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## **Sibling Bullying at 12 years and High-Risk Behavior in Early**

### **Adulthood:**

## **A Prospective Cohort Study**

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### **Abstract**

Emerging evidence suggests that sibling aggression is associated with the development of high-risk behavior. This study investigated the relationship between sibling bullying perpetration and victimization in early adolescence and high-risk behavior in early adulthood. Sibling bullying was assessed at 12 years in 6,988 individuals from the Avon Longitudinal Study of Parents and Children, a birth cohort based in the UK and high-risk behavioral outcomes were assessed at 18-20 years. Frequent sibling bullying perpetration predicted antisocial behavior (OR=1.74; 95% CI, 1.38-2.20), while frequent sibling bullying victimization increased the odds of nicotine dependence (OR=2.87; 95% CI, 1.55-5.29), even after accounting for peer bullying and parent maltreatment. Categorical analysis revealed that particularly bullies and bully-victims were at risk of developing high-risk behavior. Finally, this study found that adolescents who were involved in bullying perpetration across multiple contexts (home and school) had the highest odds of reporting antisocial behavior (OR=3.05; 95% CI, 2.09-4.44), criminal involvement (OR=2.12; 95% CI, 1.23-3.66) and illicit drug use (OR=2.11; 95% CI, 1.44-3.08). Findings from this study suggest that sibling bullying perpetration may be a marker of or a contributory factor along the developmental trajectory to antisocial behavior problems. Intervention studies are needed in order to test whether reducing sibling bullying can alleviate long term adverse social and behavioral outcomes.

**Keywords:** siblings, bullying, aggression, adolescence, antisocial behavior, ALSPAC.

## **Introduction**

Sibling violence has been reported as the most frequent form of family violence; still aggression between siblings is largely normalized by families and societies (Caffaro, 2014). Sibling bullying further remains a neglected topic in research compared to other forms of bullying (Skinner & Kowalski, 2013). Recent evidence suggests, however, that those who are victims of sibling bullying are at greater risk for mental health problems (Tucker et al., 2013) lasting into early adulthood (Bowes et al., 2014). There is also emerging evidence that sibling relationships marked by aggression and violence may be associated with the development of high-risk behavior including substance use, delinquency, and antisocial behavior (Button & Gealt, 2009; Snyder & Burraston, 2005; Solmeyer et al. 2014). Whether sibling bullying is predictive of high-risk behavior is however unknown.

### **Sibling Aggression and High-Risk Behaviors**

Social learning theory (SLT; Bandura, 1977) posits that behavior is learned via mechanisms of observation and reinforcement. According to SLT, behavior which results in a reward or desired outcome will become internalized as adaptive and later modelled in similar social interactions. On the contrary, behavior which results in punishment or sanctions will be avoided. When parents permit or fail to intervene with physical aggression amongst siblings, children may learn that violence is rewarded with compliance and dominance (Button & Gealt, 2010) over their brother or sister. SLT would therefore predict, that children who are able to get away with perpetrating aggression towards a sibling at home will consequently internalize this maladaptive interactional style and use this method to dominate across other future contexts.

Stemming from SLT, Patterson's coercion theory (Patterson, 1982) builds on principles of reinforcement to further explain how hostile sibling interactions may escalate into antisocial behavior. Patterson suggests that ineffective parenting results in coercive (i.e. aversive

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behavior to obtain rewards) parent-child interactions that spill over onto the sibling relationship. Parents who permit repeated coercive sibling exchanges encourage the development of hostility and aggression within the family. In turn, sibling relationships may become a training ground for children to practice and internalize aggressive interactional styles that later generalize to peer relations (Patterson, 1984; 1986). When coercive exchanges across family and peer relationships persist, they pave the path for the development of persistent antisocial behavior (Dishion & Snyder 2016). Coercion theory would hence predict that children who predominantly engage in coercive cycles with their siblings will learn to model this behavior beyond the family environment. Children who consequently become involved in both aggressive sibling and peer relations may further run a cumulative risk towards the development of long-term antisocial behavior.

According to general strain theory, (GST; Agnew, 1992) exposure to stressful life events may induce negative emotions within individuals. In turn, individuals engage in corrective action including deviancy and substance use as means of overcoming these negative affective states (Agnew, 1992). Particularly harsh parenting, child abuse or peer bullying have been suggested as some of the types of strain that result in delinquency and other deviant behavior (Agnew, 2001). GST would therefore predict that children who become victimized by their siblings may resort to high-risk behavior as a coping mechanism in order to reduce negative feelings experienced through the strain of victimization.

Cross-sectional and retrospective studies have identified a robust association between hostile sibling relationships and antisocial behavior in middle childhood, adolescence and adulthood (Duncan, 1999; Compton et al., 2003; Wolke & Samara, 2004; Criss & Shaw, 2005; Button & Geal, 2010; Defoe et al., 2013; Tucker et al., 2014; Mathis & Mueller, 2015). Longitudinal studies have confirmed these findings, lending further support to a link between sibling aggression and subsequent problem behavior (Bank et al., 2004; Buist, 2010; Natsuaki

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et al., 2009; Snyder & Burraston, 2005; Solmeyer et al., 2014; Stocker et al., 2002; Tucker et al., 2015). It has also been suggested that sibling conflict and aggression may predict substance use (Espelage et al., 2013; Snyder & Burraston, 2005; Tucker et al., 2015). However, others have not found such association (East & Khoo, 2005; Stormshak et al., 2004). Furthermore, it is so far unclear whether those who perpetrate aggression or bullying are involved in more high risk behavior later in life or whether it is the victims who are at increased risk, as predicted by GST.

### **Parenting and Peer Influences**

Sibling relationships do not function in isolation. Instead they are nested within multiple levels of environmental influences (Bronfenbrenner, 1979). Literature reviews on the origins of antisocial behavior consistently identify family characteristics including ineffective parenting (i.e. hostility, abuse, domestic violence), low socioeconomic status or large family size (Farrington, 2005; Murray & Farrington, 2010) as some of the important risk factors. Maternal mental health and substance use have also been linked to children's behavior problems (Goodman et al., 2011; Kim-Cohen et al., 2005; Whitaker et al., 2006). Studies on sibling aggression have found that predictions of externalizing problems are partly explained by parenting influences (Bank et al., 2004; Natsuaki et al., 2009), emphasizing the importance of considering family influences when studying the effects of sibling aggression.

Peer bullying has also received extensive attention by scholars studying antecedents of high-risk behavior. Systematic reviews and meta-analysis investigating bullying and violence longitudinally, consistently found that perpetration is strongly associated with criminal offending and violence, even after controlling for childhood risk factors (Farrington et al. 2011; Ttofi et al., 2011; Ttofi et al., 2012). Children that bully their peers are also found more likely to report substance use (Bender et al., 2011; Durand et al., 2013; Farrington & Ttofi, 2011; Moore et al., 2014; Sourander et al., 2007; Wolke et al., 2013). Peer bullying perpetration has

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further been identified as an important mechanism underlying the relationship between family violence and substance use (Espelage et al., 2013). Peer deviancy has similarly been found to mediate the link between sibling hostility and externalizing behavior (Kim et al., 1999; Low et al., 2012).

To our knowledge, there is only one previous study that has longitudinally explored the relationship between negative sibling interactions and adolescent externalizing problems, after accounting for both parent and peer negativity (Defoe et al., 2013). While they did find a concurrent link between sibling negativity and externalizing problems, no longitudinal path was found.

### **Cumulative Sibling and Peer Influences**

Children's relationship with their siblings and peers accommodate a range of similarities in terms of their nature and dynamics. Sibling aggression has been found in different cultures to be associated with involvement in peer bullying (Wolke & Samara, 2004; Tanrikulu & Campbell, 2015; Tippett & Wolke, 2015; Tucker et al., 2014) and participating in bullying at home and at school has further been shown to have a cumulative effect on experiencing behavioral problems (Wolke & Skew, 2012). Whether there is a cumulative effect of involvement in sibling and peer bullying in the context of high-risk behaviors, as predicted by coercion theory, is unknown.

### **Methodological Issues**

While there are a number of studies supporting the link between sibling aggression and high-risk behavior, the majority of longitudinal studies are based on small sample sizes and thus had limited statistical power (Bank et al., 2004; Buist, 2010; Snyder & Burraston, 2005; Solmeyer et al., 2014; Stocker et al., 2002) or they were limited to short follow-up periods of one to three years (Natsuaki et al., 2009; Tucker et al., 2015). What is needed are large population-based and long-term longitudinal studies that explore the association between

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sibling aggression and high-risk behavior, while being able to control for potential confounders.

A further caveat is that previous studies have focused on sibling conflict more generally, thereby ignoring whether outcomes may differ for children who act as perpetrators or victims within the aggressive interaction. Studies on peer bullying suggest that children who act as both the bully and the victim may be at the highest risk of high-risk behavior (Moore et al., 2014; Sourander et al., 2007; Wolke et al., 2013). There are however no studies that have simultaneously looked at sibling perpetration and victimization as separate constructs or have studied different high-risk outcomes according to the sibling bullying role assumed. For the purpose of this study, we will focus on the construct of sibling bullying; which has previously been defined as any unwanted aggressive behavior (physical, psychological or social) by a sibling that is intended to inflict harm/distress to a brother or sister and may involve a power imbalance between the siblings involved (Wolke et al., 2015).

Although sibling and peer bullying have been suggested to have cumulative effects for behavior problems (Wolke & Skew, 2012), no studies so far have explored whether there is a similar cumulative relationship between sibling and peer bullying and high-risk behavior.

### **The Present Study**

The aim of the present study was to examine the relationship between sibling bullying in early adolescence on the development of high-risk behavior in early adulthood in a UK-based longitudinal birth cohort. We investigated (1) whether the frequency of experiencing sibling bullying (victimization or perpetration) at 12 years is associated with high-risk behavior at 18 or 20 years; (2) whether the role taken in sibling bullying (uninvolved, victim, bully, bully-victim) is differentially associated with high-risk behavior; and (3) whether bullying involvement in more than one context (siblings at home and peers at school) is cumulatively associated with high-risk behavior.



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We predicted that sibling bullying perpetration would be most strongly associated with high-risk behavior and that there would be a dose-response relationship with more frequent perpetration resulting in higher odds of high-risk behavior, as found for peer bullying previously (Farrington et al. 2011; Klomek et al., 2015; Ttofi et al., 2011; Ttofi et al., 2012). We further expected that those children who acted as either pure bullies or bully-victims would show the highest odds of high-risk behavior as previously reported for peer bullying (Klomek et al., 2015). We also predicted that involvement in sibling and peer bullying would have a cumulative relationship with engagement in high-risk behavior in early adulthood (Tippett & Wolke, 2014; Wolke & Skew, 2012).

### **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 1st April 1991 and 31st 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 19th of 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 profiles (Boyd et al., 2012; Fraser et al., 2012). 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.

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### **Sample**

Our starting sample was made up of all children who successfully completed a detailed assessment of sibling bullying at 12 years. The sibling bullying assessment was part of the “All Around Me” questionnaire which was sent out to eligible family’s homes. Out of the 11,132 questionnaires that were sent out, 7,505 (67.4%) were returned and completed. Children with no siblings (n=477) were excluded, yielding a final starting sample of 6,988 children who completed items on sibling bullying.

### **Measures**

#### **Sibling Bullying**

Sibling bullying was assessed using a sibling bullying questionnaire (Bowes et al., 2014) adapted from the Olweus Bullying Questionnaire (Olweus, 2007). Children who indicated having at least one brother or sister (93.6%) were told that they would be asked about sibling bullying, 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]”. Sibling bullying was used as both an ordinal (frequencies of victimization and perpetration) and categorical variable (uninvolved, victim, bully, bully-victim). Children were first asked to report whether they had ever been bullied by a sibling at home in the past 6 months on a 5-point Likert-scale (0=never; 1=only ever once or twice; 2=2 or 3 times a month; 3=about once a week; 4=several times a week; Bowes et al., 2014). Children were then asked to report whether they had ever bullied a sibling at home in the past 6 months. Responses were now given as “yes” or “no”. Children who responded “no” were coded as 0=never. Children who responded “yes” were asked to report how frequently they had bullied a sibling according to 6-items (e.g. calling siblings nasty/hurtful names). The highest frequency reported on any given item was used to assign

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children a sibling perpetration frequency. Children were also asked to indicate the age at which perpetration and victimization first started. Additionally, children were grouped into sibling bullying roles (uninvolved, victim, bully-victim, bully) if they reported the bullying behavior either “several times a week” or “about once a week”. Children were coded as “bully-victims” if they reported both victimization and perpetration; “victims” if they reported only victimization; “bullies” if they reported only perpetration; “uninvolved” if they reported neither victimization nor perpetration.

### **Peer Bullying**

Peer bullying was measured at 12 years using a 9-item version of the Bullying and Friendship Interview Schedule (Olweus, 2007). Children reported on both overt (e.g. taking personal belongings) and relational (e.g. telling lies) peer bullying perpetration and victimization in the past 6 months. Children who reported experiencing at least one of the nine behaviors repeatedly ( $\geq 4$  times in past 6 months) or very frequently (at least once per week) were coded as “victims”. Children who reported perpetrating at least one of nine behaviors repeatedly or very frequently were coded as “bullies” (Schreier et al., 2009).

### **High-Risk Behavior**

We used measures of antisocial behavior, criminal involvement, alcohol use, nicotine dependence, cannabis use and illicit drug use as high-risk behavior outcomes. An illustration of our complete data sample is provided in Figure 1. Our final sample size ranges from 2,018 to 4,322 depending on the high-risk behavior outcome measure fully completed 6 to 8 years later. A full list of all individual items making up the high-risk outcome variables is further provided in Figure 2.

### *Antisocial Behavior*

Antisocial behavior was assessed at 18 and 20 years using a 12-item self-completed questionnaire adapted from the Edinburgh Study of Youth Transition and Crime (Smith &

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McVie, 2003). Assessment at 18 years took place at the “Teen Focus 4” (TF4) clinic session where computer-assisted interviews were completed. At 20 years questionnaires were sent out to study participants by post. Participants were asked whether they had participated in a range of antisocial activities in the past year. The Cronbach’s Alpha was  $\alpha=.59$  at 18 and  $\alpha=.54$  at 20 years. As the distribution was inverse J-shaped, participants were classified as having been involved in antisocial behavior if they reported engagement in at least one antisocial behavior item at 18 or 20 years.

### *Criminal Involvement*

Criminal involvement was assessed at 18 years via computer-assisted interviews at the TF4 clinic session using a set of 9 items ( $\alpha=.52$ ) reflecting involvement with the police, court or prison. Criminal involvement was coded as a dichotomized variable (1=reported involvement in one or more criminal items; 0=reported no involvement in any criminal items) seeing as frequencies on the higher end of the scale were very low (e.g. 3.1% reported involvement in more than 1 criminal activity).

### *Substance Use*

All substance use measures (alcohol use, nicotine dependence, cannabis use, illicit drug use) at 18 years were obtained via computer-assisted interviews at the TF4 clinic session, while measures at 20 years were obtained via self-completed questionnaires that were sent directly to the study participants.

### *Alcohol Use*

Alcohol use was assessed via the self-completed 10-item alcohol use disorder identification test (AUDIT; Babor et al., 2001). A cut-off of 16/40 points or above was used to indicate harmful alcohol use (Kretschmer et al., 2014).

### *Nicotine Dependence*

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Nicotine dependence was assessed via the six-item Fagerstrom Test for Nicotine Dependence (FTND; Heatherton et al., 1991;  $\alpha=.61$ ). The three items with yes/no response categories were scored 0 (no) and 1 (yes), while the multiple-choice items were scored from 0-3 yielding a total score range from 0-10 with higher scores indicating higher nicotine dependence. A cut-off of 6 points or higher was used to classify participants with high nicotine dependence (Fagerström et al., 1990).

### *Cannabis Use*

Cannabis use was assessed via the six-item Cannabis Abuse Screening Test (CAST) with an internal consistency of  $\alpha=.75$  (Legleye et al., 2011). Items that were given responses of either “more often than not” or “almost always” were given the score of 1, yielding a total score range from 0-6. A cut-off of 2 points or above was used to classify participants as reporting frequent cannabis use (Legleye et al., 2011).

### *Illicit Drug Use*

Illicit drug use was assessed by asking participants if they had ever used one or more illicit drugs from a list of seven. The frequency distribution was inverse J-shaped, for this reason respondents who reported using one or more drugs were classified as having used illicit drugs (e.g. 8.2% reported having ever used more than one drug).

[Figure 1]

[Figure 2]

## **Potential Confounders in Childhood**

Previous mental health was 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 with 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).

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Internalizing and externalizing problems were assessed via the Strengths and Difficulties Questionnaire (Goodman et al., 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 at 8 years was assessed using the same instrument and cut-off criteria as described for peer bullying at 12 years above. 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 (Schreier et al., 2009). 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; SD=16.54).

### *Maternal characteristics, household and maltreatment*

Maternal depression was assessed during pregnancy at 18 weeks' gestation via the Edinburgh Post-Natal Depression Scale (Cox et al., 1987;  $\alpha=0.87$ ). Maternal substance use was also assessed at 18 weeks' gestations. Maternal reports further provided information about 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 assessed across four time points when children were between 8 months and 4 years and was 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 (Lereya et al., 2015) when children were between 1 and 8 years and was considered present if mothers reported any physical or sexual abuse at any time point.

### **Statistical Analysis**

All analyses were conducted using IBM SPSS Statistics version 23.0 and STATA version 14.0. First, we assessed the distribution of sibling bullying behavior across all of our

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confounding variables, including gender. Mann Whitney U-tests and one-way ANOVA analysis were performed in order to examine individual and family characteristics across children who reported sibling perpetration and victimization (Supplement: S1).

In order to assess whether sibling bullying in adolescence was associated with high-risk behavior in early adulthood a set of binary logistic regression analyses were run separately for each high-risk behavior outcome. Unadjusted analyses indicate the crude relationship between our exposure and outcome variables. Odd ratios (OR) and 95% confidence intervals (CI) are reported.

Sibling bullying was first explored as an ordinal variable, allowing us to test whether the frequency of perpetration (Table 1) or victimization (Table 2) was related to high-risk behavior. We also used sibling bullying as a continuous variable in order to test for a linear trend between perpetration/victimization and high-risk behavior.

We then tested whether the role taken in sibling bullying (uninvolved, victim, bully, bully-victim) was differentially associated with high-risk behavior (Table 3). For this purpose, sibling bullying was used as a categorical variable.

Our last set of logistic regression analyses was utilized in order to assess whether bullying perpetration in multiple contexts (home and school) would result in a cumulative risk of developing high-risk behavior (Table 5). An ordinal variable was created for sibling and/or peer bullying (uninvolved, either, both) and binary logistic regression analyses were conducted individually for each high-risk outcome (Supplement: S2).

Bonferroni correction (Armstrong, 2014) was applied in all logistic regression models in order to account for multiple testing and guard against type I error ( $p < .0083$ ).

In order to pinpoint which specific high-risk behavior items were most likely displayed by adolescents reporting sibling bullying, we performed additional post-hoc analyses. We first used  $X^2$  analysis to index which individual items were most often reported by adolescents. We

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then ran binary logistic regression analysis in order to pinpoint where the difference was (victims, bullies or bully-victims).

### **Missing Data**

Fully conditional specification equations as implemented in Multiple Imputation by Chained Equations algorithm in STATA 14 were applied in addition to our crude analysis in order to account for missing data by attrition. Sociodemographic variables were included as auxiliary variables, as these have been associated with missing values in ALSPAC. We further included a range of confounding variables previously associated with high-risk behavior into our model. Using averaged parameter estimates over 60 imputed datasets using Rubin's rules (Little & Rubin, 2002) we were able to impute up to the same starting sample as seen with our crude analyses. All logistic regression analyses outlined above were then repeated using this imputed dataset.

## **Results**

### **Characteristics of Siblings in our Sample**

A total of 6,990 (93.6%) children in our sample reported having at least one brother or sister. Out of these children, 3,251 (46.5%) were male, 2,499 (43.5%) were first-born, 1,875 (32.6%) had an older brother, 1,828 (31.8%) had an older sister and 1,923 (34.1%) children grew up in households with three or more children.

### **Prevalence and Characteristics of Sibling Bullying Involvement**

Sibling bullying victimization ( $M=8.3$ ,  $SD=2.51$ ) and perpetration ( $M=8.7$ ,  $SD=2.38$ ) was reported to have started around 8 years. Most children involved in sibling bullying were bully-victims (771/6,836) or victims (664/6,836), those who were pure bullies made up the smallest group (486/6,838). Males were more likely to be pure bullies; while no gender difference was found for the other sibling bullying roles.

Associations of roles in bullying with precursor variables are shown in Table S1.



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### **Sibling Bullying Perpetration/Victimization and High-Risk Behavior**

Children reporting bullying their brothers or sisters as little as two or three times a month were found to be 1.5 times more likely to report antisocial behavior in early adulthood (Table 1; OR=1.50; 95% CI, 1.21-1.86). Children who reported perpetrating sibling bullying several times a week were furthermore at higher odds of reporting illicit drug use (OR=1.48; 95% CI, 1.17-1.88). A linear trend was identified between sibling bullying perpetration and antisocial behavior, criminal involvement, alcohol use and illicit drug use, indicating a dose-response relationship.

Children who were victimized by their siblings several times a week were found to be almost three times more likely to report nicotine dependence in early adulthood (Table 2; OR=2.87; 95% CI, 1.55-5.29). A linear trend was also found for sibling bullying victimization and nicotine dependence.

Using the imputed dataset and accounting for various confounders slightly attenuated the associations, although the majority of our findings remained significant. Associations which were no longer significant were between sibling bullying perpetration and frequent illicit drug use (Table 1; imputed adjusted model) and the linear trend for sibling bullying victimization and nicotine dependence disappeared (Table 2; imputed adjusted model).

[Table 1]

[Table 2]

### **Sibling Bullying Roles and High-Risk Behavior**

Examining children according to the roles they assumed in sibling bullying (Table 3) revealed that bullies were at increased risk of reporting antisocial behavior (OR=1.94; 95% CI, 1.52-2.47), criminal involvement (OR=1.66; 95% CI, 1.15-2.40) and illicit drug use (OR=1.45; 95% CI, 1.12-1.87). Bully-victims, on the other hand, were only at increased odds of antisocial behavior (OR=1.44; 95% CI, 1.18-1.76), while victims were no more likely to report any high-

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risk behavior than those uninvolved. Once confounders were included and analyses were rerun using the imputed dataset, results remained significant only in the domain of antisocial behavior. Bullies (OR=1.66, 95% CI, 1.29-2.13) and bully-victims (OR=1.42, 95% CI, 1.15-1.76) had higher odds of being engaged in antisocial behavior in early adulthood.

[Table 3]

*What kinds of high-risk behaviour are sibling bullying perpetrators involved in?*

Bully-victims were more often involved in taking/driving a vehicle without permission and hurting/injuring animals on purpose. Adolescents who were bullies or bully-victims were further at particular risk of being rowdy/rude in public, hitting, or punching someone with the intention of hurting them, deliberately damaging/destroying property, or carrying a knife/weapon for protection. More details can be found online (Supplement: S2). In terms of criminal involvement, pure bullies were more likely to get in trouble with the police and regarding illicit drug use they had higher odds of taking cocaine at 18 years (Supplement: S2).

*Birth-Order effects*

Post-hoc analysis of birth-order effects (first-born vs. later-born) revealed that children who are sibling bullies were at increased risk of high-risk behavior only if they were also first-born. Crude associations (Table S4) found that first-born children who are bullies, were more likely to report antisocial behavior (OR=1.97; 95% CI, 1.41-2.73), criminal involvement (OR=1.99, 95% CI, 1.24-3.19) and illicit drug use (OR=1.68, 95% CI, 1.18-2.38).

### **Cumulative Effects of Sibling and/or Peer Perpetration**

Sibling and peer bullying were found to be significantly associated. Particularly those children who were perpetrators in one context (i.e. home) were also more likely to be a perpetrator in the other (i.e. school) (Table 4). Children who were bullies at home and at school were further found to have three-fold odds of engaging in antisocial behavior (Table 5; OR=3.05; 95% CI, 2.09-4.44). Furthermore, these children were also twice as likely to report

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criminal involvement (OR=2.12; 95% CI, 1.23-3.66) and illicit drug use (OR=2.11; 95% CI, 1.44-3.08). A linear trend was identified for antisocial behavior (OR=1.61; 1.41-1.84), criminal involvement (OR=1.33; 95% CI, 1.09-1.63), alcohol use (OR=1.24; 95% CI, 1.08-1.42) and illicit drug use (OR=1.48; 95% CI, 1.29-1.69) suggesting that involvement in multiple perpetration (at home and school) may result in a higher likelihood for high-risk behavior in early adulthood as opposed to being involved in bullying behavior in a single context.

When using the imputed dataset and accounting for confounds, the results were attenuated, although bullying perpetration across the home and school context remained a significant predictor of antisocial behavior and illicit drug use (Table 5; imputed adjusted models). Linear trend association was also maintained for antisocial behavior, alcohol use and illicit drug use.

[Table 3]

[Table 4]

*What kind of high-risk behavior are adolescents involved in when they act as both sibling and peer perpetrators?*

Adolescents who were perpetrators in both the home and school context were more likely to be rowdy/rude in public, hit, kick or punch someone with the intention of hurting them, deliberately damage/destroy property, carry a knife/weapon for protection and use a cheque book/credit card/cash which was stolen (Supplement: S3). Adolescents involved in both sibling and peer perpetration were furthermore often in trouble with the police, were in trial in court, and took part in a mediation process (Supplement: S3). Finally, this group of adolescents was also most likely to have tried/taken cocaine at 18 years (Supplement: S3).

## **Discussion**

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This study found that sibling bullying perpetration was associated with the development of antisocial behavior and illicit drug use in a dose-response fashion, while sibling bullying victimization was found to increase the risk of nicotine dependence. Categorical analysis revealed that bullies were at increased risk of criminal involvement and illicit drug use, while both bullies and bully-victims were at higher odds of reporting antisocial behavior, even after accounting for peer and parental influences. Finally, a cumulative relationship was identified for perpetrating bullying at home and at school, with those acting as perpetrators across both contexts at the highest risk of antisocial behavior, criminal involvement and illicit drug use.

A range of previous longitudinal studies on sibling aggression or conflict have consistently found a relationship with poor adjustment including antisocial behavior and substance use (Bank et al., 2004; Buist, 2010; Natsuaki et al., 2013; Snyder & Burraston, 2005; Solmeyer et al., 2014; Tucker et al., 2015). Our study extends these findings by looking beyond the general construct of sibling conflict and instead examined differential outcomes depending on the frequency of sibling bullying perpetration and victimization as well as sibling bullying roles assumed by children (uninvolved, victim, bully, bully-victim).

According to SLT and coercion theory we predicted that sibling bullying perpetration would be most strongly associated with high-risk behavior. Our findings support this hypothesis, particularly in the domain of antisocial behavior, which is in line with previous longitudinal studies on perpetrating sibling aggression (Natsuaki et al., 2009; Tucker et al., 2015) and peer bullying (Bender et al. 2011; Farrington et al., 2011; Ttofi et al., 2011; Ttofi et al., 2012). While sibling bullying perpetration did not remain a significant predictor across other forms of high-risk behavior, once confounds were accounted for, a linear trend was identified for criminal involvement, alcohol use and illicit drug use, suggestive of a dose-response relationship. This is supported by studies on peer bullying which found similar dose-response associations between bullying perpetration and antisocial behavior, violence,

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criminality and substance use (Klomek et al., 2015). On the contrary, adolescents who were victimized by a sibling were found to be at increased risk for nicotine dependence, but only if the bullying occurred several times a week. This has not yet been studied, however the findings for peer victimization and smoking are consistent with this finding (Moore et al., 2017). GST may serve as a framework for explaining this association. According to GST environmental strain produces negative emotions which may trigger engagement in corrective behavior (Agnew, 1992). Our results are consistent with GST by suggesting sibling bullying victimization as an additional specific strain that may result in compensatory behavior (nicotine dependence) in order to alleviate the stress of sibling bullying (Agnew, 2001). We further predicted that those who acted as sibling bullies or bully-victims would most likely be involved in high-risk behavior. This was confirmed for antisocial behavior, as previously shown with peer perpetration (Klomek et al., 2015). These findings support SLT and coercion theory, according to which aggression is learned via observation/experience and reinforcement (Bandura, 1977). Children who lack parental guidance and grow up in households where aggressive behavior between brothers and sisters is permitted will learn that aggression may be a useful resource towards reaching a desired outcome (i.e. ownership of a toy). In turn, these children are likely to internalize this interactional style and continue to resort to maladaptive behavior in future contexts. Along those lines, this study shows that adolescents who are involved in frequent sibling bullying perpetration at home, either as a bully or bully-victims, are at increased odds of engaging in antisocial behavior beyond the family environment.

A discrepancy to the peer literature was evident in the domains of criminal involvement and substance use. Peer bullies are frequently found to be at risk for substance use (Durand et al., 2013; Moore et al., 2014; 2017) and both peer bullies and bully-victims have been reported to be at significantly higher odds of criminal involvement (Klomek et al., 2015). Our study only found evidence of an association between sibling bullies and antisocial behavior, criminal

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involvement and illicit drug use, particularly when children were also first-born. However, this link was no longer significant once confounds were allowed for.

Our final hypothesis was that involvement as a bullying perpetrator across both the sibling and peer context would yield the highest odds of high-risk behavior in early adulthood, as suggested by coercion theory. This prediction was confirmed for antisocial behavior, criminal involvement and illicit drug use, where adolescents had 2-3 times the odds of being involved with any of the three outcomes. This extends previous findings which have shown that sibling and peer bullying have cumulative adverse effects on problem behavior (Wolke & Skew, 2012) and allows for similar conclusions to be made for high-risk behavior. Moreover, our findings suggest a synergistic effect of sibling and peer bullying perpetration on high-risk behavior. This would have important implications for intervention and prevention strategies. As shown in our findings, involvement in bullying perpetration across multiple contexts may exacerbate high-risk behavior outcomes and thereby strengthen an already underlying antisocial tendency (Farrington & Ttfofi, 2011). Our findings support SLT (Bandura, 1977), and in particular coercion theory (Patterson et al., 1982) illustrating how repeated intentional harm-doing within the family context (sibling bullying) may provide a training ground and an internalized aggressive interpersonal model encouraging similar behavior patterns outside the family environment (peer bullying), in turn increasing the likelihood of following an antisocial trajectory later in life (Solmeyer et al., 2014).

This and other recent evidence on the negative consequences of sibling bullying (Bowes et al., 2014; Tucker et al., 2013) have implications for helping parents to deal with sibling aggression. Parents who do not intervene in their offspring's repeated aggressive exchanges or are inconsistent in intervening, allow the perpetrators to learn that they can get away with aggressive interpersonal behavior that then generalises across other contexts (Ensor et al., 2010; Wolke & Samara, 2004; Tanrikulu & Campbell, 2015; Tippett & Wolke, 2015; Tucker

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et al., 2014). Preventative measures in the form of parental education should be offered to help parents improve sibling relationship quality (Pickering & Sanders, 2015). Health professionals should ask about sibling bullying and monitor children's early aggressive tendencies, as these may be an early warning sign or predictor of long term problems (Song et al., 2016). Moreover, there is a need for researchers to develop and evaluate interventions that are specifically aimed at altering and improving the sibling relationship quality of children involved in sibling bullying to reduce high-risk behavior later in life.

### **Strengths and Limitations**

Our study has several strengths. First, to our knowledge this is the first long-term longitudinal prospective birth cohort study that has explored the relationship between sibling bullying and high-risk behavior. This has allowed us to make predictions up to 8 years after sibling bullying was assessed. Using a large longitudinal dataset has further allowed us to account for a range of pre-existing childhood risk factors of our outcome (e.g. maltreatment, domestic violence, conduct disorder), thereby increasing confidence in a predictive relationship between sibling bullying and high-risk behavior. Second, this study separately explored the influence of sibling bullying perpetration and victimization on high-risk behavior outcomes. This has allowed us to make differential conclusions based on the roles assumed between sibling bullying. Third, we explored the cumulative relationship of bullying perpetration across the home and school context and high-risk behavior outcomes, enabling us to identify multiple risk-factors that may synergistically predict high-risk antisocial behavior trajectories. Finally, we applied Bonferroni correction (Armstrong, 2014) to all of our analysis, providing conservative estimates of associations.

There were also limitations to our study. Large longitudinal population studies are prone to subject loss. We addressed this by applying multiple imputation analysis in order to account for missing values. However, the outcome variables criminal involvement, nicotine

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dependence and cannabis use had much lower response rates than all other outcome variables, although they were still in their thousands. This reduces statistical power and could for instance be one possible explanation for why sibling bullying perpetration may not be as strongly associated with criminal involvement as expected from peer bullying studies (Farrington et al. 2011; Ttofi et al., 2011; Ttofi et al., 2012). Finally, although early externalizing and internalizing problems and diagnoses were included as confounds, we cannot exclude the possibility of reverse causality as we did not have measures of our outcome variables prior to the time point where sibling bullying was measured. However, antisocial behavior has been reported to show a marked increase and peak in prevalence during adolescence (Moffitt et al., 2001). Hence, only a small proportion of children would have been expected to display antisocial behavior beyond externalizing problems and conduct disorder during early childhood, which this study accounted for.

### **Conclusion**

Children who are involved as perpetrators in sibling bullying are more likely to show antisocial behavior in early adulthood. The association between perpetration and antisocial behavior is strongest when children bully their sibling every week or day and, in particular, when they are also involved in bullying peers. Thus, sibling bullying perpetration is not a normal rite of passage but provides an early warning for later antisocial behavior. Sibling bullying may be a marker of the trajectory to antisocial behavior problems or even a causative factor in the development of antisocial behavior. Intervention studies (Natsuaki et al., 2009; Tucker et al., 2015) are needed to determine whether changes in sibling bullying are related to improved long-term social and behavior outcomes.



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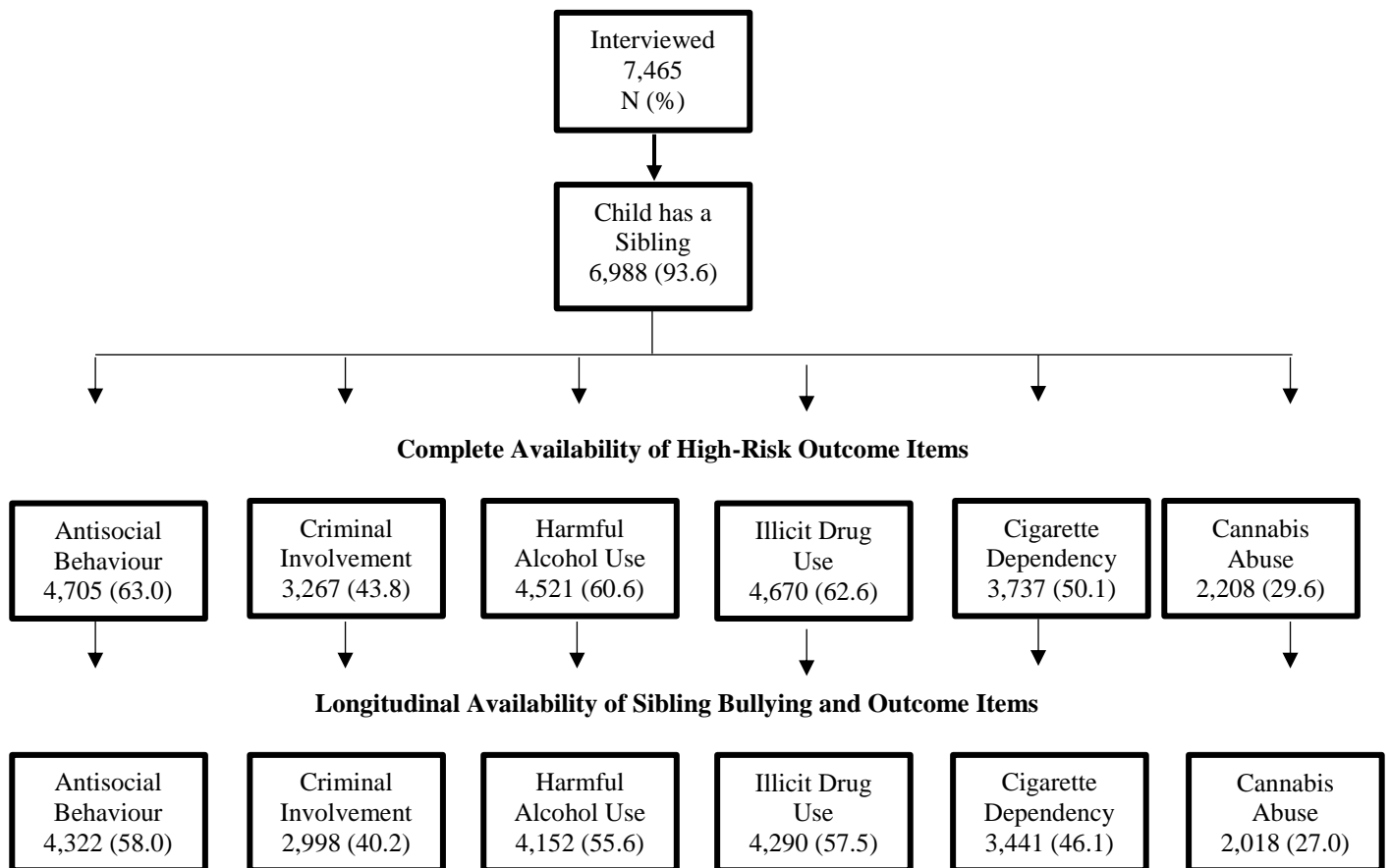
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# SIBLING BULLYING AND HIGH-RISK BEHAVIOR FIGURES

**Figure 1.** Flowchart of sample size distribution across high-risk behavior outcomes



## SIBLING BULLYING AND HIGH-RISK BEHAVIOR

**Figure 2.** High-Risk Behavior Items at 18 and 20 years

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### **Antisocial Behavior**

- Been rowdy/rude in public
- Stolen something from a shop without paying
- Bought something you knew/suspected was stolen
- Broken into a vehicle with the intention of stealing something
- Taken/driven a vehicle without permission
- Broken into a house/building with intention to steal something
- Stolen money/something else that someone was holding/carrying/wearing
- Hit, kicked or punched someone with intention of hurting them
- Deliberately damaged/destroyed property
- Hurt/injured animals/birds on purpose
- Carried a knife/weapon for protection or in case it was needed for a fight
- Used a cheque book/credit card/cash which you knew/suspected of being stolen

### **Criminal Involvement**

- Got in trouble with the police
- Was on trial in court for something they had done
- Received and official police caution
- Received a fine from the court
- Was given a Community Service Order
- Was given an Antisocial Behaviour Order (ASBO)
- Spent some time in a Secure Unit
- Spent some time in a Young Offenders Institution or prison
- Took part in a mediation process as an offender

### **Alcohol Use**

- Frequency of having a drink containing alcohol
- Number of units had on a typical day when drinking
- Frequency of having six or more units on one occasion
- Frequency of feeling unable to stop drinking once started
- Frequency of failing to do what is expected because of drinking
- Frequency needed a first drink to get up in the morning after heavy drinking session
- Frequency of feeling guilt or remorse after drinking
- Frequency of being unable to remember what happened the night because of drinking
- Respondent or someone else injured as a result of respondent's drinking
- Relative/friend/doctor/health worker concerned about respondent drinking

### **Nicotine Dependence**

- Number of cigarettes smoked every day on average.
- How soon after waking up first cigarette is smoked.
- Finds it difficult to refrain from smoking in places where it is forbidden.
- Cigarettes would be the most hated thin to give up.
- Smoked more frequently during first hours after waking than during rest of day.
- Smokes if they are so ill that they are in bed most of the day.

### **Cannabis Use**

- Used cannabis before midday.
- Used cannabis when they were alone.
- Ever had memory problems when they used cannabis.
- Friend/family member tells them they ought to reduce cannabis use.
- Ever tried to reduce/stop cannabis use without succeeding.
- Ever had problems because of their use of cannabis (fighting/argument/accident...)

### **Illicit Drugs**

- Cocaine
  - Amphetamines
  - Inhalants
  - Sedatives/sleeping pills
  - Hallucinogens
  - Opioids
  - Injected any drugs
-

## SIBLING BULLYING AND HIGH-RISK BEHAVIOR

**Table 1.** Odds ratios for risky behavior at 18 or 20 years according to sibling bullying perpetration at 12 years.

Outcome OR (95% CI)	Sibling Bullying Perpetration					
	Never	Only Ever Once or Twice	2 or 3 Times a Month	About Once a Week	Several Times a Week	Linear Trend
<b>Antisocial Behavior (N=4,350)</b>						
Unadjusted	Reference	1.30 (1.06-1.59)	<b>1.50 (1.21-1.86)</b>	<b>1.81 (1.46-2.24)</b>	<b>1.74 (1.38-2.20)</b>	<b>1.18 (1.12-1.24)</b>
Imputed Adjusted	Reference	<b>1.37 (1.11-1.69)</b>	<b>1.47 (1.18-1.84)</b>	<b>1.73 (1.39-2.15)</b>	<b>1.62 (1.27-2.07)</b>	<b>1.16 (1.10-1.22)</b>
<b>Criminal Involvement (N=3,020)</b>						
Unadjusted	Reference	1.14 (0.83-1.57)	1.46 (1.05-2.01)	1.48 (1.07-2.06)	1.56 (1.09-2.23)	<b>1.13 (1.06-1.22)</b>
Imputed Adjusted	Reference	1.19 (0.86-1.66)	1.43 (1.02-2.00)	1.37 (0.97-1.92)	1.39 (0.95-2.04)	<b>1.11 (1.02-1.20)</b>
<b>Alcohol Use (N=4,179)</b>						
Unadjusted	Reference	1.16 (0.96-1.41)	1.24 (1.01-1.52)	1.31 (1.06-1.62)	1.25 (0.99-1.58)	<b>1.08 (1.03-1.13)</b>
Imputed Adjusted	Reference	1.18 (0.96-1.43)	1.22 (0.99-1.51)	1.33 (1.07-1.65)	1.25 (0.98-1.58)	<b>1.08 (1.03-1.13)</b>
<b>Illicit Drug Use (N=4,319)</b>						
Unadjusted	Reference	1.12 (0.90-1.38)	1.25 (1.00-1.56)	1.34 (1.07-1.67)	<b>1.48 (1.17-1.88)</b>	<b>1.10 (1.05-1.16)</b>
Imputed Adjusted	Reference	1.11 (0.89-1.38)	1.18 (0.94-1.48)	1.29 (1.02-1.62)	1.36 (1.06-1.74)	<b>1.08 (1.03-1.14)</b>
<b>Nicotine Dependence (N=3,459)</b>						
Unadjusted	Reference	1.96 (1.05-3.69)	1.33 (0.61-2.90)	1.93 (0.97-3.85)	1.86 (0.88-3.92)	1.18 (1.01-1.37)
Imputed Adjusted	Reference	1.89 (0.99-3.61)	1.35 (0.61-2.98)	1.70 (0.83-3.45)	1.56 (0.71-3.40)	1.13 (0.97-1.33)
<b>Cannabis Use (N=2,036)</b>						
Unadjusted	Reference	1.24 (0.69-2.24)	0.88 (0.44-1.76)	1.41 (0.77-2.59)	1.50 (0.82-2.76)	1.10 (0.96-1.25)
Imputed Adjusted	Reference	1.29 (0.71-2.35)	0.85 (0.42-1.72)	1.28 (0.69-2.40)	1.33 (0.71-2.51)	1.06 (0.93-1.22)

OR = Odds ratio. CI = Confidence intervals.

Bold =  $p < .0083$  (Bonferroni Correction).

Confounders included in imputed adjusted model: gender, maternal education, marital status, maternal depression, domestic violence, maltreatment, peer bullying, child psychiatric problems, internalizing and externalizing problems, IQ.

Significant confounders after Bonferroni correction: Antisocial Behavior: single mothers, male gender. Criminal involvement = lower maternal education, single mothers, male gender. Alcohol use = higher IQ. Illicit drug use = higher IQ, single mothers, domestic violence and maltreatment present. Nicotine dependence = none. Cannabis = male gender.

**Table 2.** Odds ratios for risky behavior at 18 or 20 years according to sibling bullying victimization at 12 years.

Outcome OR (95% CI)	Sibling Bullying Victimization					
	Never	Only Ever Once or Twice	2 or 3 Times a Month	About Once a Week	Several Times a Week	Linear Trend
<b>Antisocial Behavior (N=4,362)</b>						
Unadjusted	Reference	1.26 (1.06-1.51)	1.20 (0.95-1.51)	1.24 (0.99-1.56)	1.25 (1.01-1.55)	1.06 (1.02-1.11)
Imputed Adjusted	Reference	1.27 (1.06-1.53)	1.19 (0.93-1.52)	1.28 (1.01-1.62)	1.24 (0.99-1.54)	1.06 (1.01-1.11)
<b>Criminal Involvement (N=3,028)</b>						
Unadjusted	Reference	1.07 (0.81-1.40)	1.00 (0.69-1.44)	0.92 (0.64-1.32)	1.02 (0.73-1.42)	0.99 (0.93-1.07)
Imputed Adjusted	Reference	1.09 (0.81-1.45)	0.98 (0.67-1.44)	0.97 (0.67-1.41)	0.95 (0.67-1.36)	0.99 (0.92-1.06)
<b>Alcohol Use (N=4,190)</b>						
Unadjusted	Reference	1.08 (0.91-1.28)	0.93 (0.75-1.16)	1.25 (1.00-1.56)	1.04 (0.85-1.27)	1.02 (0.98-1.07)
Imputed Adjusted	Reference	1.09 (0.92-1.29)	0.92 (0.73-1.14)	<b>1.28 (1.03-1.60)</b>	1.06 (0.87-1.31)	1.03 (0.98-1.08)
<b>Illicit Drug Use (N=4,330)</b>						
Unadjusted	Reference	1.19 (0.99-1.43)	1.01 (0.79-1.30)	1.24 (0.98-1.56)	1.18 (0.95-1.47)	1.05 (1.00-1.10)
Imputed Adjusted	Reference	1.15 (0.95-1.39)	0.95 (0.74-1.22)	1.21 (0.95-1.53)	1.11 (0.88-1.39)	1.03 (0.98-1.08)
<b>Nicotine Dependence (N=3,469)</b>						
Unadjusted	Reference	1.73 (0.93-3.21)	1.92 (0.90-4.10)	1.18 (0.49-2.88)	<b>2.87 (1.55-5.29)</b>	<b>1.24 (1.07-1.43)</b>
Imputed Adjusted	Reference	1.58 (0.83-2.97)	1.80 (0.83-3.91)	0.96 (0.39-2.39)	<b>2.26 (1.19-4.31)</b>	1.17 (1.01-1.36)
<b>Cannabis Use (N=2,040)</b>						
Unadjusted	Reference	0.87 (0.50-1.52)	1.26 (0.66-2.39)	0.85 (0.41-1.74)	1.18 (0.66-2.13)	1.03 (0.90-1.17)
Imputed Adjusted	Reference	0.85 (0.48-1.50)	1.23 (0.64-2.36)	0.83 (0.40-1.74)	1.14 (0.62-2.09)	1.02 (0.89-1.17)

OR = Odds ratio. CI = Confidence intervals.

Bold =  $p < .0083$  (Bonferroni Correction).

Confounders included in imputed adjusted model: gender, maternal depression, domestic violence, maltreatment, peer bullying, child psychiatric problems, internalizing and externalizing problems, IQ.

Significant confounders after Bonferroni correction: Antisocial behavior = single mothers, male gender. Criminal involvement = more conduct problems, male gender. Alcohol use = higher IQ. Illicit drug use = higher IQ, single mothers, domestic violence and maltreatment present. Nicotine dependence = none. Cannabis use = male gender.

## SIBLING BULLYING AND HIGH-RISK BEHAVIOR

**Table 3.** Odds ratios for risky behavior at 18 or 20 years according to sibling bullying status at 12 years.

Outcome OR (95% CI)	Sibling Bullying Status			
	Uninvolved	Victim	Bully	Bully-Victim
<b>Antisocial Behavior</b> (N=4,322)	639/2,578 (24.8)	160/534 (30.0)	147/445 (33.0)	163/436 (37.4)
Unadjusted	Reference	1.00 (0.79-1.26)	<b>1.94 (1.52-2.47)</b>	<b>1.44 (1.18-1.76)</b>
Imputed Adjusted	Reference	0.99 (0.78-1.26)	<b>1.66 (1.29-2.13)</b>	<b>1.42 (1.15-1.76)</b>
<b>Criminal Involvement</b> (N=2,998)	232/1,803 (12.9)	55/281 (14.4)	55/311 (17.7)	53/295 (18.0)
Unadjusted	Reference	0.77 (0.53-1.13)	<b>1.66 (1.15-2.40)</b>	1.23 (0.90-1.68)
Imputed Adjusted	Reference	0.77 (0.52-1.14)	1.34 (0.91-1.98)	1.17 (0.84-1.64)
<b>Alcohol Use</b> (N=4,152)	1,359/2,477 (54.9)	296/506 (58.5)	262/436 (60.1)	261/425 (61.4)
Unadjusted	Reference	1.04 (0.84-1.29)	1.22 (0.95-1.56)	1.24 (1.02-1.51)
Imputed Adjusted	Reference	1.07 (0.86-1.32)	1.20 (0.94-1.55)	1.28 (1.04-1.57)
<b>Illicit Drug Use</b> (N=4,290)	635/2,559 (24.8)	143/531 (26.9)	29/442 (29.2)	132/431 (30.6)
Unadjusted	Reference	1.11 (0.88-1.40)	<b>1.45 (1.12-1.87)</b>	1.31 (1.07-1.62)
Imputed Adjusted	Reference	1.08 (0.85-1.37)	1.36 (1.04-1.77)	1.25 (1.01-1.55)
<b>Nicotine Dependence</b> (N=3,441)	34/2,028 (1.7)	14/432 (3.2)	8/361 (2.2)	11/345 (3.2)
Unadjusted	Reference	1.45 (0.71-2.99)	1.33 (0.56-3.13)	1.89 (1.03-3.47)
Imputed Adjusted	Reference	1.21 (0.58-2.55)	1.22 (0.50-2.95)	1.51 (0.80-2.86)
<b>Cannabis Use</b> (N=2,018)	54/1,132 (4.8)	15/256 (5.9)	10/236 (4.2)	14/212 (6.6)
Unadjusted	Reference	0.49 (0.19-1.22)	1.07 (0.53-2.19)	1.57 (0.93-2.64)
Imputed Adjusted	Reference	0.49 (0.19-1.23)	0.88 (0.42-1.82)	1.48 (0.86-2.57)

OR = Odds ratio. CI = Confidence intervals.

Confounders included in imputed adjusted model: gender, maternal education, marital status, maternal depression, domestic violence, maltreatment, peer bullying, child psychiatric problems, internalizing and externalizing problems, IQ.

Significant confounders after Bonferroni correction: Antisocial behavior = male gender, single mothers. Criminal involvement = more conduct problems, lower maternal education, single mothers, male gender. Alcohol use = higher IQ. Illicit drug use = higher IQ, more maternal depression, single mothers, domestic violence and maltreatment present. Nicotine dependence = lower IQ, less internalizing problems, more externalizing problems. Cannabis = male gender, single mothers.

**Table 4.** Odds ratios of associations between sibling and peer bullying at 12 years.

OR (95% CI)	Peer Bullying		
	Pure Victim	Pure Bully	Bully-Victim
<b>Sibling Bullying</b>			
Neutral	1	1	1
Pure Victim	<b>1.33 (1.04-1.71)*</b>	1.42 (0.79-2.53)	1.28 (0.84-1.97)
Pure Bully	<b>1.42 (1.06-1.90)*</b>	<b>2.74 (1.62-4.66)**</b>	<b>3.42 (2.40-4.87)**</b>
Bully-Victim	<b>1.86 (1.49-2.33)**</b>	<b>2.50 (1.56-4.00)**</b>	<b>4.17 (3.13-5.56)**</b>

OR = Odds ratio. CI = Confidence intervals.

Reference group: Neutral peer bullying status.

\*p<0.05 \*\*p<.01.

SIBLING BULLYING AND HIGH-RISK BEHAVIOR

**Table S1.**

Individual and Family Characteristics of Sibling Bullying Victims and Perpetrators.

	Never % or M (SD)	Only Ever Once or Twice % or M (SD)	2 or 3 Times a Month % or M (SD)	About Once a Week % or M (SD)	Several Times a Week % or M (SD)	<i>P</i>
<b>Victimization (N)</b>	3636	1190	645	662	783	
Male	49	44.3	45.7	41.1	44.6	<b>&lt;.001</b>
IQ	105.95 (15.9)	105.30 (16.95)	105.67 (15.63)	104.54 (16.38)	103.75 (16.45)	<b>.031</b>
Internalizing Problems	1.44 (1.61)	1.51 (1.71)	1.47 (1.68)	1.69 (1.69)	1.75 (1.77)	<b>&lt;.001</b>
Externalizing Problems	1.41 (1.39)	1.58 (1.40)	1.61 (1.45)	1.71 (1.48)	1.96 (1.60)	<b>&lt;.001</b>
Peer Perpetration	6.7	5.5	8.6	8.9	9.7	<b>&lt;.05</b>
Peer Victimization	35.5	39.9	37.3	43.7	45.9	<b>&lt;.001</b>
Psychiatric Diagnosis	4.3	4.3	4.1	5.5	9.1	<b>&lt;.001</b>
Single-mother	16.5	17	15.4	14.9	16.3	>.250
Maternal Education (>CSE)	60.1	59	54.9	57.1	61.4	.336
Maternal Depression	6.26 (4.53)	6.34 (4.40)	6.55 (4.48)	7.01 (4.77)	7.07 (4.74)	<b>&lt;.001</b>
Maltreatment Domestic Violence	11.8 16.7	12.6 19.5	13.3 20.7	12.4 22.1	16.2 2.5	<b>&lt;.05</b> <b>&lt;.001</b>
<b>Perpetration (N)</b>	4072	841	697	673	598	
Male	47.2	39.0	43.8	49.8	52.8	>.250
IQ	105.58 (16.17)	105.66 (15.75)	107.18 (15.83)	104.71 (16.29)	103.21 (17.17)	<b>.003</b>
Internalizing Problems	1.41 (1.59)	1.56 (1.79)	1.69 (1.70)	1.69 (1.71)	1.78 (1.85)	<b>&lt;.001</b>
Externalizing Problems	1.37 (1.35)	1.61 (1.50)	1.76 (1.43)	1.84 (1.46)	2.11 (1.65)	<b>&lt;.001</b>
Peer Perpetration	6.4	5.1	8.3	9.2	12.7	<b>&lt;.001</b>
Peer Victimization	36.1	38.3	38.4	41.8	49.3	<b>&lt;.001</b>
Psychiatric Diagnosis	4.0	5.7	3.8	6.6	9.6	<b>&lt;.001</b>
Single-mother	15.9	15.5	17.1	17.8	17.7	.177
Maternal Education (>CSE)	59.1	57.7	57.4	60.3	63.1	>.250

## SIBLING BULLYING AND HIGH-RISK BEHAVIOR

Maternal	6.39	6.24	6.41	6.85	6.87 (4.77)	<b>.025</b>
Depression	(4.52)	(4.54)	(4.48)	(4.77)		
Maltreatment	11.7	13.8	14.3	13.7	14.4	.079
Domestic	17.4	19.0	20.0	24.1	24.9	<b>&lt;.001</b>
Violence						

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M = Mean. SD = Standard deviation.