.T., Witt, S.H., Woodside, D.B., Yilmaz, Z., Zillich, L., Adolfsson, R., Agartz, I., Air, T.M., Alda, M., Alfredsson, L.,

Andreassen, O.A., Anjorin, A., Appadurai, V., Soler Artigas, M., Van der Auwera, S., Azevedo, M.H., Bass, N., Bau, C.H.D., Baune, B.T., Bellivier, F., Berger, K., Biernacka, J.M., Bigdeli, T.B., Binder, E.B., Boehnke, M., Boks, M.P., Bosch, R., Braff, D.L., Bryant, R., Budde, M., Byrne, E.M., Cahn, W., Casas, M., Castelao, E., Cervilla, J.A., Chaumette, B., Cichon, S., Corvin, A., Craddock, N., Craig, D., Degenhardt, F., Djurovic, S., Edenberg, H.J., Fanous, A.H., Foo, J.C., Forstner, A.J., Frye, M., Fullerton, J.M., Gatt, J.M., Gejman, P.V., Giegling, I., Grabe, H.J., Green, M.J., Grevet, E.H., Grigoroiu-Serbanescu, M., Gutierrez, B., Guzman-Parra, J., Hamilton, S.P., Hamshere, M.L., Hartmann, A., Hauser, J., Heilmann-Heimbach, S., Hoffmann, P., Ising, M., Jones, I., Jones, L.A., Jonsson, L., Kahn, R.S., Kelsoe, J.R., Kendler, K.S., Kloiber, S., Koenen, K.C., Kogevinas, M., Konte, B., Krebs, M.O., Landén, M., Lawrence, J., Leboyer, M., Lee, P.H., Levinson, D.F., Liao, C., Lissowska, J., Lucae, S., Mayoral, F., McElroy, S.L., McGrath, P., McGuffin, P., McQuillin, A., Medland, S.E., Mehta, D., Melle, I., Milaneschi, Y., Mitchell, P.B., Molina, E., Morken, G., Mortensen, P.B., Müller-Myhsok, B., Nievergelt, C., Nimgaonkar, V., Nöthen, M.M., O'Donovan, M.C., Ophoff, R.A., Owen, M.J., Pato, C., Pato, M.T., Penninx, B., Pimm, J., Pistis, G., Potash, J.B., Power, R.A., Preisig, M., Quested, D., Ramos-Quiroga, J.A., Reif, A., Ribasés, M., Richarte, V., Rietschel, M., Rivera, M., Roberts, A., Roberts, G., Rouleau, G.A., Rovaris, D.L., Rujescu, D., Sánchez-Mora, C., Sanders, A.R., Schofield, P.R., Schulze, T.G., Scott, L. J., Serretti, A., Shi, J., Shyn, S.I., Sirignano, L., Sklar, P., Smeland, O.B., Smoller, J. W., Sonuga-Barke, E.J.S., Spalletta, G., Strauss, J.S., Świątkowska, B., Trzaskowski, M., Turecki, G., Vilar-Ribó, L., Vincent, J.B., Völzke, H., Walters, J.T. R., Shannon Weickert, C., Weickert, T.W., Weissman, M.M., Williams, L.M., Wray, N. R., Zai, C.C., Ashley-Koch, A.E., Beckham, J.C., Hauser, E.R., Hauser, M.A., Kimbrel, N.A., Lindquist, J.H., McMahon, B., Oslin, D.W., Qin, X., Agerbo, E., Børglum, A.D., Breen, G., Erlangsen, A., Esko, T., Gelernter, J., Hougaard, D.M., Kessler, R.C., Kranzler, H.R., Li, Q.S., Martin, N.G., McIntosh, A.M., Mors, O., Nordentoft, M., Olsen, C.M., Porteous, D., Ursano, R.J., Wasserman, D., Werge, T., Whiteman, D.C., Bulik, C.M., Coon, H., Demontis, D., Docherty, A.R., Kuo, P.H., Lewis, C.M., Mann, J.J., Rentería, M.E., Smith, D.J., Stahl, E.A., Stein, M.B., Streit, F., Willour, V., Ruderfer, D.M., 2022. Dissecting the shared genetic architecture of suicide attempt, psychiatric disorders, and known risk factors. Biol. Psychiatry 91, 313–327. https://doi.org/10.1016/j.biopsych.2021.05.029.

Nagelkerke, N.J.D., 1991. A note on a general definition of the coefficient of determination. Biometrika 78, 691–692. https://doi.org/10.1093/biomet/78.3.691.

Newcombe, R.G., 1998. Two-sided confidence intervals for the single proposition: comparison of seven methods. Stat. Med. 17, 857–872. https://doi.org/10.1002/(SICI)1097-0258(19980430)17.

Office for National Statistics, 2018. Suicides in the UK: 2017 registrations. https://www.ons.gov.uk/releases/suicidesintheuk2017registrations (accessed 10.21.22).

Office for National Statistics, 2022. Suicides in England and Wales: 2021 registrations. https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/suicidesintheunitedkingdom/2021registrations (accessed 4.4.24).

Paget, A., Parker, C., Heron, J., Logan, S., Henley, W., Emond, A., Ford, T., 2018. Which children and young people are excluded from school? Findings from a large British birth cohort study, the Avon longitudinal study of parents and children (ALSPAC). Child Care Health Dev. 44, 285–296. https://doi.org/10.1111/cch.12525.

Pirkis, J., Gunnell, D., Shin, S., Del Pozo-Banos, M., Arya, V., Aguilar, P.A., Appleby, L., Arafat, S.M.Y., Arensman, E., Ayuso-Mateos, J.L., Balhara, Y.P.S., Bantjes, J., Baran, A., Behera, C., Bertolote, J., Borges, G., Bray, M., Brečić, P., Caine, E., Calati, R., Carli, V., Castelpietra, G., Chan, L.F., Chang, S.-S., Colchester, D., Coss-Guzmán, M., Crompton, D., Ćurković, M., Dandona, R., De Jaegere, E., De Leo, D., Deisenhammer, E.A., Dwyer, J., Erlangsen, A., Faust, J.S., Fornaro, M., Fortune, S., Garrett, A., Gentile, G., Gerstner, R., Gilissen, R., Gould, M., Gupta, S.K., Hawton, K., Holz, F., Kamenshchikov, I., Kapur, N., Kasal, A., Khan, M., Kirtley, O.J., Knipe, D., Kõlves, K., Kölzer, S.C., Krivda, H., Leske, S., Madeddu, F., Marshall, A., Memon, A., Mittendorfer-Rutz, E., Nestadt, P., Neznanov, N., Niederkrotenthaler, T., Nielsen, E., Nordentoft, M., Oberlerchner, H., O'Connor, R.C., Papsdorf, R., Partonen, T., Phillips, M.R., Platt, S., Portzky, G., Psota, G., Qin, P., Radeloff, D., Reif, A., Reif-Leonhard, C., Rezaeian, M., Román-Vázquez, N., Roskar, S., Rozanov, V., Sara, G., Scavacini, K., Schneider, B., Semenova, N., Sinyor, M., Tambuzzi, S., Townsend, E., Ueda, M., Wasserman, D., Webb, R.T., Winkler, P., Yip, P.S.F., Zalsman, G., Zoja, R., John, A., Spittal, M.J., 2022. Suicide numbers during the first 9-15 months of the COVID-19 pandemic compared with pre-existing trends: an interrupted time series analysis in 33 countries. eClinicalMedicine 51, 101573. https://doi.org/10.1016/j.eclinm.2022.101573.

Power, S., Taylor, C., 2020. Not in the classroom, but still on the register: hidden forms of school exclusion. Int. J. Incl. Educ. 24, 867–881. https://doi.org/10.1080/13603116.2018.1492644.

Power, S., Taylor, C., 2021. School exclusions in Wales: policy discourse and policy enactment. Emot. Behav. Difficulties 26, 19–30. https://doi.org/10.1080/13632752.2021.1898761.

Pritchard, C., King, E., 2000. 'High risk' adolescents five years on: The subsequent suicide and homicide of former 'looked-after' and 'exclusion unit' adolescents (11–15). Int. J. Adolesc. Youth 8, 139–148. https://doi.org/10.1080/02673843.2000.9747848.

Rojas, Y., Stenberg, S.-Å., 2010. Early life circumstances and male suicide – a 30-year follow-up of a Stockholm cohort born in 1953. Soc. Sci. Med. 70, 420–427. https://doi.org/10.1016/j.socscimed.2009.10.026.

Samaritans Cymru, 2019. Exclusion from school in Wales: the hidden cost. Cardiff, UK.

Schwarz, G., 1978. Estimating the dimension of a model. Ann. Stat. 6, 461–464. https://doi.org/10.1214/aos/1176344136.

Shaw, R.J., Cullen, B., Graham, N., Lyall, D.M., Mackay, D., Okolie, C., Pearsall, R., Ward, J., John, A., Smith, D.J., 2021. Living alone, loneliness and lack of emotional support as predictors of suicide and self-harm: a nine-year follow up of the UK biobank cohort. J. Affect. Disord. 279, 316–323. https://doi.org/10.1016/j.jad.2020.10.026.

Smerillo, N.E., Reynolds, A.J., Temple, J.A., Ou, S.R., 2018. Chronic absence, eighth-grade achievement, and high school attainment in the Chicago longitudinal study. J. Sch. Psychol. 67, 163–178. https://doi.org/10.1016/j.jsp.2017.11.001.

The UK government, 2020. Prime Minister's statement on coronavirus (COVID-19): 23 March. https://www.gov.uk/government/speeches/pm-address-to-the-nation-on-coronavirus-23-march-2020 (accessed 10.27.22).

Turecki, G., Brent, D.A., 2016. Suicide and suicidal behaviour. Lancet 387, 1227–1239. https://doi.org/10.1016/S0140-6736(15)00234-2.

Welsh Assembly Government, 2010. Information for parents and carers of children and young people who may have special educational needs. https://gov.wales/sites/default/files/publications/2018-03/information-for-parents-and-carers-of-children-and-young-people-who-may-have-special-educational-needs.pdf.

Welsh Assembly Government, 2011. Strategies for schools to improve attendance and manage lateness.https://dera.ioe.ac.uk/2945/3/110308section3en.pdf (accessed 10.28.22).

Welsh Government, 2014. Welsh Index of Multiple Deprivation (WIMD) 2014 Revised. Cardiff, UK.

Welsh Government, 2020a. Absenteeism from schools by pupil characteristics: September 2018 to August 2019. https://gov.wales/absenteeism-schools-pupil-characteristics-september-2018-august-2019 (accessed 10.21.22).

Welsh Government, 2020b. Permanent and fixed-term exclusions from schools: September 2018 to August 2019. https://gov.wales/permanent-and-fixed-term-exclusions-schools-september-2018-august-2019.

Welsh Government, 2021. Timeline of school closures during the coronavirus (COVID-19) pandemic, March 2020 to April 2021.https://gov.wales/timeline-school-closures-during-coronavirus-covid-19-pandemic (accessed 10.27.22).

Welsh Government, 2022a. Pupils present in maintained schools: 7 September 2020 to 23 July 2021. https://gov.wales/pupils-present-maintained-schools-7-september-2020-23-july-2021 (accessed 10.27.22).

Welsh Government, 2022b. Permanent and fixed-term exclusions from schools: September 2020 to August 2021. https://gov.wales/permanent-and-fixed-term-exclusions-schools-september-2020-august-2021-html (accessed 10.27.22).

Welsh Government, 2023a. Absenteeism from secondary schools: September 2022 to August 2023 (accessed 6.15.24).

Welsh Government, 2023b. Understanding pupil absence in schools in Wales: A report by Parentkind for Welsh Government (accessed 6.15.24).

Welsh Parliament Senedd Research, 2022. Implementing major education reforms https://research.senedd.wales/research-articles/implementing-major-education-reforms (accessed 4.4.24).

World Health Organization, 2021. Suicide worldwide in 2019: global health estimates.

Yur'Yev, A., Värnik, P., Sisask, M., Leppik, L., Lumiste, K., Värnik, A., 2013. Some aspects of social exclusion: do they influence suicide mortality? Int. J. Soc. Psychiatry 59, 232–238. https://doi.org/10.1177/002076401143179.