

Original Article

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Sibling bullying in middle childhood and psychotic disorder at 18 years: a prospective cohort study

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Abstract

Background. Being bullied by a sibling has been recently identified as a potential risk factor for developing depression and self-harm. It is unknown whether this risk extends to other serious mental health problems such as psychosis. We investigated whether sibling bullying victimization or perpetration in middle childhood was prospectively associated with psychotic disorder in early adulthood.

Methods. The current study investigated 6988 participants of the Avon Longitudinal Study of Parents and Children, a UK community-based birth cohort. Sibling bullying was reported at 12 years and psychotic disorder was assessed via a semi-structured interview at 18 years.

Results. Involvement in sibling bullying was associated with psychotic disorder in a dose-response fashion, even after controlling for a range of confounders. Those involved several times a week were 2–3 times more likely to meet criteria for a psychotic disorder [odds ratio (OR); 95% confidence interval (CI)]: victimization (OR 2.74; CI 1.28–5.87); perpetration (OR 3.16; CI 1.35–7.41). Categorical analysis indicated that particularly victims (OR 3.10; CI 1.48–6.50) and bully-victims (OR 2.66; CI 1.24–5.69) were at increased risk of psychotic disorder. Involvement in both sibling and peer bullying had a dose-effect relationship with a psychotic disorder, with those victimized in both contexts having more than four times the odds for a psychotic disorder (OR 4.57; CI 1.73–12.07).

Conclusion. Parents and health professionals should be aware of the adverse long-term effects of sibling bullying.

Introduction

There is a paucity of prospective studies considering sibling aggression as a precursor to the development of mental health problems. This is surprising, considering that sibling aggression is the most common form of family violence (Finkelhor *et al.* 2006; Radford *et al.* 2013). Nevertheless, parents and health professionals continue to perceive aggression between siblings as benign and normative behavior that children will outgrow (Eriksen & Jensen, 2009). While the occasional conflict between siblings can be constructive, repeated negative interactions may have detrimental outcomes such as increasing the risk of internalizing and externalizing problems (Buist *et al.* 2013).

Repeated aggressive behavior perpetrated by a sibling, with the intention to cause harm and involving an element of perceived or real power imbalance has been labeled as sibling bullying (Wolke *et al.* 2015). Sibling bullying has been associated with adjustment problems such as increased emotional and behavioral problems, as well as greater mental health distress (Wolke & Samara, 2004; Wolke & Skew, 2011; Tucker *et al.* 2013, 2014). However, these findings have been based on cross-sectional or retrospective designs, preventing conclusions to be drawn on whether emotional or behavior problems preceded sibling bullying, or vice versa.

At present, we are only aware of one study that prospectively studied the relationship between experiencing sibling bullying in middle childhood and mental health in late adolescence/early adulthood. This recent study (Bowes *et al.* 2014) reported that experiencing sibling bullying several times a week in middle childhood increased the odds of depression and self-harm twofold, even after controlling for peer bullying, other confounders and pre-existing emotional problems.

There is now ample evidence that childhood trauma such as physical or sexual abuse increases the odds of reporting psychotic symptoms (Varese *et al.* 2012) as well as developing psychotic disorders (Bebbington *et al.* 2004; Fisher *et al.* 2010; Varese *et al.* 2012). Psychotic disorders are one of the most impairing mental health problems with severe effects on individual's quality of life and significant social and economic costs (Kennedy *et al.* 2014).

Recent research has indicated that bullying, the systematic abuse by peers, is also implicated in the development of both psychotic symptoms (Cunningham *et al.* 2016) and psychotic

disorders (Bebbington *et al.* 2004; Trotta *et al.* 2013; Sourander *et al.* 2016). While most research has focused on childhood victimization, some evidence suggests that perpetrating peer bullying may also be associated with increased psychotic symptoms (Kelleher *et al.* 2008). However, it is unclear whether this is related to bullying perpetration *per se*, or the subset of children involved as both perpetrators and victims of bullying. Moreover, sibling aggression has been associated with the involvement in peer bullying (Tucker *et al.* 2014; Tippett & Wolke, 2015) and involvement in both bullying at home and at school has been found to have a dose-effect relationship on experiencing mental health distress, emotional and behavioral problems (Wolke & Samara, 2004; Wolke & Skew, 2011; Tucker *et al.* 2014). Whether this dose-effect relationship translates into the development of psychotic disorders is unknown. As far as we are aware, there are no previous prospective studies of bullying victimization or perpetration between siblings and the risk of developing a psychotic disorder by early adulthood.

The aim of the present study was to investigate the association between sibling bullying in middle childhood and psychotic disorder in early adulthood. We investigated whether (1) there is an association between experiencing sibling bullying (victimization or perpetration) at 12 years and the development of psychotic disorder by 18 years; (2) whether there is a dose-response relationship between the frequency of experiencing sibling victimization or perpetration and psychotic disorder; (3) whether the role taken in sibling bullying (victim, bully, bully-victim) is differentially associated with the psychotic disorder and (4) whether being victimized in more than one context (siblings at home and peers at school) is cumulatively associated with the psychotic disorder.

We expected to find an association between sibling bullying victimization and psychotic disorder (Schreier *et al.* 2009; Arseneault *et al.* 2011; Wolke *et al.* 2014) with those children acting as bully-victims being at the highest risk for a psychotic disorder (Wolke *et al.* 2014; Sourander *et al.* 2016). We further anticipated to see a dose-response effect for sibling and peer victimization, where victimization across both contexts is associated with higher risk of psychotic disorder (Wolke & Skew, 2011; Tucker *et al.* 2014).

Methods

Study design

The Avon Longitudinal Study of Parents and Children (ALSPAC) is a birth cohort study that recruited 14 541 pregnant women from Avon, UK with an expected delivery date between 1 April 1991 and 31 December 1992. Out of this initial number of pregnancies, where enrolled mothers had either returned at least one questionnaire or attended one 'Children in Focus' clinic by the 19 June 1999, there were 14 062 live births with 13 988 of these children still alive at the age of 12 months. A detailed report on the recruitment process of the mother and child cohorts are available in the cohort profile (Boyd *et al.* 2013; Fraser *et al.* 2013). Children were invited to attend annual assessment clinics, including face-to-face interviews, and psychological and physical tests from 7 years onwards. Please note that the study website contains details of all the data that is available through a fully searchable data dictionary at <http://www.bris.ac.uk/alspac/researchers/data-access/data-dictionary/>. Ethical approval for the study was

obtained from the ALSPAC Ethics and Law Committee and the Local Research Ethics Committees.

Sample

Our starting sample includes 6988 children who completed detailed questions on sibling bullying at the 12-year assessment. Questionnaires were sent out to 11 132 eligible participants, of which 7505 (67.4%) were returned and completed. Children with no siblings ($N = 477$) were excluded. Semi-structured interviews measuring psychotic experiences at 18 years were available for 4718 adolescents. Our complete sample consists of 3596 participants where data were available across both exposure and outcome variables.

Assessment of sibling bullying

Sibling bullying was assessed at 12 years via a standard sibling bullying questionnaire adapted from the Olweus Bullying Questionnaire (Olweus, 2007). Children were informed that they would be asked about bullying by brothers and sisters, explaining that this is when a sibling tries to upset them 'by saying nasty and hurtful things, or completely ignores [them] from their group of friends, hits, kicks, pushes or shoves [them] around, tells lies or makes up false rumors about [them]'. Children were asked whether they were ever bullied (victimization) or had ever bullied (perpetration) their brother or sister in the past 6 months. Responses were on a Likert scale: 'never', 'only ever once or twice', '2 or 3 times a month', 'about once a week' and 'several times a week'.

We used sibling bullying as an ordinal (frequencies of victimization and perpetration, respectively) and categorical variable (victim, bully, bully-victim). Children reporting victimization several times a month or every week were classified as victims, children reporting perpetration several times a month or every week was classified as bullies. Those who were victimized, but also bullied a sibling several times a month or every week were 'bully-victims'. Children who neither bullied or were victimized several times a month or several times a week were classified as 'non-involved' (Wolke *et al.* 2014).

Psychotic disorder in early adulthood

The psychotic disorder was assessed via the semi-structured face-to-face Psychosis-like Symptoms Interview (PLIKSi) at a mean age of 17.5 years. The PLIKSi has been adapted from the standardized clinical examination developed for the Schedule for Clinical Assessment in Neuropsychiatry (WHO, 1994). Following a brief section addressing unusual experiences, 11 core questions eliciting key psychotic experiences since the age of 12 were asked by trained Psychology graduates who administered the PLIKSi. Key psychotic experiences from the PLIKSi fell into categories of hallucinations (visual and auditory), delusions (e.g. being spied on), and experiences of thought interference (e.g. broadcasting). Inter-rater reliability, as well as the test-retest reliability of the PLIKSi were found to be high ($\kappa = 0.83$ and 0.76 ; Zammit *et al.* 2013). Individuals were classified as having a psychotic disorder if they fulfilled DSM-IV and ICD 10 criteria and reported definite psychotic experiences not attributable to the effects of sleep or fever occurring at least once per month over the previous 6 months and either caused distress, negative impact on daily functioning or led to help-seeking (Zammit *et al.* 2013).

Potential confounders

We selected potential confounders *a priori* based on the literature on peer bullying and mental health and those identified by Bowes *et al.* (2014) for sibling bullying. Confounders were assessed before the mean onset age of sibling bullying, occurring at or before the age of 8 years.

Individual characteristics

Previous psychiatric diagnoses were assessed using the Development and Wellbeing Assessment (Goodman *et al.* 2000) based on parent and teacher reports when children were 7 years. Children were classified as presenting no DSM-IV Axis I diagnosis ($N = 7775$, 94.2%) or presenting one or more Axis I diagnoses of attention deficit hyperactivity disorder, conduct disorder, oppositional defiant disorder, depression or anxiety (Schreier *et al.* 2009). Internalizing and externalizing problems were assessed via the Strengths and Difficulties Questionnaire (Goodman, 2001) via the emotional symptoms and conduct problems subscales ($\alpha = 0.70$ across both subscales), based on maternal reports when the study child was 7 years.

Peer bullying was assessed using a modified version of the Bullying and Friendship Interview Schedule (Wolke *et al.* 2014) when children were 8 and 12 years. The interview asked children about peer bullying victimization and perpetration. Children were considered as peer victims or bullies if they reported any overt or relational peer bullying several times a month or several times a week.

The UK version of the Wechsler Intelligence Scale for Children – III (Wechsler *et al.* 1992) was administered at the 8-year clinic to establish an overall score for children's intelligence quotient (grand mean = 103.97; s.d. = 16.54).

Family characteristics

Maternal depression was assessed during pregnancy at 18 weeks' gestation via the Edinburgh Post-Natal Depression Scale (Cox *et al.* 1987). Maternal reports further provided information about the study child's birth order (first born or later born), number of other children in the household (≤ 2 or ≥ 3), sibling gender (older brother/sister or not), maternal education (certificate of secondary school education and lower or ordinary-level education and higher) and marital status (single or married) when children were between 7 and 8 years old (Bowes *et al.* 2014). Domestic violence was measured across four-time points when children were between 8 months and 4 years and were considered as present if mothers reported any physical or emotional cruelty from their partner at any time point (Bowes *et al.* 2014). Maltreatment was measured across seven-time points when children were between 1 and 8 years and were considered present if mothers reported any physical or sexual abuse at any time point.

Statistical analysis

All analyses were conducted using SPSS 23 and STATA 14. Firstly, we determined the distribution of exposure to sibling bullying behavior across gender. We used Mann–Whitney U tests and χ^2 analysis to test whether gender was separately associated with bullying victimization, perpetration or sibling bullying status. Secondly, we assessed the distribution of sibling bullying behavior across all confounding variables. Mann–Whitney U tests and one-way analysis of variance (ANOVA) analyses were performed to test for individual and family characteristics of children who

were victims or perpetrators of sibling bullying (online Supplementary Table S1). Binary logistic regression analysis was utilized to examine selective drop-out, by comparing adolescents with interviews about sibling bullying who had completed the PLIKSi at 18 with those who were lost to follow-up (online Supplementary Table S2).

To assess associations between involvement in sibling bullying in middle childhood and psychotic disorder in late adolescence, a set of logistic regression models were run. First, victimization and perpetration were used as ordinal variables in order to identify a dose-response relationship. Unadjusted analyses indicate the crude relationship between victimization and perpetration with a psychotic disorder. Odd ratios (OR) and 95% confidence intervals (CI) are reported.

We then tested whether the role taken in sibling bullying was related to the psychotic disorder. Again we ran logistic regression analyses, however, this time sibling bullying was used as a categorical variable (victim, bully, bully-victim).

To test whether there was a dose-response effect of sibling and peer victimization at 12 years, we performed binary logistic regression analysis, where sibling and/or peer victimization was treated as a continuous variable (non-involved, victimized by siblings or peers, victimized by siblings and peers).

Missing data

To address possible bias in our findings, resulting from missing data by attrition, we used fully conditional specification equations as implemented in the Multiple Imputation by Chained Equations algorithm in STATA 14. We included a range of early sociodemographic variables into our model, given that these have been associated with missingness in ALSPAC. Our imputed adjusted models included a range of confounders consisting of family characteristics as well as factors that have previously been associated with psychosis (as outlined above). Using averaged parameter estimates over 60 imputed datasets using Rubin's rules (Little & Rubin, 2002) we were able to impute up to starting sample of 3559.

Results

Prevalence and characteristics of sibling bullying involvement

Children reported the onset of sibling bullying victimization ($M = 8.3$, s.d. = 2.51) and perpetration ($M = 8.7$, s.d. = 2.38) in years around the same time. Girls were more often victimized by a sibling compared with boys, while no gender difference was found for sibling bullying perpetration. Out of all children, 771 were bully-victims, 664 were pure victims and 486 were pure bullies, making up the smallest group. No gender difference was identified between bully status groups.

Children that were victimized had lower IQ, more internalizing and externalizing problems and were more frequently bullied by peers at 8 years. Moreover, they were more often later born, had more siblings and older brothers. Mothers of victimized children had higher depression scores in pregnancy, were more often exposed to domestic violence and the children to maltreatment. Children who were perpetrators of sibling bullying had lower IQ scores and higher internalizing and externalizing problems previously. Perpetrators were more often first-born and came from families with mothers with higher depression scores in pregnancy, more siblings in the household and were less likely to have

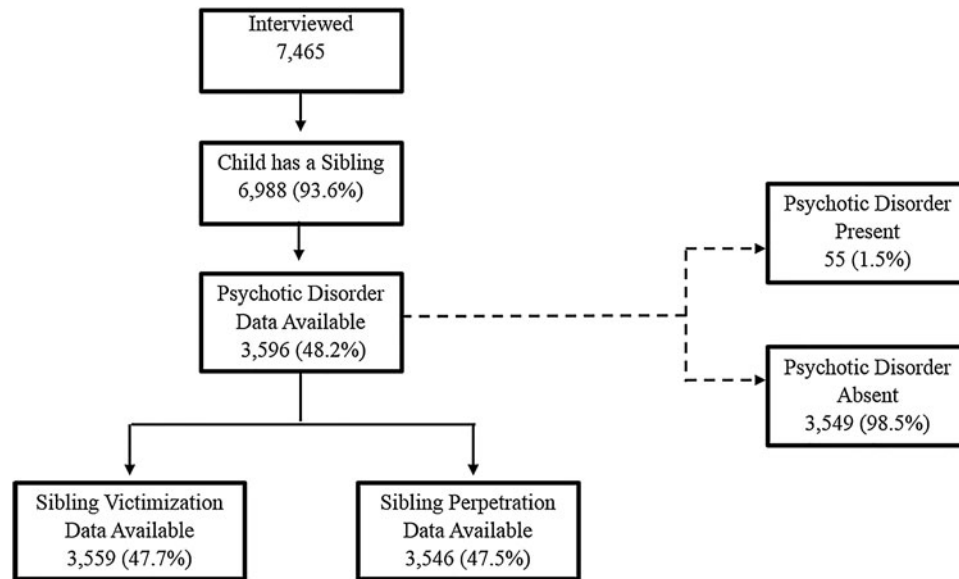


Fig. 1. Flowchart of participants assessed at 12 years on sibling bullying and subsequent assessment of psychotic disorder.

older sisters. Experience of maltreatment and domestic violence in the family were more frequent in those children who were perpetrators. For more details on individual and family characteristics of sibling bullying victims and perpetrators see online Supplementary Table S1.

Dropout analysis

Using the 12-year sibling bullying assessment as our starting point ($N = 6988$), our dropout analysis (online Supplementary Table S2) revealed that participants were less likely to have completed the PLIKSi follow-up at 18 years if they were male, had lower IQ scores, more externalizing problems in childhood and if they had bullied a sibling several times a week. Later born children, those from families where mothers were single, had higher depression scores in pregnancy, lower levels of education or reported domestic violence were also more likely to have been lost to follow-up.

Associations between sibling bullying and psychotic disorder

Out of the 3596 participants who completed both the sibling bullying assessment as well as the PLIKSi at 18 years, a total of 55 (1.5%) adolescents were classified with a psychotic disorder. The rates of psychotic disorder for those involved in sibling bullying was 11 (3%) pure victims, 6 (2.5%) pure bullies and 11 (2.9%) bully-victims.

Sibling victimization

Children who reported being victimized by a sibling several times a week had nearly three times the odds of meeting criteria for a psychotic disorder at 18 years (Table 1; OR 2.92; 95% CI 1.41–6.02). Evidence of a linear association was identified after victimization was treated as a continuous term, indicating a dose-response relationship of being victimized by a sibling and psychotic disorder (Table 1).

Sibling perpetration

Children who reported bullying a sibling several times a week were found to increase the odds of psychotic disorder threefold (OR 3.49; 95% CI 1.57–7.73). A linear trend was identified, pointing towards a dose-response relationship for bullying a sibling (Table 1).

Sibling bullying status groups

When looking at the role taken in sibling bullying (victim, bully, bully-victim), crude associations indicated that any role taken in sibling bullying is associated with being classified with a psychotic disorder (Table 2).

Sibling and peer victimization

An overlap was identified across sibling and peer victimization (online Supplementary Table S3). Binary logistic regression analysis showed that experiencing either sibling or peer victimization was associated with an increased risk of meeting the criteria of a psychotic disorder (Table 3). Moreover, there was an additional increase in the OR for children who were exposed to victimization by both siblings and peers (OR 4.72; 95% CI 1.90–11.72). A linear association was identified when victimization at home and/or school was treated as a continuous term, with cumulative victimization (home and school) being more strongly associated with the psychotic disorder.

Missing data imputation

After performing the multiple imputation, all of our logistic regression analyses were repeated using the imputed dataset and additionally controlling for a range of confounders including family characteristics and factors previously associated with psychosis (Tables 1–3). All associations between our exposure and outcome variables were only slightly attenuated.

Sensitivity analysis

We repeated all of our analysis, additionally accounting for concurrent psychotic-like experiences at 12 years in order to account

Table 1. Prevalence and ORs of psychotic disorder at age 18 according to sibling bullying victimization and perpetration at age 12

Sibling bullying	Frequency of sibling bullying					Linear trend
	Never	Only ever once or twice	2 or 3 times a month	About once a week	Several times a week	
<i>Victimization (N = 3559)</i>	1849	626	333	363	388	
% yes	1.1	1.4	0.9	2.8	3.1	
Unadjusted OR (95% CI)	Reference	1.33 (0.60–2.95)	0.83 (0.25–2.81)	2.59 (1.20–5.58)*	2.92 (1.41–6.02)**	1.31 (1.11–1.56)**
Imputed Adjusted ^a OR (95% CI)	Reference	1.27 (0.57–2.84)	0.81 (0.23–2.80)	2.37 (1.07–5.28)*	2.74 (1.28–5.87)**	1.29 (1.08–1.54)**
<i>Perpetration (N = 3546)</i>	2096	440	384	349	277	
% yes	1.0	1.4	2.6	2.3	3.3	
Unadjusted OR (95% CI)	Reference	1.44 (0.57–3.59)	2.78 (1.29–5.98)**	2.44 (1.06–5.57)*	3.49 (1.57–7.73)**	1.37 (1.15–1.63)**
Imputed adjusted ^a OR (95% CI)	Reference	1.35 (0.53–3.44)	2.71 (1.23–5.95)*	2.47 (1.00–5.61)*	3.16 (1.35–7.41)**	1.35 (1.12–1.62)**

Significant confounders:

Victimization = male gender, lower maternal education, single marital status, maltreatment present.

Perpetration = male gender, lower maternal education, single marital status, maltreatment present.

* $p < 0.05$ ** $p < 0.01$.

^aIncludes family characteristics and factors associated with psychosis as confounders.

for some reverse causality. Our results were slightly attenuated in strength (online Supplementary Tables S4–S6), however, sibling bullying victimization and involvement in both sibling and peer victimization remained strong predictors of psychotic disorder.

Discussion

This study found that sibling bullying victimization and perpetration in middle childhood is associated with the development of a psychotic disorder by 18 years in a dose-response fashion. The categorical analysis further indicated that children who act as pure victims and bully-victims several times a month or week, are at a particular risk of being classified with a psychotic disorder by early adulthood, even after imputing for missing data and adjusting for a wide range of confounders. Finally, the findings suggest that children who were victimized in more than one context (home and school) were at the highest odds of meeting criteria of a psychotic disorder.

As this is the first prospective study of sibling bullying and the development of the psychotic disorder, findings may be compared with effects found for peer bullying. We found a robust association between sibling bullying victimization and perpetration with a psychotic disorder that remained even after controlling

for well-known precursors of psychotic symptoms such as childhood cognitive abilities (Horwood *et al.* 2008), maltreatment, domestic violence and peer bullying (Kelleher *et al.* 2008; Varese *et al.* 2012; Wolke *et al.* 2014). These results are in line with previous studies who have consistently identified peer victimization as a risk factor for the development of psychotic experiences and symptoms (Schreier *et al.* 2009; Arseneault *et al.* 2011; Wolke *et al.* 2014). They are also comparable with some of the few studies on peer bullying that have suggested perpetration as an additional risk factor for psychotic experiences (Kelleher *et al.* 2008; Wolke *et al.* 2014).

Categorical analysis indicated that involvement in any role of sibling bullying was associated with an increased risk of psychotic disorder years later, however the findings were strongest for children who were pure victims or bully-victims. This parallels previous work finding that pure victims and bully-victims amongst peers are at the greatest risk for psychotic experiences (Schreier *et al.* 2009; Wolke *et al.* 2014) and psychotic disorders (Sourander *et al.* 2016) in early adulthood. Sibling bullying victimization should thus be considered as an additional risk factor or early marker in the development of the psychotic disorder. While pure bullies were also found more likely to meet criteria of a psychotic disorder, the strength of the effect was weaker

Table 2. Prevalence and ORs of psychotic disorder at age 18 according to sibling bullying status at age 12

	Sibling bullying status			
	Non-involved	Pure victim	Pure bully	Bully-victim
Bullying involvement (<i>N</i> = 3522)	2538	364	236	384
%yes	1.0	3.0	2.5	2.9
Unadjusted OR (95% CI)	Reference	3.13 (1.53–6.42)**	2.62 (1.06–6.46)*	2.96 (1.45–6.07)*
Imputed Adjusted ^a OR (95% CI)	Reference	3.10 (1.48–6.50)**	2.68 (1.04–6.89)*	2.66 (1.24–5.69)*

Significant confounders: = male gender, lower maternal education, single marital status, maltreatment present.

* $p < 0.05$ ** $p < 0.01$.

^aIncludes family characteristics and factors associated with psychosis as confounders.

Table 3. Prevalence and ORs of psychotic disorder at age 18 according to sibling and/or peer victimization at age 12

	Non-involved	Sibling OR peer	Sibling AND peer	Linear trend
Psychotic disorder (<i>N</i> = 3171)	1957	1015	199	
% yes	0.8	2.2	3.5	
Unadjusted OR (95% CI)	Reference	2.87 (1.48–5.55)**	4.72 (1.90–11.72)**	2.28 (1.51–3.44)**
Imputed adjusted ^a OR (95% CI)	Reference	2.66 (1.40–5.03)**	4.57 (1.73–12.07)**	2.23 (1.42–3.49)**

Significant confounders: = lower maternal education, single marital status.

***p* < 0.01.

^aIncludes family characteristics and factors associated with psychosis as confounders.

compared with pure victims and bully-victims. This suggests that it may be the unique combination of being a victim and perpetrator (bully-victim) of sibling bullying rather than a pure bully that increases the odds of a psychotic disorder. Alternatively, it may be due to issues of statistical power: the group of bullies was smaller and thus CIs wider. The findings indicate that all involved in frequent sibling bullying were at increased risk of developing a psychotic disorder.

Exploring bullying within the home and school environment further revealed that children exposed to multiple victimizations at the hands of both siblings and peers were at a higher risk of psychotic disorders compared with children who were only victimized in one context. This resonates with other work that has shown a dose-response relationship between experiencing multiple trauma types and psychosis (Shevlin *et al.* 2008). It also extends findings from previous studies by showing that victimization by siblings and peers not only increases the risk of clinically significant behavior problems (Wolke & Skew, 2011), but additionally poses a substantial risk towards the development of severe mental health problems like psychotic disorders.

We may speculate on why those who become victimized by a sibling, either as a pure victim or bully-victim are at increased risk for psychotic experiences years later. Social defeat is proposed as a possible route in explaining the development of schizophrenia (Selten & Cantor-Graae, 2005). Feelings of failed struggle and losing rank have been reported to induce negative self-beliefs and thereby predict psychotic symptoms (Stowkowy & Addington, 2012). There is evidence showing that social defeat is an important mediator in explaining the relationship between childhood trauma and psychotic experiences, especially in the context of bullying (Van Nierop *et al.* 2014). In peer bullying, bully-victims are found to be the most defeated, seeing that they hold the negative qualities of both pure bullies and victims (Lereya *et al.* 2015). These children become victimized, despite fighting back and may, therefore, be at the highest risk of experiencing social defeat and developing dysfunctional schemas. This tallies with our finding that sibling bully-victims had an increased risk for psychotic disorder.

Cognitive theories may also inform our understanding of how sibling bullying may increase the risk of psychotic disorder. Childhood trauma has been argued to create a lasting cognitive vulnerability generating negative schemas about the self and the world (Garety *et al.* 2001). This form of negative cognitions resulting from traumatic events such as sexual abuse (Killcommons & Morrison, 2007) or peer bullying (Campbell & Morrison, 2007) has been linked to psychotic experiences, allowing for similar speculations to be made for sibling bullying involvement.

Biopsychosocial models (Read *et al.* 2014) lend further explanation of how childhood adversities may lead to psychotic

disorders. Environmental liabilities are thought to sensitize individuals, increasing their reactivity towards minor life stressors (Collip *et al.* 2013; Myin-Germeys *et al.* 2005). Especially early life adversities such as childhood trauma, abuse and bullying have been found to elevate stress sensitivity (Knack *et al.* 2011; Lardinois *et al.* 2011) in physiological systems such as the hypothalamic-pituitary-adrenal (HPA) axis and the body's dopaminergic system (Holtzman *et al.* 2013), both which are implicated in psychosis. Inflammatory markers such as increased levels of C-reactive protein (Heppgul *et al.* 2012) or DNA methylation (Ouellet-Morin *et al.* 2013) are other examples of biomarkers that have been suggested as mediators between childhood trauma and psychosis. Sibling bullying may, therefore, be viewed as an additional trigger in altering physiological responses to stress.

Although associations between pure bullies and psychotic disorders were weaker compared with other sibling bullying groups, it is equally important to address possible mechanisms through which perpetration might lead to psychotic disorders. The presence of psychotic symptoms as well as psychotic disorders has consistently been linked to an elevated risk of aggressive behavior (Hodgins, 2008). While the etiological pathways leading to violence in psychotic disorders remain uncertain, childhood deviant behavior has been suggested as a developmental prodrome of aggression in schizophrenia (Swanson *et al.* 2008). Cross-sectional and longitudinal studies have found that childhood conduct disorders may account for violent behaviors in adults with schizophrenic disorders (Hodgins *et al.* 2008). This evidence taken together with our findings, suggests that displaying aggressive behaviors in childhood may be treated as a developmental marker of psychotic disorders in an already vulnerable individual with a tendency towards persistent aggressive behavioral patterns. This study adds that sibling bullying perpetration, beyond general conduct problems in childhood, is associated with the development of psychotic experiences.

Strengths and limitations

There are many strengths of this study. First, we used a longitudinal birth cohort that allows to make time-ordered conclusions about the association between sibling bullying and psychotic disorder. Secondly, we included a large range of potential confounders shown to be associated with sibling bullying and psychotic symptoms. This increases the confidence that the relationship between our exposure and outcome variables is causal. Third, unlike previous work on sibling bullying, focusing solely on victimization, we also showed a dose-response effect of perpetration of sibling bullying. Fourth, repeating the analysis using an imputed dataset further strengthens the confidence in our findings.

There are also limitations. Large geographically defined population studies are prone to subject loss over a 19-year period. The dropout was selective and related to family variables such as lower levels of maternal education and single-mother households, making our sample more advantaged. Thus, like many longitudinal studies, our estimate of the prevalence of sibling bullying may be inaccurate. In contrast, even when selective dropout occurs, empirical simulations have shown that associations between exposure and outcome variables are only marginally affected (Wolke *et al.* 2009). However, findings require replication. Although sibling bullying was measured via self-report, much of sibling bullying occurs behind closed doors and alternative parent reports have been found to underestimate the rate of sibling aggression with self-reports (Wolke *et al.* 2014).

Furthermore, whilst adjusting for a broad range of potential confounders had a minimal impact on our results, it remains possible that the association between sibling bullying perpetration or victimization and psychotic disorder is due to residual confounding. Finally, we cannot eliminate the possibility of reverse causality as we have no measure of parent psychotic disorder or of psychotic disorder available prior to the reported onset of sibling bullying before 8 years. However, this seems an unlikely explanation for our findings given that psychotic disorder prior to this age is extremely rare.

Conclusion

Our study adds that children involved in sibling bullying are at increased risk of developing a psychotic disorder, in keeping with findings for other kinds of stressors during childhood. If causal, as suggested by our study, this highlights the need for parents and health professionals to identify and put into place mechanisms to minimize sibling bullying within families. Interventions that focus on social skill training of children and mediation techniques for parents have been found to be helpful in alleviating sibling aggression (Tucker & Finkelhor, 2015).

Supplementary material. The supplementary material for this article can be found at <https://doi.org/10.1017/S0033291717003841>.

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