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Research paper

Exploring gender differences in risk factors for self-harm in adolescents using data from the Millennium Cohort Study

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ABSTRACT

Background: Self-harm is common in young people and girls have consistently higher rates of self-harm than boys. Differences in exposure and reactions to risk and protective factors, adverse events and problematic interpersonal relationships, and levels of wellbeing could contribute to the gender difference. This study aims to explore gender differences in risk factors associated with self-harm, to provide the foundation for developing more gender-sensitive approaches to self-harm management.

Methods: Data were analysed from 11,196 young people recruited to the Millennium Cohort Study, surveyed around age 14. We examined gender differences in the prevalence of key psychological and social risk factors for self-harm, including family and peer relationships, emotional wellbeing, and bullying and victimisation. We utilised modified Poisson regression to estimate gender-specific risks.

Results: At age 14 self-harm prevalence was 15.4 % with a ratio of 2.6 females to 1 male. Differential exposure to recorded psychosocial risk factors explained a third of the gender difference in risk of self-harm. Intense social media use and not confiding in family members were associated with a greater likelihood of self-harm in girls than boys. Bullying others and same-sex attraction were more strongly associated with self-harm in boys than girls.

Limitations: Self-harm data were obtained by self-report therefore subject to misclassification. The cross-sectional design does not enable us to establish causation.

Conclusions: Unhappiness and dissatisfaction are common in adolescence. Our findings suggest the need for further research into young people's experiences to explore why rates differ and inform the development of gender-specific approaches to self-harm management.

1. Introduction

Self-harm may be defined as any act of intentional self-poisoning or self-injury, irrespective of motive or suicidal intent (National Institute for Clinical Excellence, 2011). An alternative approach distinguishes self-harm from suicidal behaviour according to the presence or absence of suicidal intent (Zetterqvist, 2015). However, such a distinction can be problematic when seeking to understand a person's motivations for engaging in self-harm and in establishing risk of suicide (House et al., 2020). The intent behind a particular act is difficult to attribute precisely and an individual may be unclear or ambivalent about their desire to die. Even where low suicidal intent can be established for a particular act of self-harm, it may co-exist with intense suicidal thoughts in the same individual and some people report that a deliberate non-fatal act can be a means of averting suicide (House et al., 2020).

Self-harm among young people is a common problem in the UK. Studies on incidence and prevalence vary due to the private nature of self-harm, and due to variations in the definitions used in surveys. It is thought that around 25 % of young people have self-harmed on at least one occasion and around 10 % of young people have self-harmed four or more times (Royal College of Psychiatrists, 2014). Rates are increasing, especially among young women, with self-harm – as measured by self-report and hospital attendance – having doubled in the last decade (Morgan et al., 2017).

Self-harm has been consistently found to be more prevalent in females than males, particularly during younger adolescence (Hawton and

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Harriss, 2008). This gender gap is widening and there has been a notable increase in the number of girls presenting with self-harm to both hospital and their GP, over and above the increase seen in adolescent boys (Morgan et al., 2017). How might this gender difference be explained? It is possible that there are gender differences in exposure to adversity, or in factors that may be protective against such adversity and confer resilience, so that there is a gender difference in the reaction to adversity after exposure has occurred.

Early adversity including abuse, neglect, and household dysfunction, bullying or interpersonal difficulties, are common — with almost half of adults having at least one such experience during their childhood (Felitti et al., 1998; Bellis et al., 2014). The presence of such adversity increases the risk of subsequent depression and self-harm (Isohookana et al., 2013). Females are more likely to experience sexual abuse than males (Cavanaugh et al., 2015), but otherwise consistent patterns are not obviously forthcoming. In relation to protective factors, young males and females have different experiences of friendship groups and interpersonal relationships (Hinde and Stevenson-Hinde, 1987). Current mental state also influences the risk of self-harm (Hawton et al., 2012). We know that there are gender differences in how young people express emotion, so that males who do experience sexual abuse are less likely to self-harm and more likely to develop depression and go on to use substances and exhibit antisocial behaviour (Straiton et al., 2012; Chaplin and Aldao, 2013). Recent years have seen a decrease in the overall wellbeing of young girls including greater levels of body dissatisfaction (Hielscher et al., 2019).

In this context it is a striking feature of current approaches to prevention or therapy for self-harm that gender-specificity is rarely, if ever, discussed (Witt et al., 2021). A first step to develop more gender-sensitive approaches is to improve the understanding of the main factors influencing self-harm rates, especially to identify modifiable risks.

In the study described here we use cross-sectional data from the sixth wave of the UK Millennium Cohort Study to explore gender differences in the risk factors associated with self-harm in adolescents. Specifically, we were interested to: (i) examine the extent to which boys and girls differed in terms of their level of exposure to risk factors; (ii) examine whether boys and girls differed in terms of the patterns and strength of associations between risk factors and self-harm; and (iii) to evaluate the extent to which differential risk factor exposure explained the difference in risk of self-harm between boys and girls.

2. Methods

2.1. Data

The Millennium Cohort Study (MCS) is an observational, prospective cohort of the health and development of children born in the UK in the early 2000s. MCS provides multiple measures of the cohort members' physical, socio-emotional, cognitive and behavioural development over time, as well as detailed information on their daily life, behaviour and experiences. Alongside this, rich information on economic circumstances, parenting, relationships and family life is available from both resident parents (Connelly and Platt, 2014).

Over 18,000 infants were recruited between late 2000 and early 2002 with five additional waves of data collected since. The sixth wave retained 11,884 of those initially recruited, who were around age 14 at data collection (range 13–15 years old). Of these, 11,196 participants were included in our analysis. Wave six was also the first time information was collected on whether the study child had engaged in self-harm. Data were collected from young people and care givers separately in a series of interviews and digital surveys completed both alone and with researcher assistance. Child related variables, such as the strengths and difficulties questionnaire, were reported by one parent only. Parent specific variables, such as mother's or father's mental health, were reported for each individual parent. As such, there were no double sources of data used in this study.

2.2. Selection of variables

We constructed the analysis dataset using Stata 12.1/SE, extracting a dichotomous measure of self-harm where the child was asked the single question “In the past year have you hurt yourself on purpose in any way?” (no/yes). Following this question no further clarification was offered to participants. Gender was defined as a boy/girl dichotomy in the first sweep of MCS data collection. We extracted sociodemographic data as well as data on a range of psychosocial risk factors for self-harm. Selection of these exposures was based on expert knowledge about risk factors for self-harm in young people (ED & AH). We included variables pertaining to family relationships and parental health and wellbeing, schoolwork difficulties and bullying, peer and trusting relationships (Fortune et al., 2016), individual factors such as impulsivity and self-esteem, as well as markers of emotional wellbeing and mental illness (Fliege et al., 2009). Scales included the Mood and Feelings Questionnaire short form (child-reported), Shortened Rosenberg Self-esteem Scale (child-reported) and the Strengths and Difficulties Questionnaire (parent-reported). LBGT+ young people have higher risks of suicide and self-harm (Hawton et al., 2012), and so a variable on same-sex attraction was included. Gender-identity was not explored in this data sweep. Finally, data on pubertal stage was included as there is a strong association between pubertal stage and onset of self-harm, particularly in girls (Hawton et al., 2012). Variables were derived from the MCS data by the corresponding author (ED). We provide detailed information on the operationalisation of risk factors in Supplementary Table S1.

2.3. Data reduction

To allow our analyses to span a wide range of risk factors we reduced the dimensionality of the dataset where possible using confirmatory factor analysis (CFA) in Mplus 8, assessing model fit using the comparative fit index (CFI $>$ 0.95 for good fit); the Tucker-Lewis index (TLI $>$ 0.95 for good fit); and the root mean square error of approximation (RMSEA $<$ 0.05 for good fit). Factors dimensions were specified a priori based on expert opinion and included: lack of social support; bullying (as victim or perpetrator); weight issues; depressive traits; substance use; gambling; antisocial behaviour; and internalising and externalising traits. Where the initial fit of the model was poor, we examined modification indices to identify cross-loadings or item residual covariances with substantively meaningful interpretation, and then included these in the CFA model. We estimated factor scores for each of the extracted factors, exported these from Mplus 8 into Stata 12.1/SE and dichotomised them as falling below (not exposed) versus falling at or above the middle of the factor score range (exposed). The use of dichotomisation enabled all associations to be expressed and compared in terms of relative risk. Supplementary Fig. S1a–j provide details of our approach to data reduction. Where measures could not be meaningfully combined, or were of substantive intrinsic interest, we used the observed data to construct binary exposure measures, defining exposure as scoring at or above the middle of the scoring range (Table S1).

2.4. Item-missing data and multiple imputation

Out of the 11,884 wave 6 MCS participants, we excluded 581 participants (4.9 %) because of missing values on self-harm status and 12 participants because of missing values for survey design variables. Among the 11,291 remaining individuals we investigated the extent of missing covariate and exposure data (Table S2). Whilst we observed high levels of item-completeness for most variables, notable exceptions were parental socioeconomic class (16.3 % missing), whether the study child argued with their father (7.5 % missing), whether the study child had a mother or father with a long-term illness (4.2 % and 35.3 % missing respectively), had low life satisfaction (9.9 % and 39.3 % missing) or alcohol misuse issues (4.1 % and 35.3 % missing), and maternally reported internalising or externalising traits (both 9.6 %

missing). Importantly, over half of the 11,291 remaining individuals had at least one variable with item-missing data (52.4 %) and would therefore have been excluded from a complete-case analysis.

To avoid the loss of statistical power due to analysing only individuals with complete data, we created 20 imputed datasets using a multiple imputation with chained equations (MICE) approach (Azur et al., 2011). All covariate data were used in the prediction of missing values, with auxiliary data on parental employment and education being used specifically for the imputation of missing values on parental social class. We used conditional models to impute missing values for presence of long-term illness, low life satisfaction, or parental alcohol misuse, and any parent-reported characteristic of the child, imputing data only if the study child reported to live or be in contact with their parent. We used logistic and multinomial regression models for the imputation of binary and unordered categorical variables respectively. We report our combined analysis of the 20 multiple imputation datasets as the main results of this study, and present results from equivalent analyses where item-missing values were included as a separate response category in the supplement (Tables S3 and S4).

Preliminary analysis of the imputed data suggested that the fraction of missing information was ≈30 %. Using Von Hippel's formula (Von Hippel, 2020) with a coefficient of variation of 5 %, we determined that at least 19 imputations would have been needed for stable estimation of point estimates and standard errors across imputations.

2.5. Analytical methods

All analytical models were weighted to take complex survey design and effects of study attrition between the first and subsequent MCS waves into account. We employed a modified Poisson regression approach (Zou, 2004) to compare prevalence of self-harm risk factors and exposure-related relative risk of self-harm between boys and girls. Any potential sociodemographic differences between those who did and did not report self-harm (age, ethnicity, highest parental occupational class, region within the UK, urbanicity of the living environment, and social deprivation decile) were adjusted for.

2.6. Matching boys and girls on propensity scores

In addition to examining gender differences that might be attributable to different risk exposures, we used propensity score matching to determine whether there was a residual gender difference in self-harm, indicating that either there are gender differences in young peoples' responses to similar levels of exposure to known risk factors, or that there are gender differences in further risk factors not explored in this study.

Using the RStudio (build 576) statistical package, we calculated propensity scores by regressing the child's gender on the full range of risk factors using logistic regression. Using the [MatchThem] command, we then matched boys and girls on propensity scores in each of the 20 multiple imputation datasets, using the nearest neighbour algorithm, without replacement, with a caliper of 0.10 standard deviations, and restricting matches to the area of common support. We then estimated the strength of association between the child's gender and self-harm within the propensity scores matched subset separately for each multiple imputation dataset and pooled the results using Rubin's rules (Rubin, 2004) to obtain the propensity score -matched relative risk of self-harm associated with the child's gender.

2.7. Analysis plan

We first evaluated sociodemographic variation in risk of self-harm using variables to be included as potential confounders in subsequent models. For each sociodemographic characteristic, we estimated proportions and relative risks of self-harm using Stata's [mi: svy: estimate] prefix and the earlier described modified Poisson regression approach.

We then estimated the prevalence of self-harm risk factors separately for boys and girls and evaluated the statistical significance of differences between them by regressing the child's gender on the exposure of interest. We interpreted the *p*-values associated with these regression coefficients as the statistical significance of gender differences in exposure prevalence. We then also investigated gender differences in *strength of association* between psychosocial risk factors and self-harm. Our rationale was that a stronger association would be indicative of greater risk, even if the prevalence of the risk factor was the same among boys and girls.

Using the imputed datasets, we specified a [gender • risk factor] interaction term for each exposure to evaluate the extent to which there was evidence of *additional* risk of self-harm with exposure among girls compared with boys. Again, we interpret the *p*-value of the interaction term as a test of the statistical significance for differences in exposure-related relative risk of self-harm between boys and girls.

We accounted for multiple testing by dividing the traditional *p*-value threshold ($p < 0.05$) by the number of risk factors investigated (n = 67) to obtain a Bonferroni-adjusted critical *p*-value of $p < 0.00075$. We indicate the robustness of an observed association against this Bonferroni-adjusted critical *p*-value with [*] in our results below.

Thirdly, we identified a subset of boys and girls with a similar psychosocial risk factor profile using the aforementioned propensity score matching approach and estimated the relative risk of self-harm associated with gender within this subset. Comparing the association between gender and self-harm status in the full analysis dataset with the association identified in the propensity-score matched subset, we evaluated the extent to which differences in risk of self-harm between boys and girls were attributed to differential risk factor exposure.

3. Results

Of the 11,884 young people who were retained at sweep 6 (age 14) of the MCS, we included 11,196 individuals with complete or imputed data for statistical analysis. This represented 94 % of all individuals in the sweep 6 MCS cohort. We assessed gender differences in the prevalence of key psychological and social risk factors for self-harm.

3.1. Demographic and socioeconomic characteristics

Table 1 describes the demographic and socioeconomic characteristics of the MCS sample, separately for those reporting and not reporting self-harm. The overall prevalence of self-harm in the MCS sample was 15.4 %. Prevalence was greater among girls (22.7 %) than boys (8.5 %), corresponding to a relative risk of 2.69 (95%CI = 2.36–3.04; $p < 0.001$). Self-harm was also more than twice as prevalent in White children (16.5 %) compared with South Asian (6.9 %) or Black children (7.6 %). It was least prevalent in London (10.8 %) and most prevalent in the East of England (17.9 %) and North of England (17.8 %). The prevalence of self-harm did not differ by age at interview (range: 13–15 years), parental socioeconomic class, urbanicity of the living environment, or multiple deprivation.

3.2. Risk factor exposure in all boys and girls, regardless of self-harm status

Table 2 shows the exposure prevalence for a range of psychosocial risk factors in all young people of each gender, regardless of self-harm status. It also shows associations between those risk factors and the occurrence of self-harm, stratified by gender. The description of the differential exposure to risk factors experienced by each gender facilitates our understanding of the different challenges that may shape boys' and girls' adolescent development and emotional expression.

The risk factors more prevalent among all boys were: bullying, being assaulted or stolen from, self-perceived poor academic performance in English, not discussing worries with a partner, not discussing worries

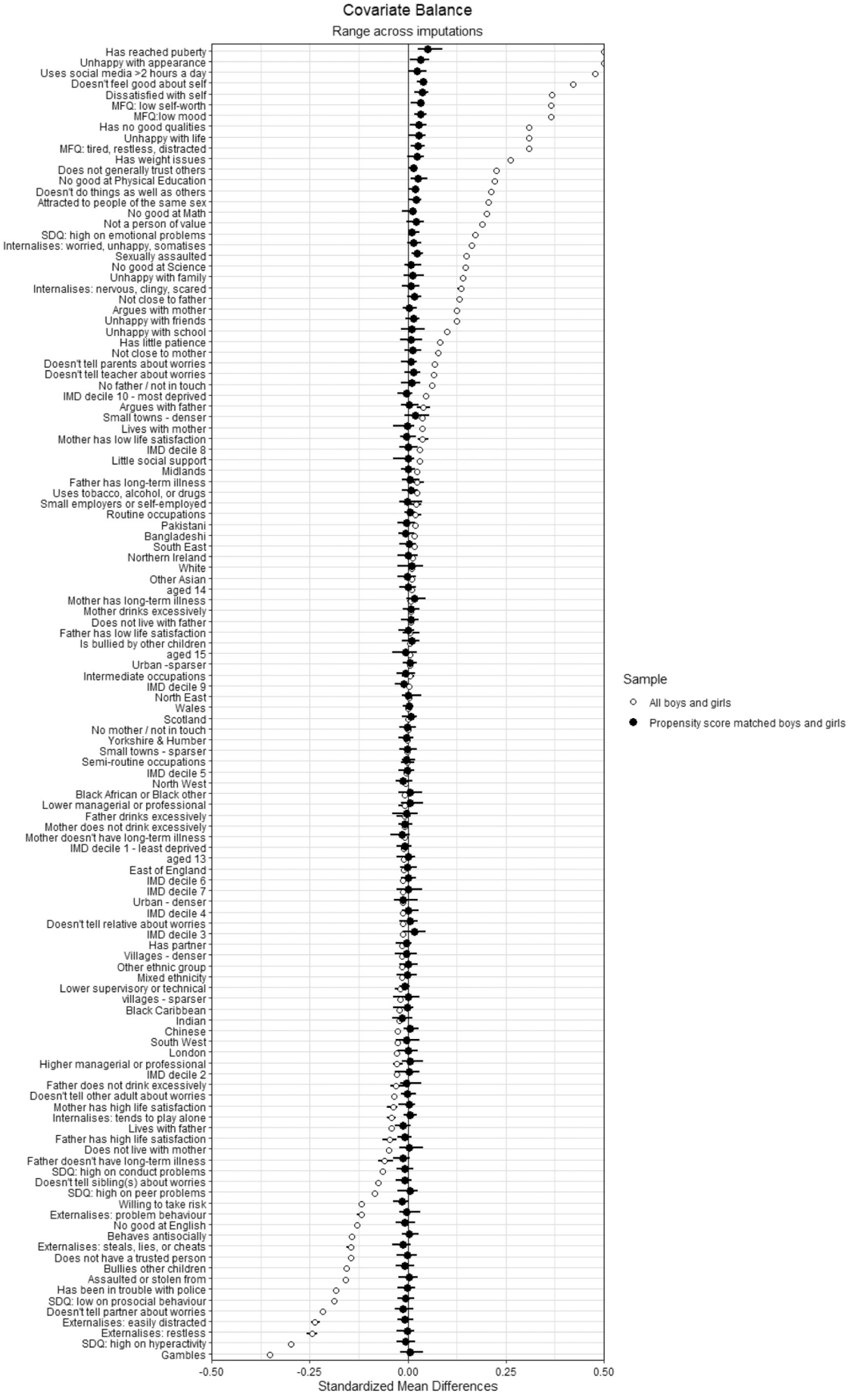

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Fig. 1. Covariate balance in the Millennium Cohort Study (MCS) sample as a whole ($N = 11,196$) and in the propensity score (PS) matched set ($N = 5674$). Key: MFQ: Mood and Feelings Questionnaire. SDQ: Strengths and Difficulties Questionnaire. IMD: Index of Multiple Deprivation. Fig. 1 shows the balance of self-harm risk factors between boys and girls in the MCS sample as a whole (○) and in the PS matched subset (●), averaged across the 20 multiple imputation datasets. The risk factors are ordered from those more common among girls (mapped in the right-hand side of Fig. 1) to those more common among boys (mapped to the left), and therefore add additional information about the relative size of differences in risk factor exposure between boys and girls. For example: many more girls had reached puberty by the age of 14, were unhappy about their appearance, used social media >2 h per day, had low self-esteem, and so on; whilst many more boys gambled, showed signs of hyperactivity, were restless, easily distracted, and so on. The centre line represents the point where risk factors are equally prevalent among girls and boys. As such, Fig. 1 provides evidence towards the effectiveness of our propensity-score matching approach and offers reassurance that the PS matched association between gender and self-harm was unaffected by differential exposure to self-harm risk factors.

with a sibling, willingness to take risk, not having a trusted person, gambling, antisocial behaviour, police contact, externalising traits, tending to play alone, conduct problems, hyperactivity, problems in peer relations, and scoring low on prosocial behaviour.

More prevalent among all girls were: problems with parents, sexual assault, weight issues, depressive symptoms, unhappiness, self-perceived poor performance in mathematics, science, and physical education, low self-esteem, intensive social media use, not discussing worries with parents or teachers, having little patience, use of tobacco, alcohol or other substances, having reached puberty, same-sex attraction, internalising traits, emotional problems, and having low generalised trust.

3.3. Risk factor exposure in boys and girls who reported self-harm

Table 2 also shows associations between exposure to some psychosocial risk factors and self-harm.

Boys who reported self-harm were more likely than girls who self-harmed to:

- Bully others (prevalence 9.3 % in boys, 5.7 % in girls)
- Not discuss worries with siblings (82.4 % vs 79.4 %)
- Have no trusted person (25.4 % vs 19.5 %).

Girls who reported self-harm were more likely than boys who self-harmed to:

Table 1
Sociodemographic characteristics of self-harming and non-self-harming adolescents: pooled analysis of 20 imputation datasets (n = 11,196).

		Self-harmed in past year		Relative risk of self-harm[1] Risk ratio (95 % CI)[2], *p*-value
		No (84.6 %)[1]	Yes (15.4 %)[1]	
		Row %[1]	Row %[1]	
Gender	Male	91.5	8.5	1.00
	Female	77.3	22.7	**2.68 (2.35–3.05), <0.001**
Age at interview	13 years	85.3	14.7	1.00
	14 years	84.2	15.8	1.07 (0.93–1.23), 0.361
	15 years	91.1	8.9	0.60 (0.33–1.09), 0.092
Ethnicity	White	83.5	16.5	1.00
	Mixed	83.1	16.9	1.02 (0.79–1.33), 0.867
	South Asian	93.1	6.9	**0.42 (0.34–0.51), <0.001**
	Other Asian	79.9	20.1	1.22 (0.66–2.24), 0.526
	Black	92.4	7.6	**0.46 (0.29–0.72), 0.001**
	Other ethnic group	90.0	10.0	0.61 (0.34–1.08), 0.092
Parental NS-SEC[3]	Higher & lower managerial	85.1	14.9	1.00
	Intermed./small employers/lower sup.	84.3	15.7	1.05 (0.89–1.23), 0.567
	Semi-routine & routine occupations	84.5	15.5	1.05 (0.88–1.24), 0.610
Region	North of England	82.2	17.8	1.00
	Yorkshire, Humber & Midlands	85.1	14.9	**0.84 (0.70–1.00), 0.045**
	East of England	82.1	17.9	1.01 (0.83–1.22), 0.936
	London	89.2	10.8	**0.61 (0.45–0.81), 0.001**
	South of England	83.4	16.6	0.93 (0.79–1.10), 0.422
	Wales and Scotland	85.2	14.8	**0.83 (0.70–0.99), 0.040**
	Northern Ireland	87.0	13.0	**0.73 (0.58–0.91), 0.005**
Urbanicity	Urban	84.5	15.5	1.00
	Small town	83.9	16.1	1.04 (0.90–1.20), 0.626
	Village	86.2	13.8	0.89 (0.73–1.09), 0.258
Index of multiple deprivation[4]	Least deprived decile	86.3	13.7	1.00
	2nd decile	85.4	14.6	1.07 (0.84–1.36), 0.600
	3rd decile	87.3	12.7	0.93 (0.71–1.21), 0.577
	4th decile	85.2	14.8	1.08 (0.86–1.36), 0.522
	5th decile	84.7	15.3	1.12 (0.87–1.43), 0.384
	6th decile	82.4	17.6	1.28 (0.98–1.68), 0.066
	7th decile	83.0	17.0	1.24 (0.94–1.64), 0.121
	8th decile	84.1	15.9	1.16 (0.90–1.50), 0.254
	9th decile	84.0	16.0	1.17 (0.92–1.49), 0.197
	Most deprived decile	83.9	16.1	1.17 (0.93–1.49), 0.182

[1] Estimates based on n = 20 imputed datasets and adjusted for complex survey design.
[2] 95 % confidence interval and *p*-value.
[3] Office for National Statistics Socio-Economic Classification.
[4] 2004 Indices of multiple deprivation (IMD) classification, estimated at the small area level and measuring deprivation across the combined domains of income, employment, health and disability, education, housing & services, living environment, and crime.

Table 2
Gender differences in psychosocial risk factors for of self-harm: pooled analysis of 20 imputation datasets (n = 11,196).

	Boys					Girls					Test comparing exposure prevalence[5]		Test comparing exposure-related RR of self-harm[6]	
	Exposure prevalence	Relative risk of self-harm				Exposure prevalence	Relative risk of self-harm							
	%	RR[1]	(LB[2]	UB[3])	p[4]	%	RR[1]	(LB[2]	UB[3])	p[4]	p[4, 7]		p[4, 7]	
Does not live with mother	3.7	1.90	(1.19	3.04)	0.007	3.1	1.03	(0.69	1.54)	0.873	0.265		0.071	
No mother/not in touch	1.7	1.74	(0.70	4.28)	0.230	1.3	1.04	(0.57	1.89)	0.892	0.213		0.313	
Does not live with father	28.4	1.23	(0.95	1.60)	0.113	28.1	1.19	(1.04	1.35)	0.009	0.722		0.878	
No father/not in touch	**7.7**	1.50	(1.01	2.24)	0.047	**10.2**	1.67	(1.37	2.04)	<0.001	**0.001**		0.397	
Not close to mother	**3.7**	2.01	(1.27	3.19)	0.003	**5.5**	1.87	(1.51	2.33)	<0.001	**0.004**		0.760	
Not close to father	**16.2**	1.60	(1.22	2.11)	0.001	**22.2**	1.79	(1.57	2.03)	<0.001	**<0.001**	*	0.272	
Argues with mother	**6.6**	2.30	(1.61	3.28)	<0.001	**9.5**	2.06	(1.77	2.39)	<0.001	**<0.001**	*	0.704	
Argues with father	6.0	1.98	(1.33	2.95)	0.001	6.8	2.24	(1.88	2.66)	<0.001	0.311		0.507	
Has little social support	5.0	2.80	(2.06	3.82)	<0.001	5.9	2.57	(2.17	3.03)	<0.001	0.162		0.768	
Bullies other children	**9.3**	**3.03**	**(2.39**	**3.85)**	<0.001	**5.7**	**2.14**	**(1.81**	**2.53)**	<0.001	**<0.001**	*	**0.027**	
Bullied by other children	12.6	3.95	(3.18	4.90)	<0.001	13.6	3.30	(2.93	3.70)	<0.001	0.256		0.305	
Assaulted or stolen from	**16.1**	3.61	(2.88	4.53)	<0.001	**11.5**	3.08	(2.74	3.47)	<0.001	**<0.001**	*	0.411	
Assaulted sexually	**1.2**	4.10	(2.59	6.49)	<0.001	**4.4**	2.91	(2.56	3.31)	<0.001	**<0.001**	*	0.266	
Struggles with weight	**25.1**	1.72	(1.35	2.19)	<0.001	**38.2**	1.65	(1.45	1.87)	<0.001	**<0.001**	*	0.647	
MFQ[8]: low mood	**12.1**	6.28	(5.02	7.85)	<0.001	**28.8**	5.43	(4.74	6.22)	<0.001	**<0.001**	*	0.442	
MFQ[8]: tired, restless, distracted	**15.4**	5.43	(4.35	6.79)	<0.001	**29.4**	4.63	(4.04	5.31)	<0.001	**<0.001**	*	0.429	
MFQ[8]: low self-esteem	**12.1**	6.94	(5.60	8.61)	<0.001	**29.8**	5.35	(4.64	6.18)	<0.001	**<0.001**	*	0.105	
Unhappy with appearance	**51.5**	2.40	(1.90	3.03)	<0.001	**74.0**	2.84	(2.27	3.57)	<0.001	**<0.001**	*	0.245	
Unhappy with school	**41.9**	1.78	(1.41	2.25)	<0.001	**47.0**	2.16	(1.85	2.52)	<0.001	**<0.001**	*	0.080	
Unhappy with family	**23.3**	2.80	(2.26	3.47)	<0.001	**29.7**	2.68	(2.36	3.04)	<0.001	**<0.001**	*	0.783	
Unhappy with friends	**23.1**	2.03	(1.61	2.56)	<0.001	**29.3**	2.03	(1.81	2.28)	<0.001	**<0.001**	*	0.896	
Unhappy with life	**30.9**	4.09	(3.24	5.17)	<0.001	**46.9**	3.71	(3.11	4.43)	<0.001	**<0.001**	*	0.545	
No good at English	**20.7**	1.24	(0.98	1.57)	0.078	**15.2**	1.06	(0.91	1.23)	0.476	**<0.001**	*	0.264	
No good at Math	**17.0**	**0.98**	**(0.74**	**1.29)**	0.883	**25.8**	**1.57**	**(1.38**	**1.78)**	<0.001	**<0.001**	*	**0.002**	
No good at Science	**19.7**	1.21	(0.92	1.59)	0.169	**26.0**	1.34	(1.16	1.55)	<0.001	**<0.001**	*	0.399	
No good at PE	**20.0**	1.27	(0.99	1.65)	0.064	**29.7**	1.37	(1.20	1.57)	<0.001	**<0.001**	*	0.647	
Unsatisfied with self	**7.4**	3.72	(2.88	4.82)	<0.001	**24.0**	3.51	(3.10	3.98)	<0.001	**<0.001**	*	0.983	
Has no good qualities	**6.2**	2.79	(2.12	3.67)	<0.001	**20.1**	2.77	(2.45	3.13)	<0.001	**<0.001**	*	0.700	
Doesn't do things as well as others	**7.6**	2.29	(1.76	2.99)	<0.001	**15.9**	2.59	(2.30	2.92)	<0.001	**<0.001**	*	0.246	
Not a person of value	**9.8**	3.16	(2.45	4.08)	<0.001	**17.7**	3.01	(2.65	3.41)	<0.001	**<0.001**	*	0.917	
Doesn't feel good about self	**10.3**	4.28	(3.33	5.49)	<0.001	**29.9**	3.67	(3.17	4.26)	<0.001	**<0.001**	*	0.674	
Uses social media >2 h a day	**39.0**	**1.37**	**(1.09**	**1.73)**	0.008	**62.4**	**1.93**	**(1.68**	**2.21)**	<0.001	**<0.001**	*	**0.007**	
Has partner	18.5	2.36	(1.85	3.01)	<0.001	19.4	2.10	(1.84	2.39)	<0.001	0.371		0.606	
Doesn't tell partner about worries	**69.6**	0.71	(0.58	0.86)	0.001	**59.7**	0.89	(0.78	1.01)	0.077	**<0.001**	*	0.138	
Doesn't tell parents about worries	**46.7**	**2.12**	**(1.65**	**2.74)**	<0.001	**51.1**	**3.12**	**(2.72**	**3.58)**	<0.001	**<0.001**	*	**0.010**	
Doesn't tell sibling(s) about worries	**82.4**	**1.29**	**(0.93**	**1.79)**	0.125	**79.4**	**2.05**	**(1.63**	**2.59)**	<0.001	**0.001**		**0.020**	
Doesn't tell other family about worries	90.1	**0.70**	**(0.48**	**1.04)**	0.079	90.5	**1.58**	**(1.22**	**2.03)**	<0.001	0.642		**0.004**	
Doesn't tell teacher about worries	**91.3**	0.82	(0.51	1.30)	0.387	**93.2**	1.36	(0.99	1.88)	0.058	**0.001**	*	0.109	
Doesn't tell other adults about worries	96.3	1.19	(0.68	2.07)	0.537	95.7	1.12	(0.81	1.57)	0.487	0.197		0.766	
Willing to take risk	**83.3**	2.05	(1.47	2.87)	<0.001	**78.3**	1.56	(1.30	1.87)	<0.001	**<0.001**	*	0.152	
Has little patience	**45.8**	1.34	(1.08	1.66)	0.008	**50.5**	1.34	(1.19	1.50)	<0.001	**<0.001**	*	0.821	
Doesn't have a trusted person	**25.4**	**1.39**	**(1.08**	**1.80)**	0.012	**19.5**	**1.93**	**(1.69**	**2.20)**	<0.001	**<0.001**	*	**0.014**	
Uses tobacco, alcohol, or drugs	**7.8**	2.38	(1.83	3.10)	<0.001	**9.5**	2.69	(2.33	3.11)	<0.001	**0.017**		0.150	
Gambles	**5.7**	1.31	(0.88	1.95)	0.177	**1.8**	2.04	(1.46	2.83)	<0.001	**<0.001**	*	0.107	
Behaves antisocially	**4.5**	3.09	(2.29	4.18)	<0.001	**2.5**	2.43	(2.00	2.95)	<0.001	**<0.001**	*	0.265	
Has been in trouble with police	**8.9**	2.57	(1.92	3.45)	<0.001	**5.3**	2.01	(1.64	2.47)	<0.001	**<0.001**	*	0.292	

(*continued on next page*)

Table 2 (*continued*)

	Boys					Girls					Test comparing exposure prevalence[5]		Test comparing exposure-related RR of self-harm[6]
	Exposure prevalence	Relative risk of self-harm				Exposure prevalence	Relative risk of self-harm						
	%	RR[1]	(LB[2]	UB[3])	p[4]	%	RR[1]	(LB[2]	UB[3])	p[4]	p[4, 7]		p[4, 7]
Mother has a long-term illness	24.4	1.40	(1.09	1.79)	0.008	25.0	1.36	(1.21	1.52)	<0.001	0.691		0.810
Father has a long-term illness	18.9	1.47	(1.06	2.03)	0.020	20.1	1.22	(1.02	1.46)	0.033	0.152		0.258
Mother has low life satisfaction	20.0	1.26	(0.93	1.70)	0.140	21.3	1.37	(1.20	1.56)	<0.001	0.203		0.578
Father has low life satisfaction	15.2	1.49	(1.06	2.11)	0.023	15.3	1.23	(0.98	1.55)	0.073	0.614		0.443
Mother is a risky/ harmful drinker	10.7	1.18	(0.83	1.67)	0.352	11.0	1.34	(1.12	1.61)	0.002	0.725		0.409
Father is a risky/ harmful drinker	23.2	1.09	(0.80	1.50)	0.571	22.6	1.21	(1.02	1.43)	0.027	0.969		0.413
Has reached puberty	**69.4**	1.23	(0.94	1.61)	0.137	**96.7**	2.11	(1.21	3.70)	0.009	**<0.001**	*	0.061
Attracted to people of same sex	**2.7**	**4.34**	**(3.30**	**5.70)**	<0.001	**8.2**	**2.92**	**(2.56**	**3.33)**	<0.001	**<0.001**	*	**0.013**
Externalises: problem behaviour	**17.6**	2.17	(1.68	2.82)	<0.001	**13.1**	2.00	(1.72	2.33)	<0.001	**<0.001**	*	0.761
Externalises: steals, lies or cheats	**20.3**	2.11	(1.64	2.71)	<0.001	**14.8**	1.76	(1.51	2.05)	<0.001	**<0.001**	*	0.266
Externalises: hyperactivity/ inattention	**28.7**	1.76	(1.36	2.27)	<0.001	**19.7**	1.43	(1.24	1.66)	<0.001	**<0.001**	*	0.255
Externalises: inattention/ impulsivity	**26.0**	2.14	(1.70	2.69)	<0.001	**17.5**	1.86	(1.62	2.14)	<0.001	**<0.001**	*	0.413
Internalises: worried, sad, somatises	**13.7**	1.62	(1.23	2.15)	0.001	**18.8**	1.77	(1.53	2.04)	<0.001	**<0.001**	*	0.576
Internalises: nervous, clingy, scared	**12.3**	2.09	(1.58	2.77)	<0.001	**18.8**	2.13	(1.86	2.43)	<0.001	**<0.001**	*	0.944
Internalises: socially isolated	**12.8**	1.96	(1.46	2.63)	<0.001	**10.8**	2.07	(1.77	2.41)	<0.001	**0.013**		0.633
SDQ[9]: high on emotional problems	**10.7**	1.83	(1.38	2.44)	<0.001	**17.8**	2.08	(1.82	2.38)	<0.001	**<0.001**	*	0.363
SDQ[9]: high on conduct problems	**7.4**	2.40	(1.78	3.23)	<0.001	**5.4**	2.03	(1.68	2.45)	<0.001	**0.002**		0.485
SDQ[9]: high on hyperactivity	**31.1**	1.96	(1.54	2.50)	<0.001	**19.6**	1.65	(1.44	1.90)	<0.001	**<0.001**	*	0.329
SDQ[9]: low on peer relations	**10.9**	2.03	(1.51	2.73)	<0.001	**7.6**	1.86	(1.59	2.17)	<0.001	**<0.001**	*	0.571
SDQ[9]: low on prosocial behaviour	**12.4**	1.19	(0.88	1.62)	0.260	**7.3**	1.69	(1.37	2.08)	<0.001	**<0.001**	*	0.081
Does not generally trust others	**32.6**	1.84	(1.49	2.27)	<0.001	**44.7**	2.00	(1.75	2.28)	<0.001	**<0.001**	*	0.456

[1] Relative risk. Associations were adjusted for child's age and ethnicity, parent's socioeconomic status, region within the UK, urbanicity of the living environment, and index of multiple deprivation decile. Adjusted for complex survey design.

[2] Lower bound of the 95 % confidence interval.

[3] Upper bound of the 95 % CI.

[4] *p*-Value.

[5] We compared exposure prevalence among boys and girls using a modified Poisson regression model, regressing the child's gender on the occurrence on the risk factor. We interpret the *p*-value for the gender term in evaluating the statistical significance of differences in exposure prevalence.

[6] Differences between boys and girls in relative risk of self-harm with exposure were evaluated using a statistical interaction term (exposure*female). As such, the interaction term evaluates the presence of a *difference* in relative risk of exposure-related self-harm between boys and girls. We interpret the *p*-value of the interaction term as a test of the statistical significance of this difference.

[7] For ease of interpretation, statistically significant differences between boys and girls is presented at the traditional critical *p*-value threshold ($p < 0.05$) in bold print. Any differences robust against a Bonferroni-adjusted critical *p*-value threshold of 0.00075 ($p < 0.05$ divided by 67 comparisons) are indicated with the [*] symbol.

[8] Mood and Feelings Questionnaire.

[9] Strength and Difficulties Questionnaire.

- Have self-perceived poor academic performance in Maths (prevalence 25.8 % in girls, 17 % in boys)
- Use social media for >2 h per day (62.4 % vs 39 %)
- Not discuss worries with parents (51.1 % vs 46.7 %)
- Experience same-sex attraction (8.2 % vs 2.7 %).

3.4. Gender differences in strength of association between risk factor and self-harm

There were also gender differences in the strength of association between some risk factors and self-harm. Same-sex attraction was more prevalent in girls who self-harm (8.2 %) than in boys who self-harm (2.7 %). However, the relative risk of self-harm in boys who were attracted to the same sex (4.3), was higher than in girls who are attracted to the same sex (2.9). This means that, of those young people who are attracted to the same sex, boys were more likely to self-harm than girls. Boys who self-harmed were more likely than girls who self-harmed to report that they did not have a trusted person (25.4 %) and they did not discuss their worries with a sibling (82.4 %), (19.5 %; 79.4 %). However, the relative risk of self-harm for these factors was higher in girls who self-harmed (1.93; 2.05) than boys (1.39; 1.29).

There were no differences between boys and girls in either risk factor prevalence or strength of association with self-harm for: living or being in touch with the biological mother, living with the biological father, arguing with the biological father, lack of social support, being bullied, having a partner, discussing worries with adults other than relatives or teachers, and long-term illness, low life satisfaction, and alcohol misuse among the child's parents.

Findings from analyses where item-missing values were included as separate response categories were broadly similar (see supplement S4).

3.5. Results from propensity score matching

When propensity score matching was used to remove the effect of differential exposure to risk factors, the relative risk of self-harm in girls compared to boys was lower (RR = 1.77, 95%CI = 1.47–2.12, $p < 0.001$) than in the original data set (RR = 2.69, 95%CI = 2.36–3.04; $p < 0.001$). This indicates that differential exposure to risk factors can account for 34 % of the difference in self-harm risk between boys and girls. Once this differential exposure was removed, there was still an increased risk of self-harm associated with female gender (RR = 1.77, 95%CI = 1.47–2.12, $p < 0.001$), meaning that approximately two thirds of the gender difference in self-harm prevalence was not explained by the factors assessed.

4. Discussion

This study examined gender differences in risk factors associated with self-harm, using data from over 11,000 participants in the Millennium Cohort Study. The MCS is a prospective, observational study, which allows for exploration of health outcomes and health inequalities. Our findings showed that prevalence of self-harm was greater among girls than boys, with a ratio of 2.6 females to 1 male. Differential exposure to psychosocial risk factors explained a third of the observed gender difference in risk of self-harm. The most notable differences were that intense social media use and not confiding in family members were more strongly associated with self-harm in girls than boys, whilst being the perpetrator of bulling and experiencing same-sex attraction were more strongly associated with self-harm in boys than girls.

Estimates of self-harm rates vary considerably between studies, as the private nature of the act makes it difficult to obtain reliable data. A GP cohort study of 10–19 year olds identified an annual incidence of self-harm presentations to the GP of 0.25 % (Morgan et al., 2017), reflecting that most young people who self-harm do not seek medical attention. It is difficult to make a direct comparison of MCS findings to other cohort studies, due to the differences in sample demographics and questions asked. The ALSPAC study is perhaps the most comparable, which recruited babies born in the early 1990s, and at 16–17 years old asked participants if they had "ever hurt themselves on purpose in any way" (Kidger et al., 2012). Self-harm prevalence in the ALSPAC study was 18.8 %, slightly higher than the MCS prevalence of 15.4 %. However, this may reflect the different time scale of the question (ever vs the last 12 months), and that self-harm prevalence increases with age (Hawton et al., 2012). The female to male ratio in ALSPAC was 2.8:1, comparable with the MCS ratio of 2.6:1.

Our findings paint a worrying and unhappy picture of UK teenage life. There were differences between boys and girls, regardless of their self-harm status, in type of problem reported. Girls were more likely to experience internalising difficulties such as low self-esteem, low mood, unhappiness and weight issues, whereas boys were more likely to externalise and present with hyperactivity and conduct problems. This gender difference in externalising and internalising emotional difficulties aligns with previous research (Cavanaugh et al., 2015). For example, in those young people who did self-harm, there was evidence that the patterns and strengths of associations between risk factors and the self-harm outcome differed for boys and girls. This differential exposure to psychosocial risk factors explained a third of the gender difference in risk of self-harm.

4.1. Interpersonal difficulties and relationships

Perhaps the most striking difference this study identifies is that girls who self-harm are less likely than boys to speak to someone when they are worried, such as parents or family. Although overall more boys reported not being able to trust others, girls who self-harm were more likely to report distrust than boys who self-harm. Therefore, despite being more prevalent in boys, not trusting others had a greater impact on risk of self-harm in girls.

Women are generally thought of as being more emotionally expressive than men and more likely to seek help (De Boise and Hearn, 2017), with public health campaigns encouraging men to talk and share their difficulties to reduce suicide rates. However, in contrast to our findings, other studies show males tend to be more trusting than females, particularly of unknown individuals (Lemmers-Jansen et al., 2017). Our study shows that young girls who self-harm are less likely to feel able to share their worries with trusted individuals than boys. It may be that boys do not need to feel trust in order to share their worries or prefer doing so with people less close to them. It may also be that those girls who feel unable to share their worries verbally utilise self-harm as a form of expression, either to communicate distress or elicit care. Conversely, girls who are least able to share concerns with others may be at greater risk of self-harm as they are unable to seek support for their underlying difficulties, particularly if they feel shame around their self-harm behaviours, or are fearful of how others will react. Girls feeling less able to confide in their family members may also represent a part of typical adolescent development, where teens tend to shift their priorities in social interactions towards peers over family members. We may be seeing this more prominently in girls as their interpersonal development is typically ahead of boys (Lemmers-Jansen et al., 2017). Clinicians should therefore pay particular attention to the support network around young girls when assessing risk and developing therapeutic goals, which may involve working to improve existing family relationships, or identifying alternative trusted adults.

4.2. Social media

Girls who self-harmed were more likely than boys to engage in social media use for >2 h per day. It is not possible to imply causality from this cross-sectional study, however, social media usage can convey both risks and benefits to young people. Time spent online may increase risk of self-harm through increasing exposure to content that may cause distress, normalising self-harm, or fostering competition and contagion.

However, there may also be benefits for young people's wellbeing through social support and connectedness and reducing social isolation. There may be direct benefits in terms of reducing self-harm, through access to crisis support and therapy (Marchant et al., 2017; Biernesser et al., 2020; Brennan et al., 2022). Enquiring about social media usage may be helpful as a marker of emotional difficulties. There is also potential for social media to be an effective way to reach young girls therapeutically and more research is needed in this area.

4.3. Abuse and violence

Both genders in this study experienced violence, however girls were more likely to experience sexual assault, whilst boys were more likely to experience physical assault. Boys who self-harmed were more likely to be the perpetrators of bullying. It has been found that males and females tend to respond differently to experiencing sexual abuse, with females being more likely to develop depression and anxiety, and males more likely to misuse alcohol (Cavanaugh et al., 2015). Although this study did not identify gender related differences in the impact of either physical assault or sexual abuse on self-harm at the age of 14–15, this may be something that develops at a later stage as young people travel towards adulthood. It would be worthwhile exploring the implications of exposure to different types of violence in later waves of the MCS data, in terms of how these may impact on future mental health outcomes, including self-harm.

4.4. Same-sex attraction

It is well documented that young people who experience same-sex attraction are at an increased risk of mental health difficulties, including self-harm (Miranda-Mendizábal et al., 2017). Our study found that the risk of self-harm in boys who are attracted to the same sex is significantly higher than in girls, despite same-sex attraction being overall more common in girls who self-harm that boys. This finding is mirrored in other studies, where there are higher rates of suicide attempts in sexual minority males, whilst there are higher rated of substance misuse in sexual minority females (Russell and Fish, 2016). People from sexual minorities often experience distinct, chronic stressors such as victimisation and discrimination, that are related to their stigmatised identities. This can be exacerbated by a lack of support on an institutional level (Russell and Fish, 2016). There is little literature available that compares the mental health of sexual minority males and females. However, the increased association of self-harm with same sex attraction in males may reflect societal pressures around expression of hegemonic masculinity, and avoidance of more “feminine” traits, which supresses emotional expression (Ahuja et al., 2015). There is a need for more research in this area, and for more supportive services that are able to understand and respond to individual needs.

5. Conclusion

This study showed that in early adolescence there are notable gender differences in the prevalence of known psychosocial risk factors for self-harm. However, there was limited evidence of gender differences in the pattern and strength of association of these risk factors with self-harm. There was some evidence that girls who had more intense social media use and girls who lacked confiding relationships were more at risk of self-harm; whilst there was a higher risk of self-harm in boys who experienced same-sex attraction and who bullied others. From our analysis, differential exposure to the extensive list of psychosocial risk factors assessed in this study can explain a third of the difference in self-harm risk between boys and girls. Further research is needed to more fully understand this gender gap. It may be that important psychosocial or physiological risk factors were not included in the analysed data set, or that there are more abstract cultural influences which are harder to quantify. Although the risk factors examined cannot fully explain the gender differences in self-harm prevalence and presentations, they do provide a starting point for us to reflect on how treatment can be individualised to better meet the differing needs of girls and boys.

5.1. Limitations and Implications for further work

For the specific purpose of this study there are limitations of the original MCS dataset — in the potential for participants to interpret the single self-harm question in different ways, and the binary recording of gender. First, the single self-reported question about self-harm limits our ability to assess the meaning of a positive response. Awareness of self-harm is high in this age group, but the term may encompass other behaviours not usually considered by researchers, such as reckless drinking and drug taking, or restriction or purging as part of an eating disorder. Similarly, self-harm may be under-reported by others who do not perceive their behaviours to be considered as self-harm. Second, there are no questions that allow us to explore gender diversity, for example young people who are uncertain about their gender, or especially those who feel a mismatch between their self-perceived gender and their physical sex. These limitations may have affected the study's ability to fully capture the complexity of self-harm experiences, and how they relate to young people's gender identity and sense of self.

More broadly, the wide remit of the MCS means that any particular category of risk cannot be exhaustively explored. This applies both to psychological characteristics that might distinguish boys and girls, and socio-economic factors. The 6th sweep took place in the middle of a period in which UK governmental austerity policies (following the financial crisis of 2008 and its sequelae) had a profound effect on community and children's services and which was associated with a general decline in the self-reported emotional wellbeing of young people (The Prince's Trust, 2023).

The potential impact of attrition and missing data should also be considered. 63 % of the original birth cohort were retained for sweep 6 at 14 years old. The MCS employs a range of procedures to track individuals and promote retention, however they have noted that non-response rates are consistently higher for families in ethnic or disadvantaged areas. Weights are provided in the data to account for attrition and reduce bias where possible, however deprivation is a risk factor for self-harm (Hawton et al., 2012) and so results should be interpreted with caution. Of those who were retained in wave 6, we were able to include data from 94 % of participants. With over half of the participants having at least one variable missing, we used multiple imputation methods to reduce the impact of missing data. The highest rates of missingness were in variables related to father's health and life satisfaction, which may reflect the male parent's unwillingness to share potentially sensitive information. Parent reported measures of their child's wellbeing, such as the Strengths and Difficulties Questionnaire (SDQ) and measures of externalising and internalising traits also had higher levels of missingness, which may reflect parents' reluctance to report on their child's internal experiences. There is potential for bias here if parental and child mental health problems have been underreported as a result.

As detailed above, although we can highlight association between gender and self-harm risk factors, we are unable to imply causation due to the cross-sectional nature of examining data from one sweep at one time-point alone. We must therefore be cautious when interpreting the results, particularly the direction of causation between the risk factors and self-harm. The associations identified here between gender and self-harm risk factors cannot fully explain the striking and widening gender differences we see in rates of self-harm. The focus of this study is on psychosocial risk factors, and so there may be other specific aspects of youth development that are related to self-harm but are not captured by the MCS. More qualitative research is needed to understand the gender differences in young people's experiences of self-harm, both in deepening our understanding of young people's experiences of the risk factors explored in this study, and in identifying other areas for further exploration. This may include work to understand what self-harm means to

them as individuals, how it impacts their lives, and how this might be shaped by their experiences and societal expectations associated with their gender. This work can complement our quantitative findings, particularly as our exploration of risk factors has only accounted for one third of the gender differences.

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Declaration of competing interest

None. MPR is currently employed by Unite Chimique Belge Biopharma.

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