

SECONDARY DATA ANALYSIS REPORT

Association between bullying victimisation, perpetration, and violent crime

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About the Youth Endowment Fund

The Youth Endowment Fund (YEF) is a charity with a mission that matters. We exist to prevent children and young people from becoming involved in violence. We do this by finding out what works and building a movement to put that knowledge into practice.

Children and young people at risk of becoming involved in violence deserve services that give them the best chance of a positive future. To make sure that happens, we'll fund promising projects and then use the very best evaluation to find out what works. Just as we benefit from robust trials in medicine, young people deserve support grounded in the evidence. We'll build that knowledge through our various grant rounds and funding activities.

And just as important is understanding children and young people's lives. Through our Youth Advisory Board and national network of peer researchers, we'll ensure they influence our work and that we understand and are addressing their needs. But none of this will make a difference if all we do is produce reports that stay on a shelf.

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Executive summary

About the project

Bullying is common, with an estimated 35% of 10–15-year-olds in England and Wales annually experiencing in-person bullying behaviours, equivalent to 1.5 million children (Office for National Statistics, 2024). Previous studies have shown an association between bullying experienced in childhood and violence perpetrated in adulthood (Tiiri et al., 2023). But the evidence is limited. Most studies use single time points rather than cumulative childhood exposures, rely on self-reported outcomes instead of police-recorded offending, and focus mainly on perpetration, not on victimisation or their combined effects. Physical bullying (i.e. hitting or beating) is also rarely examined, and no UK studies have investigated its link to weapon carrying.

This project addresses these gaps by examining how bullying involvement – perpetration, victimisation, and their co-occurrence – relates to both self-reported and police-recorded violence. It further explores how these associations vary according to the frequency of bullying experienced and the ages at which it occurs. This project uses the Avon Longitudinal Study of Parents and Children (ALSPAC), and linked records from the National Pupil Database (NPD) and Avon & Somerset Police Data. ALSPAC is a cohort study that recruited pregnant women with due dates between April 1991 and December 1992 who lived in and around Bristol. The study resulted in a sample of 14,901 children. These children and their parents have been followed up ever since via questionnaires, study clinics, and linkage to administrative and health records.

In the ALSPAC data, bullying experiences were child-reported at ages 8, 10, and 12 years. The measure captured a range of peer-directed behaviours which occurred repeatedly, either at school or on the school commute. These behaviours included threats or blackmail, name-calling, spreading rumours, and hitting or beating. All types of bullying were combined to derive an overall measure of bullying; physical bullying was also analysed separately. The outcomes explored included: self-reported violent behaviour at ages 17–18; police-recorded violent offending, comprising violence against the person, robbery, and weapon possession up to age 24; and self-reported weapon carrying at age 15.5. Associations between bullying exposure (victimisation, perpetration, or both) and these violence outcomes were examined using logistic regression, adjusting for a range of child-, family-, and area-level factors. A Structured Life Course Modelling Approach (SLCMA) was used to explore how the timing and cumulative exposure to bullying influenced the outcomes.

Key findings

Perpetrators and victims of bullying are more likely to commit acts of violence and carry weapons.	Between ages 8 and 12, 60.5% of ALSPAC participants reported an experience of bullying – 38.8% purely as victims, 21.7% as perpetrators (which includes perpetrators and perpetrator–victims). Among victims, 13.6% reported committing acts of violence (compared to 10.7% among those with no experience of bullying), 3.3% had a police-recorded violent crime (the same as those with no bullying experiences), and 11.4% reported carrying a weapon (7.2% of those with no bullying experiences reported carrying a weapon). For perpetrators of bullying, 27.1% reported committing acts of violence, 8.4% had a police-recorded violent crime, and 20.6% reported carrying a weapon.
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Once children's backgrounds are accounted for, bullying perpetration is still linked to violence, but bullying victimisation is not.	The association between bullying victimisation and self-reported violence involvement was no longer observed after accounting for child-, family-, and area-level factors. In contrast, perpetrators of bullying remained more likely to engage in violence. Compared with those not involved in bullying, they had twice the odds of self-reported violence and 1.5 times the odds of police-recorded violence. Associations were stronger for physical bullying, with perpetrators having 2.8 times the odds of self-reported violent behaviour and 2.2 times the odds of police-recorded violence.
However, being bullied is linked to carrying a weapon.	All forms of involvement in bullying were linked to carrying a weapon at 15 once children's backgrounds were accounted for. Children who bullied others were 2.2 times more likely to report carrying a weapon, and children who were bullied were 1.5 times more likely, compared with children not involved in bullying.
Bullying at multiple ages is associated with a higher likelihood of violence perpetration.	The odds of having a police record for violence increased with repeated bullying, from 43% higher odds among those who bullied at one age (odds ratio [OR] = 1.43) to 192% higher odds among those who bullied at all three ages studied (OR = 2.92). For self-reported violence perpetration, bullying at ages 8 and 12 appeared to be particularly important, with 127% higher odds for bullying at age 8 (OR = 2.27), 70% higher odds for bullying at age 12 (OR = 1.70), and 286% higher odds for those who bullied at both ages (OR = 3.86). No similar association was found for bullying at age 10.

Interpretation and implications

The results of this study show that the consequences of bullying may extend beyond the immediate harms experienced during childhood, contributing to behaviours with serious criminal justice and safety implications into adulthood. The report found strong evidence that bullying perpetration (including physical bullying) was associated with both self-reported and police-recorded violence, even after accounting for child-, family-, and area-level factors. This association was strongest for children who engaged in bullying at multiple ages. This suggests that supporting children who demonstrate bullying behaviours should be a focus of early intervention and support. While this study found no evidence that being a victim of bullying was associated with later violence perpetration, once accounting for contextual factors, all forms of bullying involvement, including victimisation, were associated with a higher likelihood of weapon carrying. This is the first time evidence from the UK has suggested a potential link between bullying victimisation and precautionary violent behaviours, even where these behaviours may put someone at greater risk of harm.

Several considerations should be taken into account when interpreting these findings. First, the dataset comprises children living in and around Bristol and captures bullying experiences during the late 1990s to mid-2000s. Consequently, more contemporary forms of bullying, such as cyberbullying, were not captured. In addition, only 5% of the ALSPAC sample consisted of participants from ethnic minority backgrounds. Although this reflected the demographic composition of the study area at the time of recruitment, the small number of participants from these groups meant that analyses by ethnicity could not be conducted. Together, these factors limit the generalisability of the findings to the contemporary UK population. Finally, although the results provide strong evidence that bullying was associated with later involvement in violence and weapon carrying, even after adjustment for a wide range of contextual and individual-level factors, the nature of the study design means we cannot conclude that bullying had a causal impact on later involvement in violence and weapon carrying.

Introduction

Context and literature review

Successful violence prevention interventions depend on the identification of upstream risk factors and an understanding of their relative importance and how they relate to one another. In our recent work, we have examined several risk factors, including adverse childhood experiences (ACEs), positive educational factors, and school absence and exclusion (Rollings et al., 2025). The present project builds on this body of work by focusing on a risk factor that is associated with these other factors and with violent offending: bullying.

Bullying is a common, worldwide social problem that can take many forms – physical, behavioural, verbal, or relational (e.g. disrupting social relationships between the victim and their peers). It can also be classified as overt (e.g. direct physical or verbal attacks) or covert/relational (i.e. indirect, such as ostracising someone or spreading rumours) (Casper and Card, 2017). Cyber-bullying, defined as bullying via electronic means (e.g. social media posts with the aim of embarrassing someone or threatening private messages), is a relatively new type of bullying that has increased in recent years in parallel with the rapid growth of social media platforms (Ray et al., 2024). Regardless of its form, bullying typically involves three key characteristics: repetition over time, harm, and an imbalance of power (Berger, 2007). While boys and girls experience a similar overall prevalence of bullying, the form differs: boys are more likely to engage in overt and physical bullying (Walters, 2021).

Bullying tends to peak in early adolescence as children develop greater independence, form new peer groups, and shape their adult identities and behavioural patterns (López-Castro et al., 2023). Global estimates suggest that 30–37% of adolescents aged 12–18 years were bullied in the past month, with higher estimates in some regions (Biswas et al., 2020). More recently, one meta-analysis estimated that the prevalence of bullying victimisation, perpetration, and involvement in both (bully–victim) was 25%, 16%, and 16%, respectively (Ariani et al., 2025). In England and Wales, 34–36% of children aged 10–15 years experience bullying annually (Lasher and Baker, 2015; Office for National Statistics, 2024). It is important to note that variations in bullying estimates reflect differences in how bullying is measured – such as the types of bullying behaviours assessed, questionnaire wording, the time period of assessment (e.g. lifetime, past 12 months, past six months), age at assessment, and the characteristics of the population studied (i.e. some children are more likely to experience bullying than others).

Theories of bullying

Theories of bullying perpetration have tended to emphasise two interacting factors: family environments and individual dispositions. In the family context, bullying-type behaviour, such as manipulation, coercion, shaming, and violence, is modelled by parents and siblings as a way to deal with difficulty and stress (Powell and Ladd, 2010). These strategies are observed, internalised, and, ultimately, acted out in a peer setting by the bullying child. If the child

perceives these strategies as successful, they form part of the child's behavioural repertoire to be used again; if they are not perceived as successful, they are discarded. An alternative model of how family environments influence bullying is that the experience of adversity, such as child abuse, neglect, or household adversity (e.g. substance misuse, domestic abuse, mental illness), creates a traumatising effect, which results in hypersensitivity to threat and aggressive responses to normal interactions, in turn resulting in both conduct and social problems (Merrin et al., 2024). This can manifest as bullying as a strategy to exert control over a challenging environment through verbal and physical threats or aggression.

An alternative theory is that bullying perpetration is a result of behavioural and social deficits that are independent of household exposure to adversity (Thomas et al., 2018). These can include developmental problems, impulse control deficits, and social information processing deficits, which can manifest as both covert/relational and overt bullying behaviours.

Theories of bullying victimisation place less emphasis on individual-level factors and suggest that who becomes the target of bullying is dependent on system factors, such as the mix of people in a group and the group's values and characteristics (Juvonen and Galván, 2008). In groups where the conditions for bullying are present, bullies identify isolated and vulnerable peers over whom they can exert control. Accordingly, susceptibility to victimisation is likely driven by deficits in social skills, resulting in peer rejection and/or a mismatch between an individual's norms, characteristics, and behaviours and those of their peer group. As such, the risk of bullying victimisation may be dynamic, depending on the volatility of peer group norms.

Explanations of bullying have also considered broader societal influences. Bullying is more prevalent in societies characterised by greater social hierarchies and economic inequality (Due et al., 2009; Elgar et al., 2009; Elgar et al., 2019), where status competition and power differentials are more pronounced. In such contexts, hierarchical structures and the acceptance of inequality may be reflected in children's and school officials' attitudes, making behaviours that reinforce status differences, such as bullying, more normative and tolerated. Such structural conditions may shape school environments and peer dynamics, influencing how power is asserted and maintained.

Determinants of bullying perpetration and victimisation

Bullying perpetration and victimisation are not mutually exclusive, particularly over multiple years. Those who both bully others and are bullied themselves are termed bully-victims (Walters, 2021). Accordingly, there is overlap in the risk factors for bullying perpetration and victimisation. A review of longitudinal studies – an important design consideration for delineating any causal direction – found that both conduct and social problems were associated with later bullying perpetration and victimisation, although for victims, the associations were weaker than for perpetrators (Kljakovic and Hunt, 2016). Further longitudinal risk factors for bullying perpetration include conduct problems and commencement of bullying at a younger age. For victims, additional longitudinal risk factors

include internalising problems, such as depression, and peer rejection (Sentse et al., 2017), although victim susceptibility is likely influenced by group characteristics and dynamics (Salmivalli, 2010). Risk for perpetration and victimisation differ with time: prior victimisation predicts future victimisation, but there is a negative relationship between age and perpetration (Sentse et al., 2017). Kljakovic and Hunt (2016) noted that this has important implications for intervention. Bullying perpetrators may simply age out of this behaviour, thus not requiring and being less amenable to intervention, but also suggesting that the risk of perpetration is dynamic. Victims, on the other hand, are susceptible to victimisation for longer, allowing opportunities for early intervention and suggesting that risk factors are more stable. Succinctly, risk for victimisation appears driven by social isolation, while risk for perpetration is characterised by antisocial behaviour and social immaturity (Kljakovic and Hunt, 2016).

Consequences of bullying

Although much bullying behaviour is time-limited, its effects can be long-lasting, extending throughout adolescence and into adulthood for both victims and perpetrators. For example, involvement in bullying, whether as perpetrator, victim, or both, is associated with an increased risk of self-harm, suicide, and depression during adolescence (Hawton et al., 2012; Armitage, 2021; Myklestad and Straiton, 2021; Ye et al., 2023). In adulthood, perpetrators of bullying show elevated risks of substance misuse (Vrijen et al., 2021), while victims are more likely to experience anxiety, depression, and other mental health problems (McVie, 2014; Stapinski et al., 2014; Armitage, 2021). Victimisation is also linked to poor educational attainment and higher school absenteeism, sometimes leading to early school leaving (Armitage, 2021; Laith and Vaillancourt, 2022). A small number of studies have compared all three groups (victims, perpetrators, bully–victims), and evidence from reviews demonstrates that bully–victims have the highest risk of suicidal ideation, self-harm, and suicide attempts (Myklestad and Straiton, 2021; Ariani et al., 2025). They also appear to exhibit higher levels of psychopathology, poor emotional adjustment, poor peer relationships and poor health, and they are more likely to engage in health-harming behaviours, such as substance abuse (Piquero et al., 2017; Kiing et al., 2025).

Bullying and violence

Beyond mental health and educational outcomes, a growing body of research has examined the relationship between bullying and subsequent involvement in violence. Two meta-analyses have found that both bullying perpetration and victimisation are associated with weapon carrying (van Geel et al., 2014; Valdebenito et al., 2017) and increased risk of later violence (Ttofi et al., 2012). Longitudinal studies have found that bullying perpetration in childhood and early adolescence predicts violence in later adolescence (Farrington and Ttofi, 2011; McVie, 2014) and adulthood (Tiiri et al., 2023). However, only two of the studies identified to date are based in the UK (Farrington and Ttofi, 2011; McVie, 2014). Many studies

had small sample sizes and focused solely on boys (Kokko et al., 2009; Bender and Losel, 2011; Fergusson et al., 2014), underscoring the need for context-specific, population-based longitudinal evidence.

Victims of bullying

Evidence on the association between bullying victimisation and later violence is mixed and generally weaker than that observed for bullying perpetration (Ttofi et al., 2012). While some meta-analyses suggest that victimisation may predict later violence, these associations are attenuated after adjusting for other childhood risk factors (Ttofi et al., 2014). This attenuation may reflect the overlap between violent victims and violent offenders, which earlier studies did not account for (Ttofi et al., 2012). Several longitudinal studies have found that childhood victimisation does not predict later violent or antisocial outcomes once confounders are accounted for (Sourander et al., 2007; Ttofi and Farrington, 2010; Sourander et al., 2011; Wolke et al., 2013; Klomek et al., 2015; Tiiri et al., 2023).

Perpetrators of bullying

In contrast, numerous studies have identified a more consistent link between bullying perpetration and later criminal or violent behaviour. Bullying others appears to be a robust predictor of subsequent violence (Ttofi et al., 2012; Ttofi et al., 2014). Bullies have been found to have higher rates of violent offending than non-bullies, even after adjustment for childhood risk factors (Fergusson et al., 2014). Similar findings have been reported across diverse contexts: bullying at age 11 predicted violence at age 21 in a longitudinal US study of the aetiology of problem behaviour (Kim et al., 2011), and in Sweden, bullying between ages 13 and 16 predicted violence between ages 16 and 24 (Olweus, 2011). Moreover, bullying perpetration by age 15 predicted violent offending at age 24, independent of family factors and emotional or behavioural problems (Bender and Losel, 2011). In one Finnish study, bullying predicted later offending primarily among boys with elevated childhood psychiatric symptoms (Sourander et al., 2007). Associations were stronger for short-term outcomes in adolescence than long-term adult outcomes (Farrington and Ttofi, 2011; Klomek et al., 2015). Many studies have examined the association between bullying perpetration and general offending; however, the strongest associations are consistently observed for violent offending, even after controlling for childhood risk factors (Farrington and Ttofi, 2011; Olweus, 2011; Fergusson et al., 2014; Ttofi et al., 2014). For instance, a review and meta-analysis found that bullying perpetration increased the likelihood of later criminal offending by more than half and the likelihood of later violent behaviour by two-thirds (Ttofi et al., 2014). Overall, while the association between bullying perpetration and violence attenuates after adjustment for confounding, bullying remains an independent risk factor for later violent behaviour (Farrington and Ttofi, 2011).

Bully-victims

Children who are both perpetrators and victims – bully–victims – appear to experience the poorest long-term offending outcomes (Klomek et al., 2015; Piquero et al., 2017). Although relatively few prospective studies have examined this group specifically, existing evidence suggests that bully–victims have substantially heightened risks of later offending and violence. For example, in a Finnish cohort, frequent bully–victim status at age 8 predicted repeat and violent offending in later life (Sourander et al., 2007). However, studies isolating violence as a specific outcome for bully–victims remain scarce, with many focusing instead on broader measures of criminal behaviour.

Physical bullying

Bullying can take many forms. Physical bullying is a direct form of bullying – its 12-month prevalence is estimated to be approximately 18–24% among 13–17-year-olds, with boys more likely than girls to be involved both as perpetrators and as victims (prevalence of any physical bullying perpetration and/or victimisation in the past two months among 14-year-olds: 28% of boys vs 14% of girls) (Wang et al., 2009; Sarfo et al., 2024). There is evidence that aggressive behaviour in childhood and adolescence tends to persist into adulthood, suggesting continuity in aggressive tendencies over time (Farrington, 1991; Huesmann et al., 2002; Pepler et al., 2008; Kokko et al., 2009). One study of males showed that physical bullying perpetration at school was a stronger predictor of self-reported violence in adulthood than other forms of verbal or indirect bullying (Bender and Losel, 2011). There is also evidence that physical aggression or aggressive traits emerging in early childhood are associated with an elevated risk of later violence (Cao, 2025). Despite the strong link between physical bullying and later violence, the literature examining how different types of bullying relate to violence outcomes is limited.

Sex differences in bullying and violence

Sex differences further complicate the bullying–violence relationship. Many studies have either focused primarily on males or adjusted for sex without stratified analyses. Among those that have examined males and females separately, few have explored violence as an outcome. A Finnish birth cohort study linked with police records found that bullying at age 8 predicted violent offences in adulthood among boys but not among girls (Sourander et al., 2011). These differences may reflect the varying forms of peer victimisation: boys tend to engage in overt physical bullying, while girls are more often involved in relational forms (Crick and Bigbee, 1998; Nansel et al., 2001). Consequently, relational bullying shows stronger associations with mental health problems, whereas physical bullying perpetration is more strongly associated with later criminal and violent behaviour (Van der Wal et al., 2003; Bender and Losel, 2011).

Timing and accumulation of bullying in relation to violence

The timing, frequency, and accumulation of bullying involvement may each play distinct roles in shaping later violence outcomes. Studies have assessed bullying exposure at different time points, yet few have directly examined which periods confer the greatest risk. Importantly, frequency refers to how often bullying occurs within a specific period (e.g. weekly or monthly incidents), whereas accumulation reflects exposure across multiple time points, such as bullying reported at ages 8, 10, and 12, and, therefore, captures the potential for cumulative risk over time (accumulation of risk).

Life course epidemiology theories may help with understanding how the timing and duration of bullying may be associated with later violence. Previous research has demonstrated the importance of timing and cumulative exposure to childhood adversity and later mental health outcomes (Farooq et al., 2024). However, to our knowledge, research on violence outcomes is scarce. Under the critical or sensitive period hypotheses, timing of an exposure in the life course is important, as its impact may vary depending on when it occurs relative to vulnerable developmental periods (Kuh et al., 2003; Knudsen, 2004). Under these hypotheses, there may be a specific window during which exposure to bullying has a stronger association with later violence than exposure at other points in childhood (Ben-Shlomo and Kuh, 2002). In contrast, the accumulation of risk hypothesis posits that the total duration of bullying involvement, regardless of when it occurs, confers increasing risk, such that a greater number of exposure periods leads to a progressively higher likelihood of later violence.

Evidence for dose–response relationships – where either more frequent or more prolonged involvement in bullying predicts a greater risk of later violence – remains limited. For example, one study incorporated frequency into its definition of bullying (Wolke et al., 2013), and another found that both occasional and frequent bullying among boys predicted adult criminal behaviour, even after controlling for confounders (Sourander et al., 2011). In contrast, frequent victimisation alone did not independently predict offending, suggesting that dose–response patterns may be more relevant for perpetrators than for victims.

Overall, few studies have systematically explored the persistence of bullying over time in relation to violence. While there are early indications of a possible dose–response relationship, particularly for bullying perpetration, the current evidence base is limited (Klomek et al., 2015). Further longitudinal research is needed to elucidate whether the accumulation of bullying involvement over time is associated with later violence and whether experiences of bullying at particular ages heighten vulnerability to later violence. Existing longitudinal research is crude in that it reveals time-point associations but offers little explanation of how these exposures are linked over time. This has left us with weak theories and little actionable knowledge about how time and cumulative exposure influence the bullying–violence relationship.

Bullying and weapon carrying

Related to violence, but arguably more complex, is weapon carrying. Weapon carrying is a behaviour in anticipation of the threat of violence and can be motivated by a combination of desires for self-protection (precaution), to be more effective in threatening or enacting violence, or to reduce anxiety about future violence (Brennan and Moore, 2009). These motivations mirror the dynamics of bullying, where individuals may act as perpetrators, victims, or both.

A meta-analysis demonstrated that all forms of bullying involvement – victim, perpetrator, or bully–victim – were associated with a greater likelihood of weapon carrying (Valdebenito et al., 2017). Weapons may therefore serve different functions: bullying perpetrators may use them to intimidate others, bullying victims may carry them for protection or comfort, and bully–victims may carry them for both purposes (Dijkstra et al., 2012). Bully–victims are at greatest risk for carrying a weapon (van Geel et al., 2014). An issue of note in this literature is the narrow emphasis on school-based bullying experiences, which excludes issues such as neighbourhood bullying and exploitation. Accordingly, these studies are modelling a highly specific bullying and weapon carrying relationship and should not be taken as representative of the wider relationship.

Most of the evidence on the link between bullying and weapon carrying is based on cross-sectional study designs. As a result, bullying experiences and weapon carrying can appear concurrent, or at least closely linked in time, meaning that from this literature, it is impossible to determine whether there is a causal link. Theoretically, weapon carrying could be part of the bullying experience: for victims, it could be a way to end the bullying or to feel safer, and for perpetrators, weapons could form part of the bullying activity. If this theory is correct, weapon carrying and bullying should initiate and cease roughly at the same time.

However, it is possible that the experience of bullying has a longer-term influence on weapon carrying. For example, exposure to threats outside the home may affect a person's general view of their safety in public settings, resulting in precautionary weapon carrying; experience of bullying victimisation may have damaged their trust in safeguarding organisations (e.g. police and schools) to keep them safe, resulting in weapon carrying as a form of managing uncertainty; and success in bullying may have reinforced the rewards of violence and coercion, resulting in weapon carrying as an effective strategy for managing victim resistance and for causing harm.

In contrast to cross-sectional studies, relatively few studies have explored these potential longitudinal effects. Valdebenito et al (2017) found that across four international studies, there was a modest association between bullying victimisation and weapon carrying one or more years later, although the quality and context of these studies varied. Only one study in the review examined the association between bullying perpetration and weapon carrying and found a strong relationship between bullying perpetration at age 12–13 and weapon carrying at age 16–17 (odds ratio [OR] 2.64, 95% confidence interval [CI] 1.35–5.18) and a very strong relationship when bullying perpetration was measured around age 15–16 years (OR 4.27, 95% CI 2.23–8.16) (Hemphill et al., 2011). However, when the study statistically adjusted for other

factors, including previous weapon carrying, the association was not statistically significant for bullying perpetration at either age. More recently, the only study that has examined the longitudinal effects of bullying experiences on weapon carrying according to the type of bullying exposure – perpetration, victimisation, or perpetration–victimisation – found that only victimisation was associated with an increased risk of weapon carrying one year later (Lu et al., 2020).

Given the small body of literature on the long-term associations of bullying experiences and weapon carrying, there is a need to test this association to better inform our understanding of the lasting associations. Finally, as most evidence comes from the US, it is unclear to what extent these associations apply in the UK, where the landscape of violence – particularly in terms of the availability and accessibility of firearms – is very different. Understanding these links in a UK context is crucial for informing violence prevention and safety strategies.

Limitations of existing studies

Several methodological and conceptual limitations remain in the current literature. Definitions and measures of bullying vary widely across self-, teacher-, parent-, and peer-reports, making cross-study comparisons difficult (Bender and Losel, 2011; Sourander et al., 2011; Klomek et al., 2015). Studies also differ in the timing of bullying assessments, the length of follow-up, and the definition of outcomes, with some focusing on general aggression or crime rather than violence specifically (Klomek et al., 2015).

Most studies have assessed bullying at a single time point or have collapsed multiple assessments into a general any exposure variable (Nansel et al., 2003; Bender and Losel, 2011; Farrington and Ttofi, 2011; Renda et al., 2011; Tiiri et al., 2023). This may obscure sensitive periods or cumulative patterns whereby repeated bullying involvement is more strongly linked to later violence than bullying occurring at a single point in time. Furthermore, physical bullying has rarely been examined separately from other forms. Many studies also rely on self-reported outcomes, which are vulnerable to bias from attrition or non-response, especially among high-risk individuals (Bender and Losel, 2011; McVie, 2014). Most research has focused solely on bullying perpetration as a risk factor for later violence, rather than considering both victimisation and perpetration (Renda et al., 2011; McVie, 2014). Finally, many studies have concentrated primarily on boys, limiting generalisability, and therefore the association between bullying and later violence among girls is poorly understood (Bender and Losel, 2011).

The present study

The present study addresses many of these gaps by examining both bullying perpetration and victimisation measured separately across multiple time points, distinguishing physical bullying from other types, and including both male and female participants. It also uses data from a

large, prospective birth cohort, with repeated measures of bullying, and incorporates both self-reported and police-recorded violence outcomes through data linkage.

The link between bullying behaviours in childhood or early adolescence and violent behaviour in young adulthood could be causal, but it could also be spurious, caused by common confounding factors that predispose young people to being a bully or a victim and to later violence, such as abuse, negative peer group influences, low connectedness to school, and poor academic achievement (Ttofi and Farrington, 2010; Lucas et al., 2016). The Avon Longitudinal Study of Parents and Children (ALSPAC) has a wealth of measures at the individual, family, and neighbourhood levels that allow us to consider the role of confounding in the relationship between bullying and violence.

By leveraging this unique and valuable data set, we provide some of the most robust evidence to date about the pathways and predictors from bullying to violence and weapon carrying, guiding the allocation of violence prevention resources and creating a better understanding of how this pervasive behaviour affects young lives.

Research aims

This project aims to examine the association between bullying victimisation and perpetration and later self-reported and police-recorded violence.

Research questions

Primary research question:

1. What is the association between bullying perpetration or victimisation and (i) self-reported violent behaviour and (ii) official sanction for serious violence?

Secondary research questions:

2. Does the association between bullying involvement and violence differ depending on (i) the accumulation of exposure to bullying involvement across multiple time points (i.e. is there a cumulative risk?) or (ii) when the bullying involvement is experienced? (i.e. is there a timing-related association)?
3. What is the association between bullying involvement and self-reported weapon carrying in adolescence?
4. What is the association between physical bullying perpetration or victimisation and (i) self-reported violent behaviour and (ii) official sanction for serious violence?

Hypotheses

Research questions 1, 3, and 4: based on findings from previous studies on the association between bullying and violence, we expect that the children in our study sample who have

been involved in bullying will be at increased risk of violent behaviour and weapon carrying in late adolescence/early adulthood. However, any observed relationship between bullying and violence could be a result of confounding. Our null hypothesis is that there is no association between bullying involvement or self-reported weapon carrying and subsequent self-reported or police-recorded violence.

Research question 2: to our knowledge, research examining the timing and cumulative impact of bullying involvement on later violence is limited. Evidence from studies of mental health outcomes, however, suggests that both timing and cumulative risk may be important (Farooq et al., 2024). Accordingly, we formulated a priori hypotheses regarding timing and accumulation of risk. We hypothesised that the timing of bullying involvement (ages 8, 10, and 12 years) may differentially predict later violence. It is also plausible, under the accumulation of risk hypothesis, that each additional time point of exposure confers a progressively higher risk of violence, irrespective of timing (i.e. cumulative exposure across time points, rather than timing, may be the primary driver of risk).

Key concepts

Bullying: bullying exposure was measured as the victimisation or perpetration of peer-directed behaviours occurring in the past six months at school or on the way to/from school involving other children and occurring frequently (several times a month) or very frequently (several times a week) between ages 8 and 12 years.

The types of bullying behaviours assessed include:

- Personal belongings were taken; took personal belongings from others
- Was threatened/blackmailed; threatened/blackmailed others
- Was hit/beaten up; hit/beat up others
- Was tricked in a nasty way; tricked others in a nasty way
- Was called bad/nasty names; called others bad/nasty names
- Others wouldn't play with them to upset them; wouldn't play with others to upset them
- Was made to do things they didn't want to do; got others to do things they didn't want to do
- Had lies told/nasty things said about them; told lies/said nasty things about others
- Had games spoilt; spoilt other children's games

Physical bullying: defined as the child being hit/beaten up or hitting/beating up others.

Self-reported violence: defined as violence occurring in the previous 12 months at ages 17 or 18 years, including hitting, kicking, or punching someone else on purpose with the intention

of hurting them, or carrying a knife or other weapon for protection or in case it was needed in a fight.

Self-reported weapon carrying: defined as carrying a knife or other weapon for protection or in case it was needed in a fight, assessed at age 15 years.

Police-recorded violence: defined using Home Office offence codes to identify police records for (i) violence against the person, indictable only; (ii) robbery, indictable only; and (iii) possession of weapons, triable either way or indictable only, occurring between ages 13 and 24 years. [As per Home Office definition of serious violence].

Ethics

ALSPAC has its own Ethics and Law Committee. Informed consent for the use of questionnaires and clinical data was obtained from participants following this committee's recommendations. When the study children turned 18, they were sent fair processing materials describing ALSPAC's intended use of their health and administrative records and were given clear means to object. Data were not extracted for participants who objected or who were not sent fair processing materials. Linkage to criminal records is acceptable to the vast majority of ALSPAC participants, including many with criminal records (Teyhan et al., 2023).

Project team/stakeholders

Dr Alison Teyhan (AT) (University of Bristol) is the principal investigator and is responsible for managing the project. Alison has been involved in all elements of this project, including the research design, funding acquisition, advisory board engagement, ALSPAC Executive approval application, project management, recruitment of Dr Bushra Farooq (BF), supervision of BF, dataset curation, contribution to this report and to the ongoing analyses.

Dr Rosie Cornish (RC) (University of Bristol) is the lead statistician on the project. Rosie has been involved in the research design, funding acquisition, recruitment of BF, supervision of BF, contribution to this report and to the ongoing analyses.

Professor Iain Brennan (University of Hull) is the lead substantive expert on the project. Iain has been involved in the research design, funding acquisition, and contributions to this report and ongoing analyses.

Dr Bushra Farooq (University of Bristol) is the analyst for this project. Bushra is responsible for data cleaning and preparation, data analysis, and the initial drafting of the interim report and this final report.

The UK Medical Research Council and Wellcome Trust (Grant ref: 217065/Z/19/Z) and the University of Bristol provide core support for ALSPAC. Linkage of ALSPAC to administrative data was supported by the Project to Enhance ALSPAC through Record Linkage, a programme of research funded by the Wellcome Trust (WT086118/Z/08/Z).

The authors have no competing interests to declare.

Study design

Overview of research design

Table 1: Research design

Research design		Prospective cohort study
Dataset(s) used		Avon Longitudinal Study of Parents and Children (ALSPAC); Avon & Somerset Police (A&SP) Data; National Pupil Database
Population of interest		Children participating in ALSPAC, born between 1991 and 1992 in the Avon region (UK), with permission for linkage to criminal and education records, and followed up from birth to age 24 years.
Size of the sample population		The initial number of pregnancies enrolled in ALSPAC was 14,541. Of these initial pregnancies, there was a total of 14,676 fetuses, resulting in 14,062 live births and 13,988 children who were alive at 1 year of age. When the oldest children were approximately 7 years of age, an attempt was made to bolster the initial sample with eligible cases who had failed to join the study originally. With these children included, a total of 14,901 children were alive at 1 year of age.
Primary outcome(s)	Variable	Self-reported violence-related behaviours and police-recorded violence.
	Measure (instrument, scale, source)	<u>Self-reported violence-related behaviours</u>: assessed at ages 17 and 18 years and defined as saying yes to both or either of the following questions, covering experiences in the last year: “[Have you] hit, kicked or punched someone else on purpose with the intention of really hurting them?” “[Have you] carried a knife or other weapon with you for protection or in case it was needed in a fight?” A binary variable derived and coded as 1 (yes) if the individual answered yes to either or both of these questions at either or both ages 17 and 18 years and coded as 0 (no) otherwise. <u>Police-recorded violence</u>: any record of serious violence occurring between ages 13 and 24 years recorded in the A&SP data and defined by the Home Office as (i) violence against the person, indictable only; (ii) robbery, indictable only; and (iii) possession of weapons, triable either way or indictable only. A binary variable was derived and coded as 1 (yes) if any record of violence occurring between ages 13 and 24 was identified in the police data. It was coded as 0 (no) if the individual was living in the Avon and Somerset region during all of the following age periods: 13–16, 17–20, or 21–24 and had no record of violence during that time.
Secondary outcome(s)	Variable(s)	Self-reported weapon carrying
	Measure(s) (instrument, scale, source)	Self-reported weapon carrying was assessed at age 15; individuals were asked whether they: “[Have] carried a knife or other weapon with you for protection or in case it was needed in a fight?”

		The binary variable was coded as 1 (yes) if individuals answered yes to this question and coded as 0 (no) if they reported no.
Main method to be used or tested		Logistic regression and the Structured Life Course Modelling Approach

Data sources

Dataset 1: Avon Longitudinal Study of Parents and Children

Table 2: Dataset description

Name of dataset	Avon Longitudinal Study of Parents and Children
Data owner(s)	University of Bristol
Type of data	Longitudinal birth cohort study
Population/geographic coverage or sampling frame	Pregnant women living in a defined area in and around the city of Bristol (formerly known as Avon), UK, with expected delivery dates between April 1, 1991, and December 31, 1992, were invited to take part, and any child born from these pregnancies was eligible for inclusion in the study. Women resident in the catchment areas of three health administrative districts within the South-West Regional Health Authority (later renamed the Bristol and District Health Authority) were eligible for the study. This area encompassed the City of Bristol along with nearby urban, rural, and farming communities. The Avon Longitudinal Study of Parents and Children (ALSPAC) recruitment campaign was opportunistic, with the aim of recruiting pregnant women early in their pregnancies. Eligible women were contacted via media information and staff visiting community locations, alongside the promotion of the study in antenatal and maternity health services.
Years covered or survey waves	1991–present
Exclusion criteria	Cohort children who were not alive at 1 year of age; children for whom we did not have permission for data linkage with criminal (Avon & Somerset Police [A&SP]) and/or education (National Pupil Database) records; children not resident (indicated by correspondence address held by ALSPAC) in the Avon and Somerset area at least once during each of the following ages: 13–16, 17–20, and 21–24 years and who did not have an A&SP record for violence; and children with insufficient bullying data (i.e. missing data on bullying at all three time points between ages 8 and 12 years) and no available data on auxiliary variables to support imputation (e.g. parent- or teacher-reported bullying, Strengths and Difficulties Questionnaire scores, or school enjoyment/attachment assessments).

Expected population/sample size (following exclusion criteria)	The total number of individuals in the final analytical sample was 9,944.
Documentation	Details of the ALSPAC study have been published (Boyd et al., 2013; Fraser et al., 2013), and a searchable data dictionary is available (www.bristol.ac.uk/alspac/).

Dataset 2: Avon and Somerset Police data

Table 3: Dataset description

Name of dataset	Avon and Somerset Police Data
Data owner(s)	Avon & Somerset Police (A&SP)
Type of data	Administrative data
Population/geographic coverage or sampling frame	The A&SP data includes records of charges, cautions and other out of court disposals for crimes committed in Avon and Somerset (the geographical area that includes the original Avon Longitudinal Study of Parents and Children (ALSPAC) recruitment area).
Years covered or survey waves	2007–2021 (plus a small number of pre-2007 records).
Expected population/sample size (following exclusion criteria)	The total number of individuals in the final analytical sample was 9,944.
Documentation	A data note describing the linkage of ALSPAC to A&SP data has been published (Teyhan et al., 2023).

Dataset 3: The National Pupil Database

Table 4: Dataset description

Name of dataset	National Pupil Database
Data owner(s)	The Department for Education
Type of data	Administrative data
Population/geographic coverage or sampling frame	The National Pupil Database (NPD) is the central repository of education data for children attending state schools in England.
Years covered or survey waves	This project primarily used Key Stage 1 and Key Stage 2 data from the NPD.
Documentation	https://www.find-npd-data.education.gov.uk/categories

Linking datasets

The linkage between ALSPAC, Avon & Somerset Police (A&SP) data and the National Pupil Database (NPD) data had already been established prior to the current project. Linkage of ALSPAC with A&SP is described in a data note (Teyhan et al., 2023). In summary, ALSPAC had permission to link to the criminal records for 12,662 children in the cohort. The ALSPAC Data Linkage Team established the linkage using personal identifiers common to both the ALSPAC

participant database and A&SP records using deterministic and probabilistic methods. A&SP then extracted attribute data from the matched individuals, removed personal identifiers and securely shared the de-identified records with ALSPAC. The police data extraction took place in July 2021, when the participants were in their late 20s to early 30s.

As part of this project, we aimed to link our data with the Police National Computer (PNC) to capture police-recorded violence in England and Wales. However, at the time of submitting this final report (March 2026), this linkage had not yet been achieved. Further information is provided in Appendix 1.

Data protection

The data for this project were provided by an ALSPAC data manager and include ALSPAC clinical and questionnaire variables, education variables (from the NPD), and crime variables (from A&SP). The variables were prepared for analysis and combined into a single dataset. Therefore, the rest of this section refers only to this one dataset, not to the three separate datasets.

ALSPAC adheres to the principles of the Office for National Statistics Five Safes framework (safe data, safe projects, safe people, safe settings, and safe outputs).

Safe data

The following are common to all projects using ALSPAC data:

- (1) the dataset was minimised to only include variables necessary for this project;
- (2) the data was de-identified;
- (3) the ID variable in the dataset was unique to this project, meaning it could not be linked to any other ALSPAC data;
- (4) potentially disclosive variables (e.g. small cell counts and precise dates) were not released to researchers.

Safe projects

The proposal for this project was approved by the ALSPAC Executive in July 2024 and assigned the B number B4657; a summary of the approved project is listed on the ALSPAC study's Proposal Summaries webpage.

Safe people

All members of the research team are researchers experienced in working with sensitive, individual-level data. The data for this project is accessible only to three members of the research team (BF, AT and RC), who have completed the Office for National Statistics' safe

accredited researcher training and/or the Medical Research Council's Research and the General Data Protection Regulation (GDPR) and confidentiality training.

Safe setting

Due to the sensitive nature of the linked education and crime data, the dataset is accessed via the UK Secure e-Research Platform (UKSeRP), a secure and controlled online data-sharing platform hosted by Swansea University. Only three members of the research team (AT, RC and BF) have access to the data. Their access to the data will cease at the end of this project.

Safe outputs

All outputs were disclosure-checked by an ALSPAC Data Linkage Manager prior to release from UKSeRP.

Data processing roles

The data controller for information directly collected by ALSPAC is the University of Bristol. ALSPAC is also the (joint) data controller for information about participants collected from routine administrative sources.

Legal basis for data processing

ALSPAC's purpose is to conduct scientific research that aims to improve the public good and advance scientific understanding. The legal basis for using participants' information, under GDPR and the Data Protection Act 2018, is:

- 1) performance of a task carried out in the public interest (Article 6(1)(e) in the GDPR); and, where sensitive personal information is involved
- 2) scientific or historical research purposes or statistical purposes (Article 9(2)(j) in accordance with Article 89(1))

The GDPR defines sensitive personal information as information that reveals a person's racial or ethnic origin, political opinions, religious or philosophical beliefs, and trade union membership; the processing of genetic data or biometric data for the purpose of uniquely identifying a person; and data concerning health or data concerning sex life or sexual orientation.

The legal basis under the GDPR and the Data Protection Act 2018 is separate from, and in addition to, ALSPAC seeking consent to take part in the research process, which they use to help ensure that the research is ethical and complies with other applicable laws.

Data access process

Access to ALSPAC data is via a managed open access process. Researchers submit their research proposals to the ALSPAC Executive. Once the proposal has been approved, the

researchers compile a detailed list of the variables they require, and this is used to build the dataset for the project. AT is an ALSPAC Direct User and built the dataset of questionnaire and clinic variables required for this project. This dataset was then passed to an ALSPAC Data Buddy to verify that it matched the approved research proposal, and the Data Buddy then passed it to an ALSPAC Data Linkage Manager for upload to UKSeRP. The ALSPAC Data Linkage Manager prepared the police and education data required for this project and placed them, along with the uploaded file, into a specific project folder in UKSeRP. The ALSPAC Data Linkage Manager then performed an ID swap on all datasets for this project, ensuring that the individual ID was unique to this project (meaning the data could not be linked with any other ALSPAC data). The project folder in UKSeRP can only be accessed by the project team (AT, RC and BF).

Variables and measurement

Outcomes measures

Primary outcome

Our primary outcomes are i) self-reported violence assessed at ages 17 and 18 years and ii) police-recorded violence between ages 13 and 24 years.

Self-reported violence

Self-reported violence measures were collected at ages 17.5 and 18.5 years. At age 17.5 years, violence was assessed during an in-person research clinic (Teen Focus 4), which took place between December 2008 and June 2011. The cohort children were asked, *“During the last year, did you hit, kick, punch, or attack someone with the intention of really hurting them?”* and *“During the last year, did you carry a knife or other weapon with you for protection or in case it was needed in a fight?”* Responses were recorded as “yes” or “no” for each question, with further questions about frequency: *“How many times did you do this in the last year?”*, with responses of *“Once, twice, three times, four times, five times, between six and 10 times, and more than 10 times”*.

At age 18.5 years, violence was assessed using the postal questionnaire “Your Life Changing”, which took place between September 2010 and May 2011. The cohort children were asked, *“How often in the last year have you hit, kicked, or punched someone else on purpose with the intention of really hurting them?”* and *“How often in the last year have you carried a knife or other weapon with you for protection or in case it was needed in a fight?”* Responses were on a 4-point scale representing: *“Not at all”, “Just once”, “Two to five times”* and *“Six or more times”*.

The assessments at both ages 17 and 18 were combined to create an any violence binary variable: responses of “yes” to either of the two questions at age 17 or *“just once, two to five times, or six or more times”* to either of the two questions at age 18 were coded as 1, and responses of “no” to the age 17 or *“not at all”* to the age 18 questions were coded as 0 (i.e.

coded as 0 if individuals reported “no” or “not at all” at either time point and did not report violence [“yes” at age 17 or “*just once, two to five times, or six or more times*” at age 18] at any time point).

Police-recorded violence

Police-recorded violence was defined as any record of serious violence recorded in the A&SP data, occurring between ages 13 and 24 years. Whether an offence was coded as serious violence was determined by the Home Office offence code and applied to the following offence groups: (i) violence against the person, indictable only; (ii) robbery, indictable only; and (iii) possession of weapons, triable either way or indictable only. The A&SP data includes records of charges, cautions, and other out of court disposals for crimes committed in Avon and Somerset. A binary variable for police-recorded violence was created; it was coded as 1 if an individual had a record for a serious violence offence between the ages of 13 and 24 years. It was coded as 0 only if the individual had lived in the Avon and Somerset area at least once during each of the following age periods: 13–16, 17–20, and 21–24 years and had no record of violence. This approach helps prevent misclassification by ensuring that individuals classified as not having a record of violence were living in an area where such offences would be captured by the A&SP data.

Secondary outcomes

Our secondary outcome was self-reported weapon carrying assessed at age 15.5 years. This was assessed during an in-person research clinic (Teen Focus 3), which took place between October 2006 and November 2008. The cohort children were asked, “*How often in the last year have you carried a knife or other weapon with you for protection or in case it was needed in a fight?*” Responses were on a 4-point scale representing: “*Not at all*”, “*Just once*”, “*Two to five times*” and “*Six or more times*”. A binary variable was derived and coded as 1 if responses were “*Just once, two to five times, or six or more times*” and coded as 0 for responses of “*Not at all*”.

Exposure measures

Our exposure measure is bullying victimisation or perpetration, defined as repeated harmful behaviours involving children.

In ALSPAC, bullying was assessed at three time points (ages 8.5, 10.5, and 12.5 years) during in-person research clinics (Focus @ 8: October 1999–December 2001, Focus 10+: February 2002–October 2003, and Teen Focus 1: February 2004–October 2004) using a modified version of the Bullying and Friendship Interview Schedule (Wolke et al., 2000; Wolke et al., 2001a; Wolke et al., 2001b; Woods and Wolke, 2003).

Children were asked about victimisation or perpetration of several behaviours/events involving other children, occurring within the past six months at school or to/from school:

- Had personal belongings taken; taken personal belongings from others
- Was threatened/blackmailed; threatened/blackmailed others
- Was hit/beaten up; hit/beat up others
- Was tricked in a nasty way; tricked others in a nasty way
- Was called bad/nasty names; called others bad/nasty names
- Others wouldn't play with them to upset them; wouldn't play with others to upset them
- Was made to do things they didn't want to; got others to do things they didn't want to do
- Was told lies/nasty things said about them; told lies/said nasty things about others
- Had games spoilt; spoilt other children's games

If a child answered "yes" to any of the above questions, they were asked how often it occurred, with responses rated on a 3-point scale:

- Infrequently (one to three times in the past six months)
- Frequently (more than four times but less than once a week)
- Very frequently (at least once a week)

For each time point (8.5, 10.5, and 12.5 years), a three-category variable was created to indicate involvement in bullying. It was coded as:

- 0 (reference group) = No bullying involvement ("no" to all items, or behaviours occurred only infrequently)
- 1 = Pure victim: only victimisation occurring frequently or very frequently
- 2 = Pure bully/bully-victim: any reports of either only perpetration (pure bully) or both perpetration and victimisation (bully-victim) occurring frequently or very frequently

We combined the pure bullying group with the bully-victims group due to the small number of children involved in bullying perpetration only.

To address research questions 1 and 3, the three time-specific variables were combined to create a single three-category variable (coded as above) indicating any involvement in bullying between ages 8 and 12 years.

In parallel with the main analysis (which defines bullying as behaviours occurring frequently or very frequently), we conducted an additional analysis restricted to very frequent behaviours. This allowed us to focus on potentially more severe bullying and to assess whether associations with later violence differed by intensity of exposure.

To address research question 2 on timing and the cumulative risk of bullying involvement, we derived binary variables as described below. Binary variables are required because the planned statistical method for this aim, the Structured Life Course Modelling Approach (SLCMA; described below), is not compatible with exposures with more than two levels.

For each time point of assessment (ages 8, 10, and 12 years), we derived the following:

Bully/bully–victim:

- 0 (reference group) = No bullying involvement (“no” to all items, or behaviours occurred only infrequently) or pure victim
- 1 = Any reports of either only perpetration (pure bully) or both perpetration and victimisation (bully–victim) occurring frequently or very frequently

For this analysis, bullying was defined as frequent or very frequent behaviour, as the sample size was too small to further restrict the definition.

To address research question 4 (focused on physical bullying), responses to the “Was hit/beaten up or hit/beat up others” questions were used to create a three-category variable indicating involvement in physical bullying at any time point between ages 8 and 12 years. It was coded as: no physical bullying involvement (0), pure victim (1), or pure bully/bully–victim (2). In the main analysis, involvement in physical bullying was defined as behaviour occurring frequently or very frequently. An additional analysis applied a stricter definition, restricting involvement in physical bullying to very frequent occurrences only.

Other measures

We adjusted our associations of bullying with violence for measures related to both bullying and violence. Our final choice of confounding variables was driven by previous literature and discussions with the research team. Table 5 presents the final confounders that were included as adjustment variables in the analyses of the association between bullying and violence. A description of how these variables were derived, along with their data sources and reporting sources (i.e. mother, child, teacher), is provided in Appendix 2. Appendix 3 lists all additional variables that were considered as potential confounders. A timeline of the assessment of the study exposures, outcomes, and confounders is shown in Figure 1.

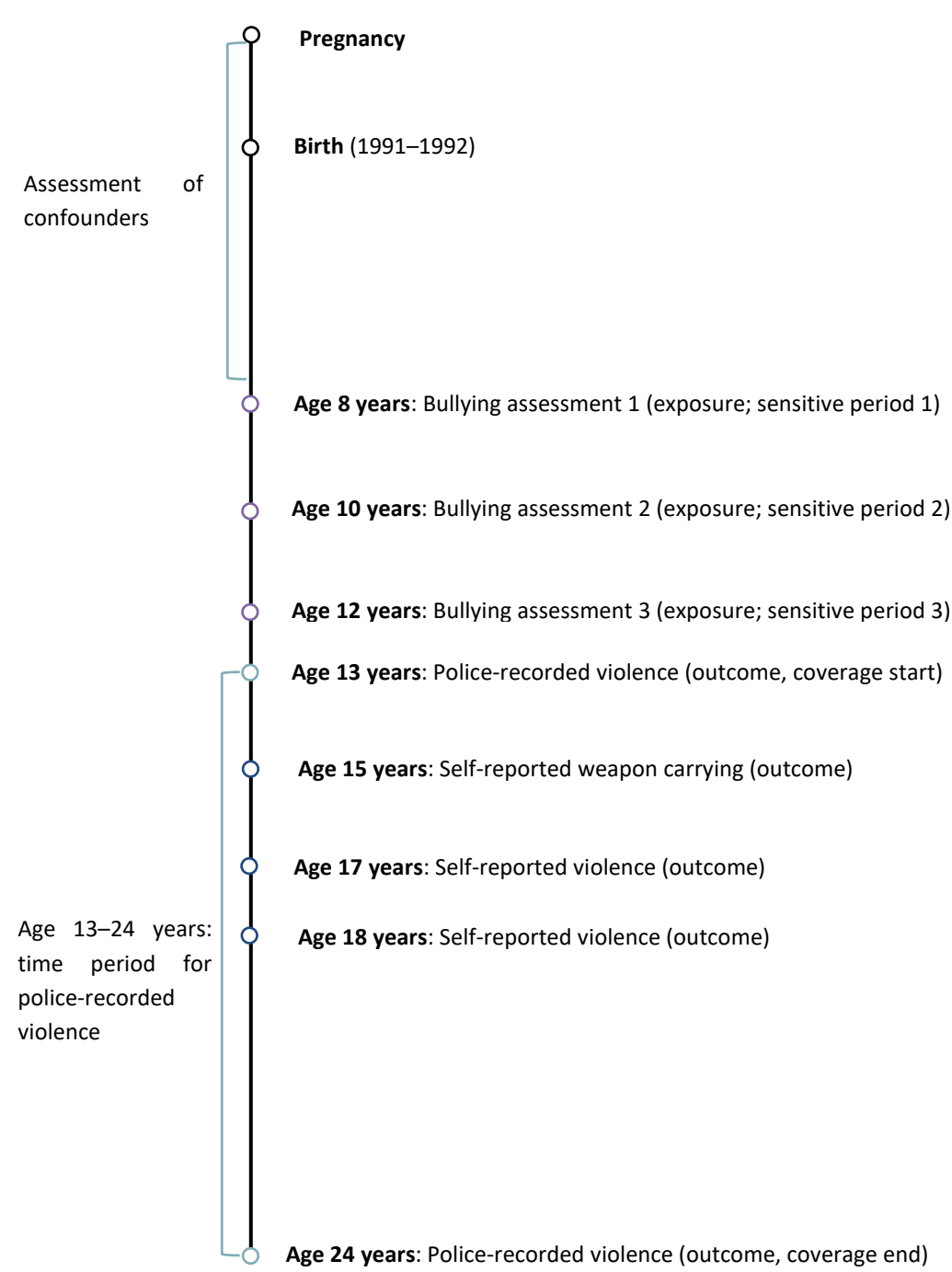
Table 5: Confounding factors

Variable	Description	Age of child at assessment/ variable derivation
Child level		
Child’s sex	Biological sex: male/female	Birth
Child’s ethnicity	White/non-White. The Avon Longitudinal Study of Parents and Children (ALSPAC) sample is predominantly of White ethnic background (>95%), which limits the possibility of further disaggregation of ethnic groups.	Birth
Emotional and behavioural problems	We used two measures of emotional and behavioural problems: i) the Strengths and Difficulties Questionnaire (SDQ) (mother-reported) and ii) the Childhood Interview for the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition Borderline Personality Disorder (BPD)	Age 6 (SDQ) and 11 (CI-BPD) years

	(Childhood Interview for Borderline Personality Disorder [CI–BPD]) child clinical assessment. The SDQ assessed conduct issues, emotional difficulties, peer relationship problems, and hyperactivity/inattention, and were summed to derive a total difficulties score ranging from zero to 40 (continuous variable). Higher scores reflect a greater level of difficulty. The CI–BPD assessed affective mood, interpersonal relations, cognitive, and impulsive symptoms.	
Childhood adversity	Exposure to trauma: physical abuse, emotional abuse, sexual abuse, and domestic violence were categorised as yes/no	Multiple repeated assessments between birth and age 5 years
Educational attainment	Children’s test results, obtained via linkage to the National Pupil Database (NPD), were categorised into quartiles: low, lower middle, upper middle, and high.	Key Stage 1
Family level		
Maternal age at delivery	Age of mother at delivery of the cohort child, grouped: under 26 years, 26–28 years, 29–31 years, and 32+ years	Birth (calculated using the mother’s date of birth and date of delivery)
Mother’s educational qualifications	Mothers were asked, “What educational qualifications do you, your partner, your mother, and your father have? Please tick all that apply.” A range of qualifications was listed, and the children’s mothers’ qualifications were subsequently categorised as: none/Certificate of Secondary Education, vocational qualifications, O-Level, A-Level, or university degree.	32 weeks’ gestation
Maternal smoking during pregnancy	Maternal smoking during pregnancy was assessed using two questions. The first asked, “Did you smoke regularly at any of the following times in the last nine months? Before pregnancy, first three months of pregnancy, or in the last two weeks.” Response options included: no or yes for each type: cigarettes, cigars, pipes, and other. The second question asked, “Did you smoke regularly in the last two months of pregnancy and since having the baby?” Response options included: yes or no for each type: cigarettes, pipe, cigar, and other. A binary variable was then derived to indicate any smoking (of any type) reported during either the first three months or the last two months of pregnancy (yes/no).	18 weeks’ gestation, eight weeks postpartum
Financial difficulties	Mothers were asked, “How difficult at the moment do you find it to afford the following items: food, clothing, heating, rent or mortgage, and things you will need for the baby?” Responses were recorded on a 4-point scale: “very difficult”, “fairly difficult”, “slightly difficult”, and “not difficult”.	32 weeks’ gestation

	Difficulties in affording these essentials were summed to create a total financial difficulties score ranging from zero (no financial difficulties) to 15 (maximum difficulties). Scores were then categorised into quartiles: None (0), 1–2, 3–5, and 6–15.	
Free school meal (FSM) eligibility	Data on cohort children’s eligibility for FSMs were obtained from linked NPD records and categorised as yes or no.	Key Stage 2
Parents’ educational engagement	Teachers’ reporting of how supportive parents are towards their child’s learning. Teachers were asked, “How much support do you think the child gets from his/her parents in regard to his/her learning?” Responses were recorded on a 4-point scale: “very supportive”, “somewhat supportive”, “not at all supportive”, and “can’t say”	School year 3
Area level		
Area-level deprivation	Deprivation was measured using the Index of Multiple Deprivation (IMD), a measure of relative neighbourhood deprivation based on the residential postcode of ALSPAC participants. The IMD is available at the Lower Layer Super Output Area (LSOA) level, with LSOAs ranked from most to least deprived according to multiple domains: income, employment, education, skills and training, health and disability, crime, barriers to housing and services, and living environment. IMD scores were divided into national quintiles, ranging from the least deprived (Q1) to the most deprived (Q5).	IMD measures from questionnaires administered when the cohort child was aged approximately 7–8 years.

Figure 1: Timeline of study measures



Note: All potential confounding variables were assessed prior to or at age 8 years, with the exception of Borderline Personality Disorder (assessed at age 11 years), and free school meals available at Key Stage 2.

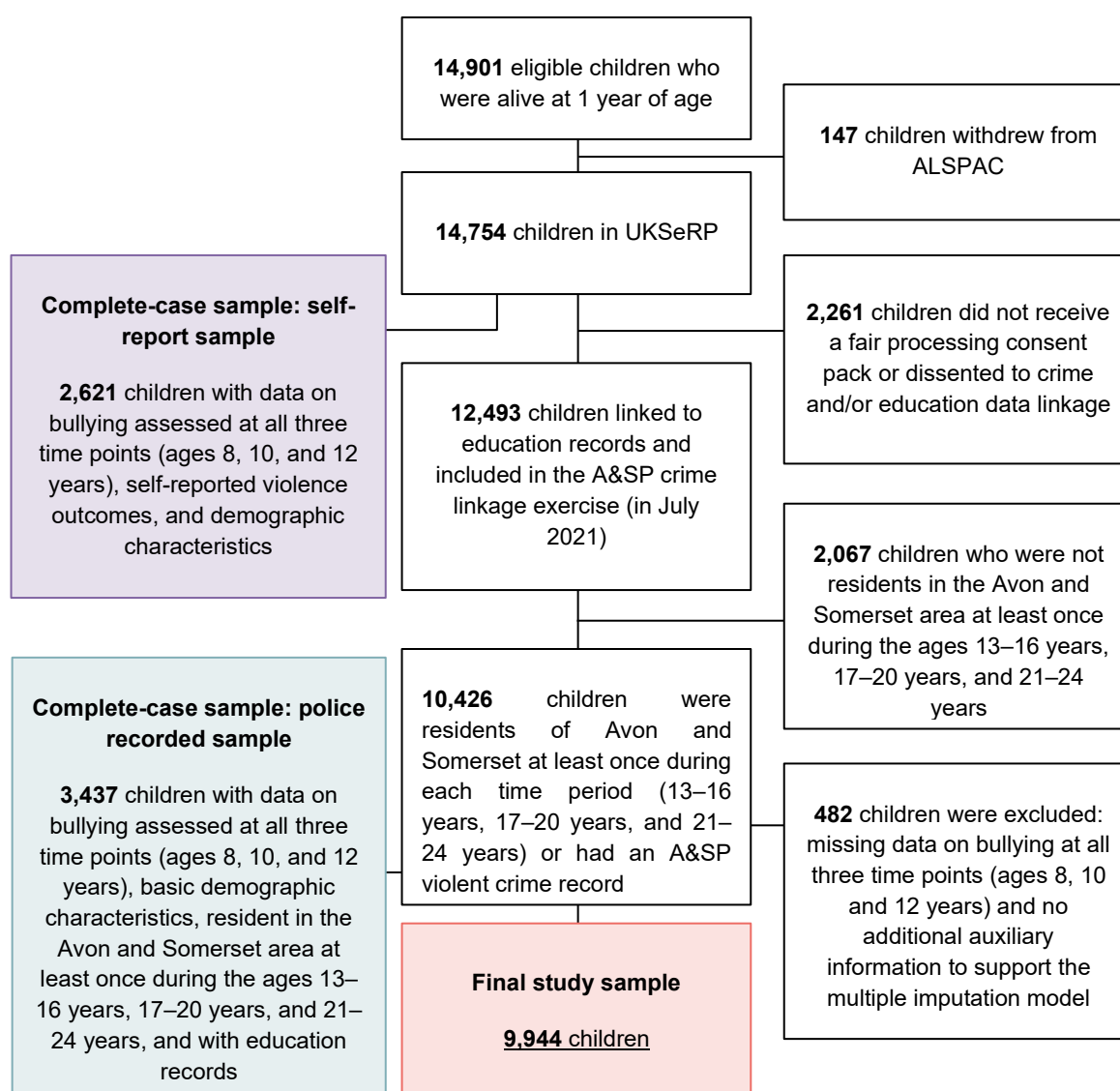
Sample size

As shown in Table 1, there were 14,901 eligible children who were alive at 1 year of age. We applied the following exclusion criteria when deriving our study sample:

- i. Children who had withdrawn from ALSPAC and asked for their data to no longer be used
- ii. Children for whom we did not have permission for data linkage with crime (A&SP) and/or education (NPD) records
- iii. Children not resident (indicated by an ALSPAC correspondence address) in the Avon and Somerset area at least once during each of the following ages: 13–16, 17–20, and 21–24 years and who did not have an A&SP record of violence
- iv. Children with insufficient bullying data (i.e. missing data on bullying at all three time points between ages 8 and 12 years) and no available data on auxiliary variables to support imputation (e.g. parent- or teacher-reported bullying, Strengths and Difficulties Questionnaire (SDQ) scores, or school enjoyment/attachment assessments)

Following these exclusions, the final study sample comprised 9,944 children. Figure 2 illustrates the derivation of the final sample.

Figure 2: Derivation of the study sample



Research methodology

Descriptive analysis

We conducted a series of descriptive analyses to describe and summarise our data:

- Prevalence of bullying involvement
- Prevalence of violence
- Prevalence of confounding variables

In addition to this, we examined the characteristics of our study sample.

We examined the prevalence of involvement in bullying and violence using simple frequency tabulations and cross-tabulations to describe the study sample.

Inferential analysis

We applied two analytical approaches to address our research aims: logistic regression and the SLCMA, as described below.

Logistic regression

To address research questions 1, 3, and 4, we applied logistic regression to examine:

- The associations between bullying involvement (three-category exposure: no bullying, pure victim, pure bully/bully–victim between ages 8 and 12 years) and
 - i) self-reported violence (between ages 17 and 18 years) and
 - ii) police-recorded violence (between ages 13 and 24 years) (research question 1)
- The associations between bullying involvement (three-category exposure as above) and self-reported weapon carrying in adolescence (age 15 years) (research question 3)
- The associations between physical bullying involvement (three-category exposure: no physical bullying, pure physical bullying victim, pure physical bully/bully–victim between ages 8 and 12 years) and
 - i) self-reported violence and
 - ii) police-recorded violence (research question 4)

For each outcome, we estimated three models:

1. Unadjusted model
2. Model adjusted for sex and ethnicity
3. Fully adjusted model, including all pre-specified confounders

We repeated these analyses using a more stringent definition of bullying (occurring very frequently, i.e. at least once a week). In addition, we conducted separate analyses for each time point when bullying was assessed (ages 8, 10, and 12 years). We also conducted complete-case analyses as a sensitivity check (restricted to research questions 1, 3, and 4 due to small sample size).

Logistic regression was chosen because all outcome variables were binary, allowing estimation of ORs to quantify the strength and direction of association between bullying involvement and each violence outcome while adjusting for potential confounders. Results were presented as ORs with corresponding 95% CIs, which indicate both the magnitude and statistical precision of the estimated associations.

An OR compares the odds of an outcome occurring in one group versus another:

$$OR = \frac{\text{odds in exposed group}}{\text{odds in unexposed group}}$$

Interpretation

OR 1 = There is no difference in the odds of the outcome occurring between the groups

OR>1 = The odds of the outcome occurring in the exposed group are higher compared to the unexposed group

OR<1 = The odds of the outcome occurring in the exposed group are lower compared to the unexposed group

95% CI = The range in which the true population value is likely to fall

Structured Life Course Modelling Approach

To address research question 2, we applied SLCMA.

The SLCMA is a two-stage approach which first tests a set of hypotheses identified a priori (e.g. timing, accumulation of risk) and selects the hypothesis that best fits the data to generate a model of the association between an exposure and outcome (Smith et al., 2022). The second stage produces ORs, 95% CIs, and p-values to quantify the strength and direction of association between the best-fitting hypothesis/hypotheses and the outcome (Smith et al., 2022). The SLCMA has the advantage of comparing several hypotheses at the same time, unlike traditional regression (Smith et al., 2015). This allows researchers to identify sensitive periods when an exposure might be more strongly associated with an outcome compared to other periods; current methods do not adequately address this time-dependent exposure–outcome association (Smith et al., 2022). Crude approaches, such as grouping individuals into ever-exposed groups (i.e. participants who experienced exposure at any time versus those who never did) or creating variables to count the number of exposures over time (such as accumulation of risk), have previously been used to test these simple hypotheses individually. However, such approaches provide little information about the timing of the exposure and do not allow for the comparison of multiple competing hypotheses at the same time. This two-stage process is described in more detail in Table 6.

Table 6: Structured Life Course Modelling Approach description

Stage	Description
Stage 1: Hypothesis Selection	
Hypothesis selection	We tested two hypotheses: the accumulation of risk and critical/sensitive periods (three time points) corresponding to the three assessments of bullying (ages 8, 10, and 12 years) to examine the association between the accumulation and timing of bullying involvement and violence. Structured Life Course Modelling Approach (SLCMA) requires the exposure measure to be a binary variable and is not compatible with a three-category exposure; therefore, we created a binary variable: pure bully/bully–victim vs no bullying involvement or pure victim.
Encoding variables	In the next step, each of the hypotheses was encoded into variables. The accumulation of risk hypothesis was encoded by one variable, created by summing the values of the exposure X at each time point (Smith et al., 2015). Assuming X is an exposure measured at three different time points, the accumulation hypothesis was encoded as $A = X_1 + X_2 + X_3$. At this stage, it is also recommended to check the correlation between the encoded variables. When variables are highly correlated, SLCMA may struggle to determine which hypothesis the data best support (Smith et al., 2015).
Perform the first stage of analysing/choosing a hypothesis	During this step, the association between the encoded variables and the outcomes was evaluated, with the strongest combinations of variables selected. This corresponds to the variable that explains the greatest outcome variation, followed by the addition of subsequent variables in order of their strength. During this stage, SLCMA uses a method (least absolute shrinkage and selection operator) that reduces the number of hypotheses, which helps prevent over-fitting. In simple terms, it looks at all the possible hypotheses and keeps only those that meaningfully explain the outcome while pushing unimportant hypotheses towards zero (Smith et al., 2022). This means that it focuses on the hypotheses that are strongly associated with an outcome and filters out those that add noise. Elbow plots were then produced to aid hypothesis selection (Smith et al., 2015; Smith et al., 2016). An elbow plot visualises the proportion of outcome variation explained against the number of variables selected at each step (Smith et al., 2015). Since the outcome variables were binary, McFadden's pseudo- R^2 was calculated. McFadden's pseudo- R^2 is a measure for logistic regression that evaluates the model's goodness-of-fit (McFadden, 1973). The elbow refers to the point on the plot where there is a sharp bend, indicating that adding additional variables no longer leads to a significant increase in the pseudo- R^2 values. This point is used to decide

	how many variables should be included in the model. Each hypothesis on the elbow plot is presented in order of the strength of its association with the outcome. The order of hypotheses on the elbow plot corresponds to the hypothesis with the strongest association with the outcome, explaining the greatest proportion of variance in the outcome. We generated elbow plots for the association between bullying involvement and each outcome (self-reported violence and police-recorded violence). In instances where the procedure began adding and removing variables in rapid succession, this was interpreted as an indication that the procedure had reached convergence and that the inclusion of additional variables did not meaningfully improve model performance. This can occur more frequently and at earlier stages when modelling binary outcomes. Consequently, when the elbow plot did not clearly indicate an optimal model, alternative model selection strategies were employed. Specifically, we compared models using the Akaike Information Criterion (AIC) and selected the model with the lowest AIC value. The AIC evaluates model quality by balancing goodness-of-fit and model complexity.
Stage 2: Selective inference	
Effect estimates	During the second stage, we generated odds ratios, confidence intervals, and p-values to interpret the results of the hypotheses in relation to each outcome (i.e. to quantify the strength and direction of the associations). We applied Bonferroni corrections to p-values (multiplying the p-value by the number of hypotheses tested) to account for having carried out multiple tests, and we selected the best-fitting hypothesis.

Exploratory sex-stratified analyses

Exploratory analyses were conducted to examine sex differences in the prevalence of bullying, violence, and their associations. We focused on the available and complete-case data, as our sample was not large enough to perform multiple imputation separately by sex.

Descriptive statistics were based on available cases, defined as all participants with data on the variables required for each specific descriptive analysis. We tested interaction effects to explore whether the association between bullying and violence differs by sex, using complete-case data. For these complete-case analyses, children had data on bullying, each violence outcome, and all confounders. We first examined the 95% CIs and p-values to test for interaction effects; if there was evidence, we then conducted sex-stratified analyses.

Missing data

Our exploration of missing data in our self-reported analytic variables included the following:

- We examined the prevalence of missing data for each of our analytic variables: exposures, outcomes, and confounders.
- We examined the characteristics of children with missing data in our analytic variables using logistic regression.
- We identified auxiliary variables to include in the imputation model to reduce bias and increase efficiency. These included variables that were informative for the analysis model (i.e. predictive of analytic variables), some of which also showed associations with patterns of missingness.

We addressed missing data in the ALSPAC data using Multiple Imputation by Chained Equations based on the assumption that data are missing at random (MAR) and included additional auxiliary information to strengthen this assumption. Multiple imputation has been shown to reduce bias even when the proportion of missing data is large (>50%), provided that the imputation model is correctly specified and that sufficient auxiliary variables are included in the model to make the MAR assumption plausible (Madley-Dowd et al., 2019). We imputed missing values for our self-reported exposure, outcome, and confounding variables up to the final study sample (n = 9,944; as shown in Figure 2). We produced two separate imputed datasets: one for analyses of overall bullying and another specifically for physical bullying. Each imputation model generated 100 imputed datasets with 50 iterations per imputation.

The imputation models included the following variables: bullying, self-reported violence, self-reported weapon carrying, police-recorded violence, all confounding variables, and additional auxiliary variables, including the Index of Multiple Deprivation (IMD), assessed at multiple time points; parent and teacher reported SDQ from multiple time points; parent, teacher, and child self-reports of bullying from multiple time points; additional measures of violence assessed at multiple time points; parent criminal behaviour; any police-recorded offenses (other than serious violence); parity; month of delivery; Key Stage 2 (KS2) educational attainment; friendships assessed at multiple time points; household social class; and housing tenure.

All analyses were conducted on the imputed datasets, unless otherwise specified. Pooled proportions were estimated and combined by averaging results across imputations using Rubin's rules.

Proportion of missing data

Approximately 41% of the study sample had complete data on bullying at all three time points, while 32.5% had missing data at all three assessment time points (Appendix 4). The proportion of missing data in self-reported outcomes ranged from 56% to 59%, while the proportion of missing data in potential confounding variables ranged from 6% to 53% (Appendix 5). Those with complete data were more likely to be female, and their mothers tended to be more educated and older at the cohort child's birth (Appendix 6). They were also less likely to come

from lower-social-class households, live in areas of high deprivation, or be eligible for free school meals (FSMs). Additionally, they were less likely to have a record of violence in the police data.

These patterns indicate that missingness was socially patterned and therefore unlikely to be missing completely at random. While the inclusion of socioeconomic and related auxiliary variables in the imputation model was intended to make the MAR assumption more plausible, it is possible that residual bias remains if missingness depended on unobserved factors. As such, complete-case analyses are presented alongside the main results from multiply imputed data as a sensitivity check.

Additional analyses and robustness checks

We used tetrachoric correlations to examine the associations between bullying assessments at ages 8, 10, and 12 years. This was done to assess the suitability of using SLCMA to investigate the timing and accumulation of bullying exposure and its association with later violence. When variables are highly correlated (>0.9), SLCMA may struggle to determine which hypothesis (i.e. timing or accumulation of risk) the data best support (Smith et al., 2015).

Deviations from the analysis plan

There were several deviations from the original analysis plan due to both methodological and conceptual considerations.

First, the analysis plan specified examining any bullying victimisation or perpetration as a combined binary exposure. We revised this approach to use a three-category variable, distinguishing between no bullying involvement, pure victim, and pure bully/bully–victim. This decision was made because the outcome of interest (violence) may be differentially influenced by victimisation and perpetration experiences. In contrast, for outcomes such as mental health, previous studies have reported similar associations for perpetration and victimisation, justifying their combination. Given our study’s focus on violence, the three-category exposure provided a more nuanced understanding of how different forms of bullying involvement relate to violent outcomes. Additionally, given the small number of children involved in bullying but not victimisation (pure bully), we combined this group with children involved in both bullying and victimisation (bully–victim).

Second, to address research question 2 on the timing and accumulation of bullying involvement, the original plan was to estimate two separate comparisons: bullying victimisation versus no bullying and perpetration and bullying perpetration versus no bullying and victimisation. However, at the interim stage, this was refined to estimate two separate comparisons: pure victims versus no bullying and pure bully/bully–victim versus no bullying. However, during the final analysis, this approach was further revised due to methodological constraints associated with multiply imputed data. When using multiply imputed data, excluding one category (e.g. pure victims) resulted in differing sample sizes across imputations, preventing valid pooling of estimates under Rubin’s rules. To ensure analytical

consistency, we therefore combined no bullying and pure victim into a single reference group and compared this to pure bully/bully–victim. Preliminary analyses showed no evidence of an association between pure bullying victimisation and either self-reported or police-recorded violence, further justifying their aggregation. We note, however, that combining pure victims with uninvolved children creates a heterogeneous reference group, which may complicate interpretation.

We also extended the analysis to include additional exploratory components not specified in the original plan. Specifically, we examined associations separately at each bullying assessment time point (ages 8, 10, and 12 years) to further explore potential timing-related associations. We also tested interaction terms (bullying $\times$ sex) to investigate sex differences in the association between bullying involvement and violence outcomes. Finally, we conducted sensitivity analyses, applying a more stringent definition of bullying, defined as bullying occurring very frequently (at least once a week).

Despite these deviations, the analyses remained consistent with the study's overall aims and provided valuable new insights into the different experiences of bullying involvement (pure victim, pure bully/bully–victim) and later violence outcomes.

Results

Descriptive summary

Overview of the study population

The study sample included 9,944 young people. Of these, 50.7% (n = 5,044) were male, 49.3% (n = 4,900) were female, and 5.2% were of a non-White ethnic background.

Compared with those with complete data on bullying and outcome measures (self-reported and police-recorded samples), the analytic sample included a higher proportion of participants from less advantaged backgrounds and those with missing data on key variables. Mothers in the complete-case samples were, on average, older, more educated, and less likely to have smoked during pregnancy (Table 7).

Table 7: Study sample characteristics

		Complete-case sample (self-reported)* % (n = 2,621)	Complete-case sample (police-recorded)& % (n = 3,437)	Multiply imputed sample^ % (n = 9,944) pooled proportions
Sex	Male	43.6 (1,142)	47.9 (1,646)	50.7
	Female	56.4 (1,479)	52.1 (1,791)	49.3
Ethnicity	White	96.6 (2,533)	96.8 (3,327)	94.8
	Non-White	3.4 (88)	3.2 (110)	5.2
Maternal education	None/CSE ¹	8.2 (215)	11.0 (379)	22.4
	Vocational	5.8 (152)	8.2 (282)	10.8
	0-level	33.3 (872)	35.7 (1,228)	35.7
	A-level	30.5 (798)	28.2 (970)	20.8
	Degree	22.3 (584)	16.8 (578)	10.3
Maternal age at delivery	Under 26	15.9 (416)	17.7 (607)	30.5
	26–28	23.7 (621)	26.2 (899)	24.8
	29–31	26.8 (701)	25.8 (886)	21.6
	32+	33.7 (883)	30.4 (1,045)	23.0
Financial difficulties ^a	None	45.5 (1,193)	43.7 (1,501)	34.8
	1–2	26.4 (693)	25.9 (891)	25.0
	3–5	16.6 (434)	16.6 (569)	19.2
	6–15	11.5 (301)	13.9 (476)	21.0
Housing tenure	Mortgaged or owned	88.8 (2,328)	87.5 (3,008)	74.2
	Council or Housing Association rented	5.3 (138)	6.6 (225)	17.1
	Private rented	3.9 (101)	3.9 (133)	5.7
	Other	2.1 (54)	2.1 (71)	2.9
Social class	Professional	14.9 (391)	11.4 (392)	7.0
	Managerial and technical	45.8 (1,201)	43.2 (1,486)	34.5
	Skilled non-manual	26.6 (698)	29.9 (1,029)	32.8
	Skilled manual	8.2 (216)	9.5 (328)	14.8
	Partly skilled	3.9 (101)	4.8 (165)	8.6
	Unskilled	0.5 (14)	1.1 (37)	2.2
Maternal smoking during pregnancy	Yes	14.2 (371)	16.6 (570)	30.1

*Complete data on bullying at all time points, self-reported violence outcomes, and basic demographic characteristics

& Complete data on bullying at all time points, basic demographic characteristics, and resident in the Avon and Somerset area at least once during the ages 13–16 years, 17–20 years, and 21–24 years

^ Data on bullying assessed at least at one time point or sufficient auxiliary information to support imputation model and a record of violence in Avon & Somerset Police between ages 13 and 24 years or resident in the Avon and Somerset area at least once during the ages 13–16 years, 17–20 years, and 21–24 years; reported percentages are pooled across 100 multiply imputed datasets. Cell counts (n) are not shown because they differ across imputations and do not represent fixed observed values.

^a Higher scores represent greater difficulties in affording food, clothing, heating, accommodation, and things for the baby

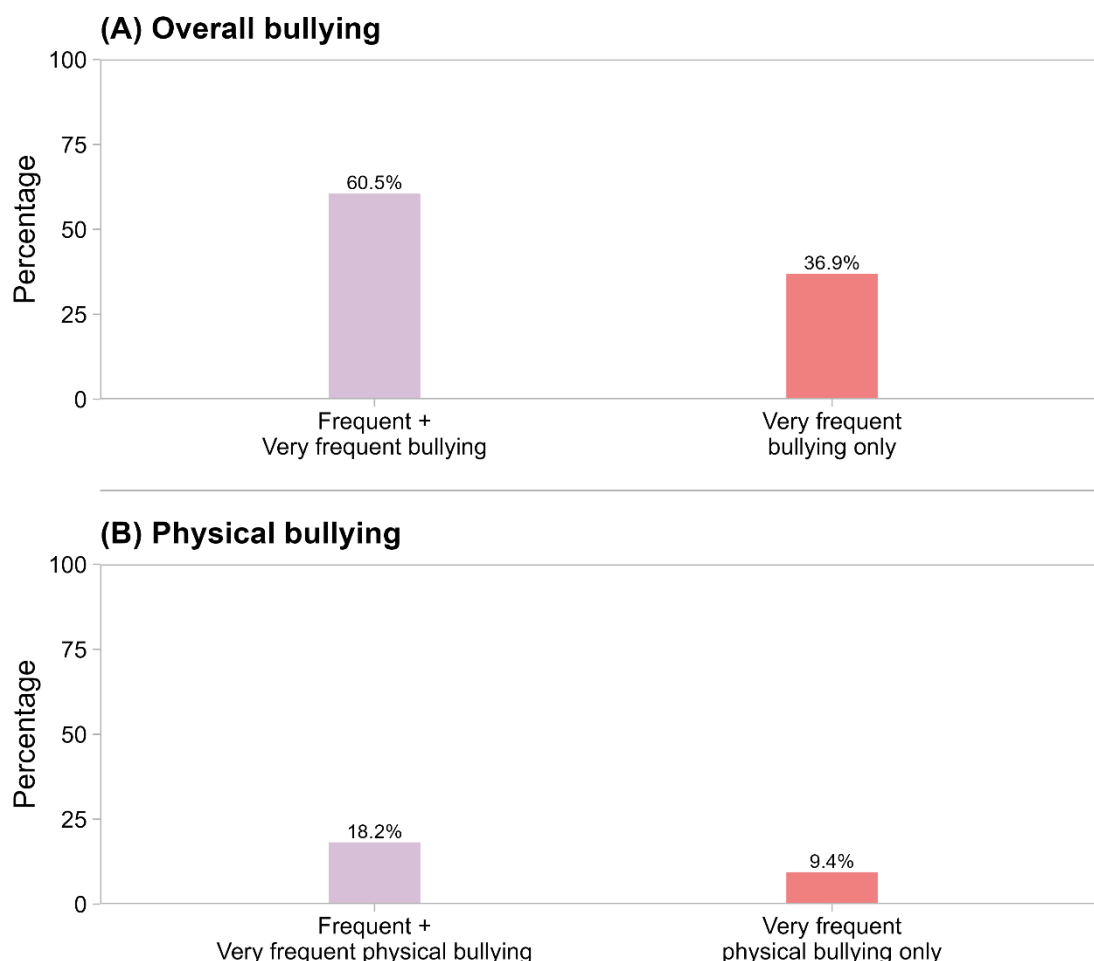
¹ Certificate of Secondary Education (CSE)

Descriptive summary of bullying involvement

Descriptive analyses were first conducted to summarise the prevalence and patterns of bullying involvement (victimisation, perpetration, and both) across three time points (ages 8, 10, and 12 years). We present pooled proportions from the multiply imputed data as our main estimates, with available-case estimates provided in Appendices 7 and 8 for reference.

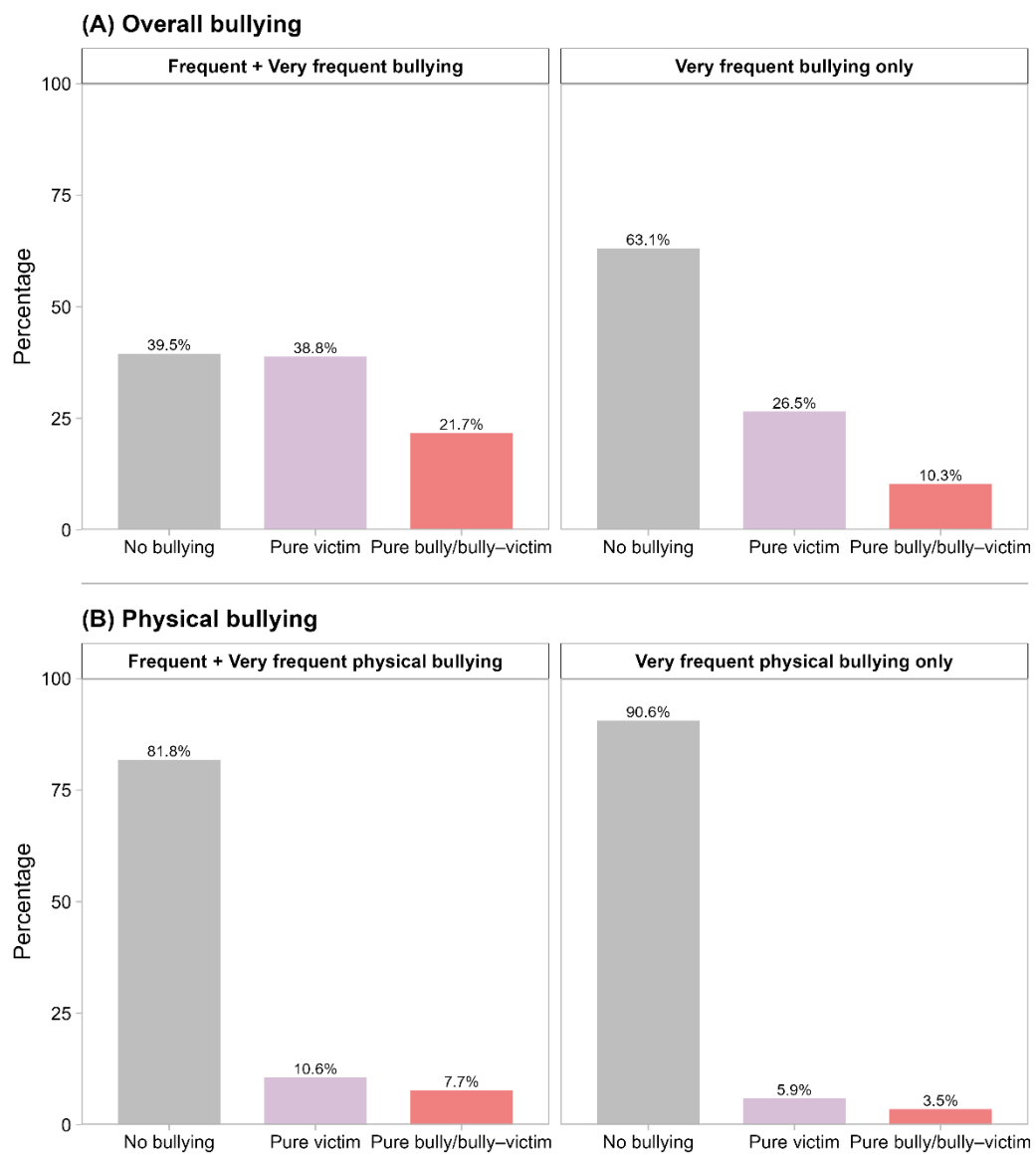
Between ages 8 and 12 years, 60.5% of the 9,944 children reported involvement in bullying as a victim and/or perpetrator at one or more time points, and 36.9% reported that this was very frequent bullying (at least once a week). For physical bullying, 18.2% reported involvement at one or more time points, with 9.4% involved very frequently (Figure 3, by age at assessment, as shown in Table 8).

Figure 3: Prevalence of any bullying involvement (combined victimisation and/or perpetration) by frequency between ages 8 and 12 years



Between ages 8 and 12 years, 38.8% of children reported bullying victimisation (pure victim), and 21.7% reported perpetration or both (pure bully/bully-victim; Figure 4). Of those who reported any involvement in bullying (frequent + very frequent), 34.1% were involved at one time point, 18.8% at two, and 7.6% at all three time points between ages 8 and 12 years. The prevalence of the other different types of bullying behaviours is summarised in Appendix 9.

Figure 4: Prevalence of overall (A) and physical (B) bullying involvement status by frequency between ages 8 and 12 years



Note: No bullying in Figure 4B for physical bullying may include other forms of bullying

Table 8: Prevalence of bullying involvement by age and frequency

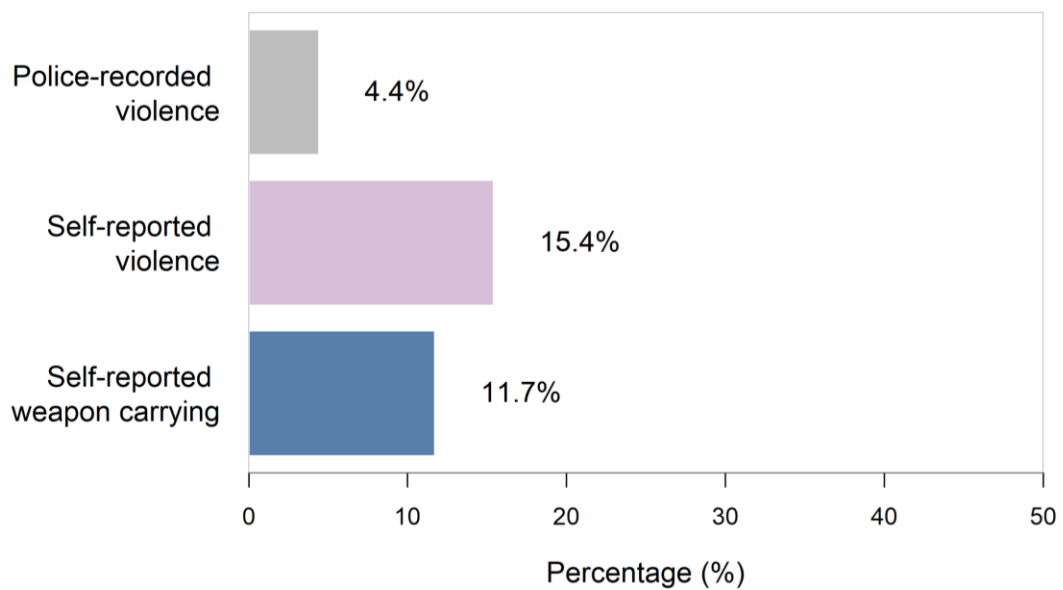
	No bullying %	Pure victim %	Pure bully/bully-victim %	Any bullying *	No bullying %	Pure victim %	Pure bully/bully-victim %	Any bullying *
Age	Frequent or very frequent bullying [§]				Very frequent (only) bullying [^]			
8 years	59.8	31.3	8.9	40.2	78.8	17.3	3.9	21.2
10 years	73.0	19.3	7.8	27.0	87.0	10.2	2.9	13.0
12 years	72.7	16.7	10.6	27.3	85.3	9.9	4.7	14.7
8-12 years	39.5	38.8	21.7	60.5	63.1	26.5	10.3	36.9
Physical bullying involvement ^{&}								
Age	Frequent or very frequent physical bullying [§]				Very frequent (only) physical bullying [^]			
8 years	88.7	7.6	3.8	11.3	94.1	4.1	1.8	5.9
10 years	94.2	3.2	2.6	5.8	97.4	1.5	1.1	2.6
12 years	95.3	2.4	2.3	4.7	98.0	1.1	0.8	2.0
8-12 years	81.8	10.6	7.7	18.2	90.6	5.9	3.5	9.4
*Any victimisation or perpetration §More than four times in the past six months but less than once a week + at least once a week ^At least once a week &Column for no bullying involvement in physical bullying may include other forms of bullying Reported percentages are pooled across 100 multiply imputed datasets. Cell counts (n) are not shown because they differ across imputations and do not represent fixed observed values.								

Descriptive summary of violence outcomes

Descriptive analyses were conducted to summarise the prevalence of self-reported and police-recorded violence and self-reported weapon carrying in adolescence and early adulthood. As with the bullying variables, we present pooled proportions from the multiply imputed data as our main estimates, with available-case estimates shown in Appendix 10 for reference.

Self-reported violence was assessed at ages 17 and 18 years; 15.4% of the 9,944 young people reported engaging in violent behaviour in the past 12 months (Figure 5), 4.4% (n = 436) had a police record for serious violence between ages 13 and 24 years, and 11.7% reported carrying a weapon at age 15 years.

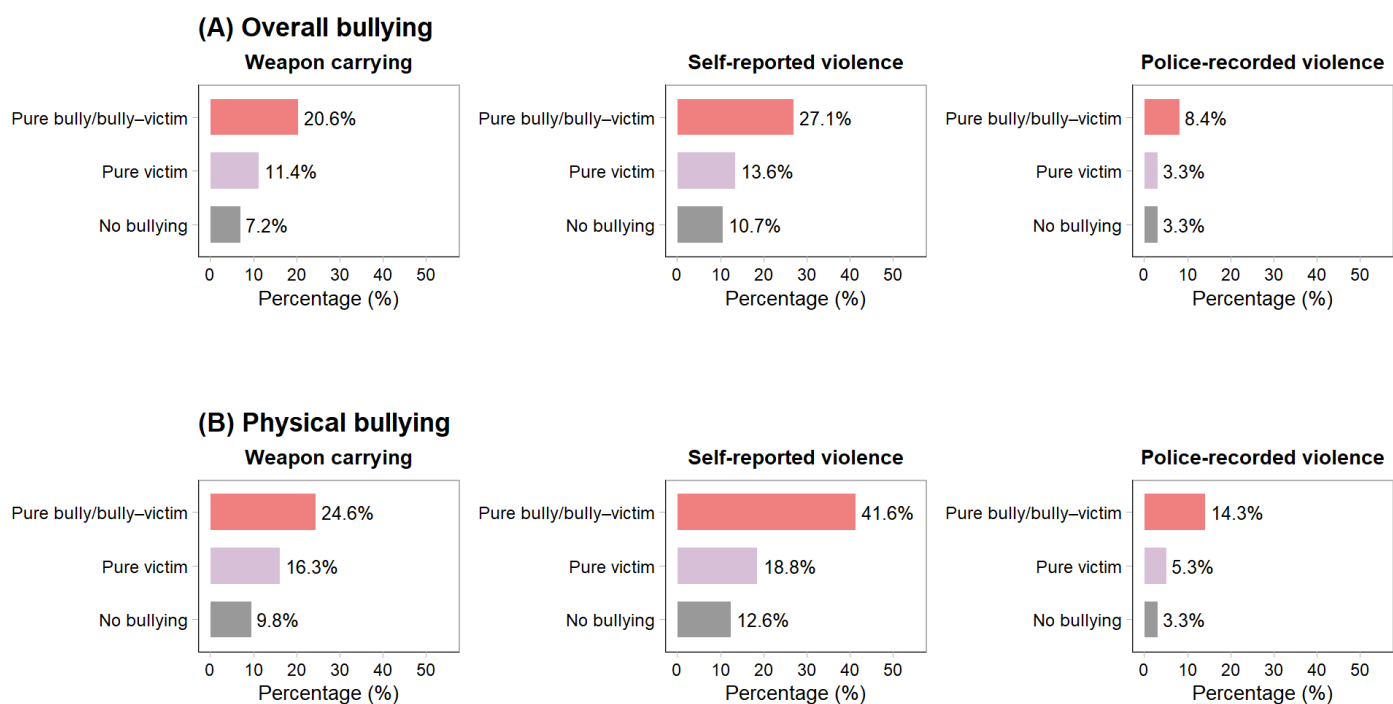
Figure 5: Prevalence of violence



Bullying and violence

Young people who did not report involvement in bullying between ages 8 and 12 years had the lowest prevalence of weapon carrying (7.2%) and self-reported violence (10.7%); their prevalence of police-recorded violence was the same as observed for the pure victim group (3.3%). In contrast, those who were perpetrators of bullying (either as pure bullies or bully–victims) had the highest prevalence of weapon carrying (20.6%), self-reported violence (27.1%), and police-recorded violence (8.4%) (Figure 6). A similar pattern emerged for physical bullying and these outcomes, with a much higher prevalence of self-reported violence among those involved in bullying perpetration (41.6%). All estimates by frequency of bullying are reported in Appendix 11 (available cases in Appendix 12). **11.4%**

Figure 6: Prevalence of violence by bullying involvement role



Note: No bullying in Figure 6B may include other forms of bullying

Results by research question

RQ 1: What is the association between bullying perpetration or victimisation and (i) self-reported violent behaviour and (ii) official sanction for serious violence?

We examined associations between bullying involvement between ages 8 and 12 years and subsequent self-reported and police-recorded violence. Figure 6 summarises these results, and Appendix 13 presents ORs and 95% CIs from logistic regression models, including those from sensitivity analyses.

We report the results of three models:

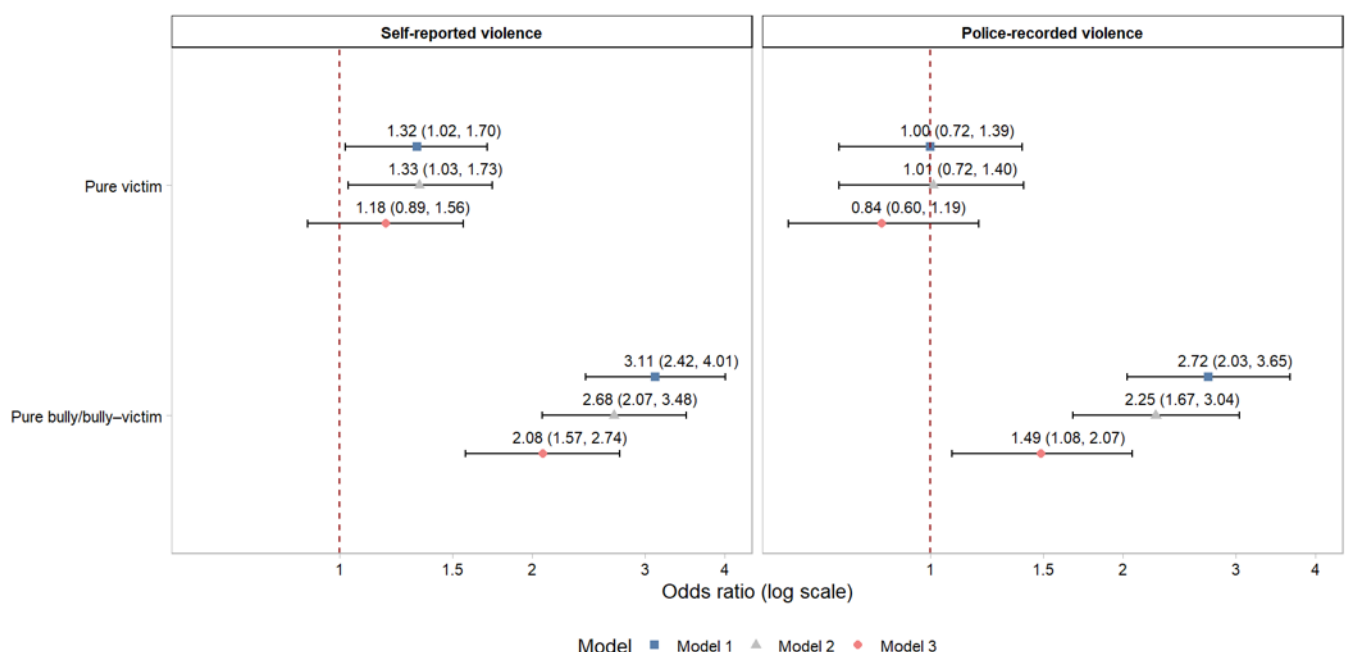
Model 1	Unadjusted
Model 2	Adjusted for sex and ethnicity
Model 3	Adjusted for sex, ethnicity, SDQ, Borderline Personality Disorder (BPD), exposure to ACEs, maternal education, maternal age at delivery, household financial difficulties, maternal smoking during pregnancy, IMD, FSM eligibility, (Key Stage 1 (KS1) attainment, parental educational engagement

The distribution and prevalence of these confounders within the analytic sample are presented in Appendix 14

Children who reported being bullied (pure victims) between ages 8 and 12 years had 32% higher odds of reporting violent behaviour (Model 1; OR = 1.32) compared with those who were not involved in bullying (Figure 7). After adjusting for sex and ethnicity (Model 2), the association was similar (OR = 1.33). However, after adjusting for all confounders (Model 3), there was no longer evidence of an association between bullying victimisation and self-reported violence. This suggests that child-, family-, or area-level factors may explain the link between bullying victimisation and self-reported violence. There was no evidence of an association with police-recorded violence (Models 1–3).

There was evidence of an association between bullying perpetration and both self-reported and police-recorded violence (Figure 7). In unadjusted models (Model 1), children who reported bullying others, either as pure bullies or bully–victims, were more than three times (OR = 3.11) more likely to self-report violence and more than two times (OR = 2.72) more likely to have a police record for violence, compared with those who were not involved in bullying between ages 8 and 12 years. After adjustment for confounders, this risk was attenuated. In fully adjusted models (Model 3), children were more than two times (OR = 2.08) more likely to self-report violence and almost 1.5 times (OR = 1.49) more likely to have a police record for violence than those who were not involved in bullying.

Figure 7: Odds ratios and 95% confidence intervals for the association between bullying involvement and self-reported and police-recorded violence



Sensitivity analyses using the more stringent definition of bullying, restricted to very frequent bullying (occurring at least once a week), showed similar patterns to the main analyses (Appendix 13), although the effect estimates were smaller. Children who reported bullying others (pure bullies or bully–victims) were approximately 1.5 times more likely to self-report violence (Model 3; OR = 1.78) or to have a police record for violence (OR = 1.47) compared with those who were not involved in bullying between ages 8 and 12 years. In addition,

sensitivity analyses using complete cases were overall consistent with the main results (Appendix 13): there was no evidence of an association between pure bullying victimisation and self-reported or police-recorded violence after adjustment for confounders. Pure bullies and bully–victims had more than twice the odds of both violence outcomes compared with non-involved peers, although the CIs were wider (due to reduced sample size) and included the null for the outcome police-recorded violence (Model 3; OR = 2.39, 95% CI 0.89–6.35, $p = 0.08$).

RQ 2: Does the association between bullying involvement and violence differ depending on (i) the accumulation of exposure to bullying involvement across multiple time points (i.e. is there a cumulative risk?) or (ii) when the bullying involvement is experienced (i.e. is there a timing-related association)?

We examined whether the association between bullying involvement and violence differed according to (i) the accumulation of exposure (i.e. cumulative risk) or (ii) the timing of exposure (i.e. timing-related associations).

First, we estimated separate regression models for bullying involvement assessed at ages 8, 10, and 12 years to explore whether associations with later self-reported and police-recorded violence varied by the timing of exposure.

We report results from three models:

Model 1	Unadjusted
Model 2	Adjusted for sex and ethnicity
Model 3	Adjusted for sex, ethnicity, SDQ, BPD, exposure to ACEs, maternal education, maternal age at delivery, household financial difficulties, maternal smoking during pregnancy, IMD, FSM eligibility, KS1 attainment, and parental educational engagement

We then applied SLCMA to formally test competing hypotheses regarding the timing and accumulation of bullying exposure in relation to both outcomes.

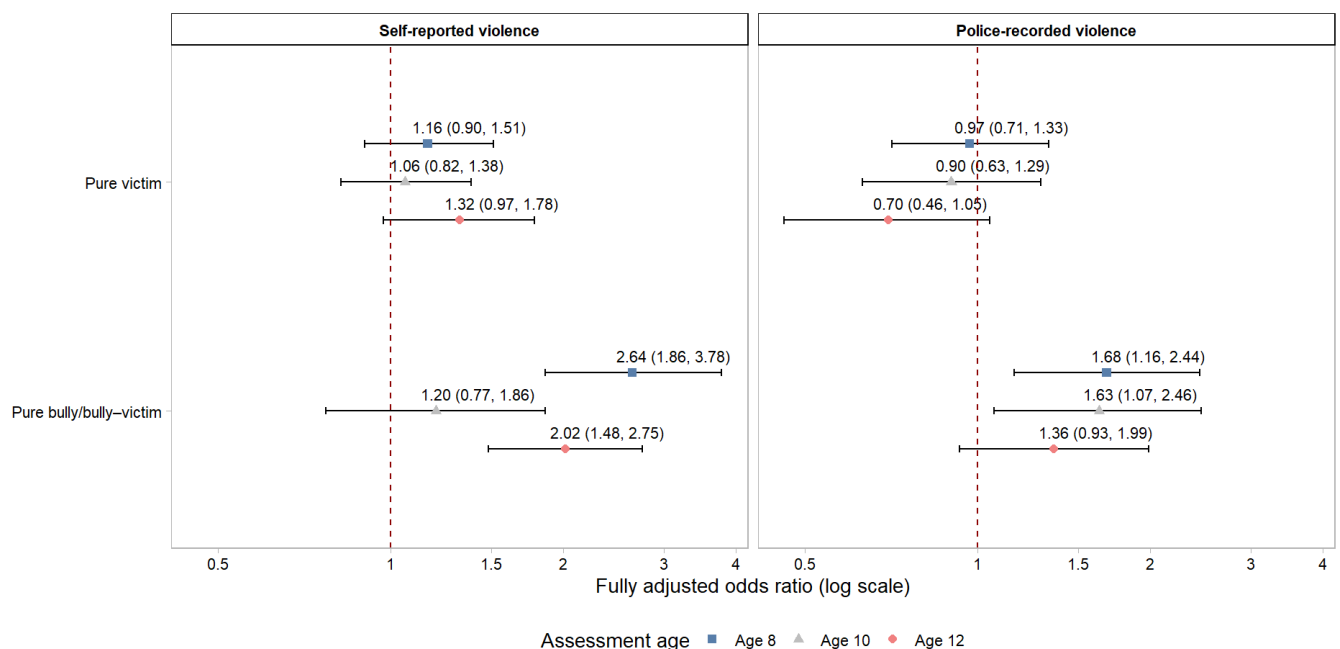
We report results from two models:

Model 1	Unadjusted
Model 2	Adjusted for sex, ethnicity, SDQ, BPD, exposure to ACEs, maternal education, maternal age at delivery, household financial difficulties, maternal smoking during pregnancy, IMD, FSM eligibility, KS1 attainment, and parental educational engagement

Results from logistic regression models on the timing of assessment and each outcome of violence are presented in Appendix 15. Figure 8 summarises the results from the fully adjusted

model (Model 3). Consistent with the results presented for research question 1, there was no strong evidence of an association between bullying victimisation (pure victims) and self-reported or police-recorded violence when stratifying analyses by age of assessment. However, there was evidence of an association between bullying perpetration (pure bully or bully–victim) at ages 8 and 12 years and self-reported violence. Results showed that exposure during these ages was associated with more than twice the odds of reporting violence (Model 3; OR = 2.64 for age 8 and 2.02 for age 12). Additionally, bullying perpetration at ages 8 and 10 years was associated with more than 1.5 times the odds of police-recorded violence (Model 3; OR = 1.68 for age 8 and 1.63 for age 10). However, the evidence of an association between bullying perpetration at age 12 and police-recorded violence was weaker (Model 3; OR = 1.36, 95% CI 0.93–1.99), as the CI spanned the null.

Figure 8: Odds ratios and 95% confidence intervals for the association between bullying involvement by age of assessment and self-reported and police-recorded violence



The fully adjusted regression model (Model 3) showed no strong evidence of an association between bullying victimisation (pure victim) and either self-reported or police-recorded violence. Therefore, we focused our subsequent SLCMA analyses on children involved in bullying perpetration (pure bullies or bully–victims) as the exposure group, and compared them with a combined reference group of children who were not involved in bullying or were classified as pure victims.

Tetrachoric correlations between bullying at ages 8, 10, and 12 years to assess the suitability of SLCMA showed moderate correlations across these ages (Appendix 16), and thus SLCMA was appropriate to address our research questions.

Table 9 summarises the best-fitting hypothesis or hypotheses supported by the data (elbow plots, shown in Appendix 17, were generated to aid selection), representing the

hypothesis/hypotheses that explain the greatest variation in the outcomes, and corresponding ORs, 95% CIs, and Bonferroni-corrected p-values. Unadjusted model results are shown in Appendix 18. Here, we focus on results from Model 2, which adjusts for sex, ethnicity, SDQ, BPD, exposure to ACEs, maternal education, maternal age at delivery, household financial difficulties, maternal smoking during pregnancy, IMD, FSM eligibility, KS1 attainment, and parental educational engagement.

In the fully adjusted analyses (Model 2), accumulation of bullying involvement as a pure bully or bully–victim was the best-supported hypothesis based on the elbow plot, as including additional hypotheses did not substantially improve model fit. There was strong evidence that each additional time point of involvement in bullying perpetration between ages 8 and 12 years was associated with an average 43% increase in the odds of police-recorded violence.

For self-reported violence, the hypothesis explaining the greatest variation in outcomes indicated a sensitive period at age 8. Model fit improved further when additional hypotheses were included – specifically, there were three candidate models: age 8 only, age 8 combined with accumulation of exposure, and age 8 combined with age 12.

Involvement in bullying perpetration (as a pure bully or bully–victim) at age 8 was associated with 2.47 times higher odds of reporting violence compared with those not involved in bullying perpetration at that age. When accumulation of exposure was included, the estimates showed that each additional time point of involvement in bullying perpetration between ages 8 and 12 years was associated with a 30% increase in the odds of self-reported violence, and exposure at age 8 contributed an additional 77% increase in the odds. When the accumulation of exposure was removed and age 12 was added as a sensitive period, results indicated that involvement in bullying perpetration was associated with 2.27 times higher odds of reporting violence, and exposure at age 12 was associated with 1.7 times higher odds. Children involved in bullying perpetration at both ages 8 and 12 years had more than three times the odds of reporting violence, suggesting multiplicative effects across these periods.

As the outcome, self-reported violence did not support a single best-fitting hypothesis; we compared the three candidate models (age 8, age 8 + accumulation of exposure, and age 8 + age 12) using the Akaike Information Criterion (AIC), which evaluates model quality by balancing goodness-of-fit and model complexity. The model with the lowest AIC value (Appendix 19) was considered the best fit, which supported the age 8 + age 12 hypothesis. These results also supported what was observed in the logistic regression models, which showed strong evidence of an association between bullying perpetration at ages 8 and 12 years and self-reported violence (Figure 8).

Table 9: Best-fitting life course hypotheses and corresponding odds ratios, 95% confidence intervals, and p-values for the association between bullying involvement (pure bully/bully–victim) and self-reported and police-recorded violence

	Self-reported violence
--	------------------------

Best-fitting hypothesis/hypotheses	Odds ratio (95% confidence interval)	p-value*
Age 8	2.47 (2.10–2.91)	<0.001
Age 8 + accumulation of exposure	Age 8: 1.77 (1.41–2.21) Accumulation of exposure: 1.30 (1.15–1.46)	<0.001 <0.001
Age 8 + age 12	Age 8: 2.27 (1.92–2.68) Age 12: 1.70 (1.44–2.00)	<0.001 <0.001
Police-recorded violence		
Accumulation of exposure	1.43 (1.25–1.63)	<0.001
*Bonferroni correction is applied to p-values to adjust for model selection The reference group is no bullying involvement or pure victim		

RQ 3: What is the association between bullying involvement and self-reported weapon carrying in adolescence?

We examined associations between bullying involvement between ages 8 and 12 years and subsequent self-reported weapon carrying. Appendix 20 presents ORs and 95% CIs from logistic regression models, and Figure 9 summarises these results.

We report results from three models:

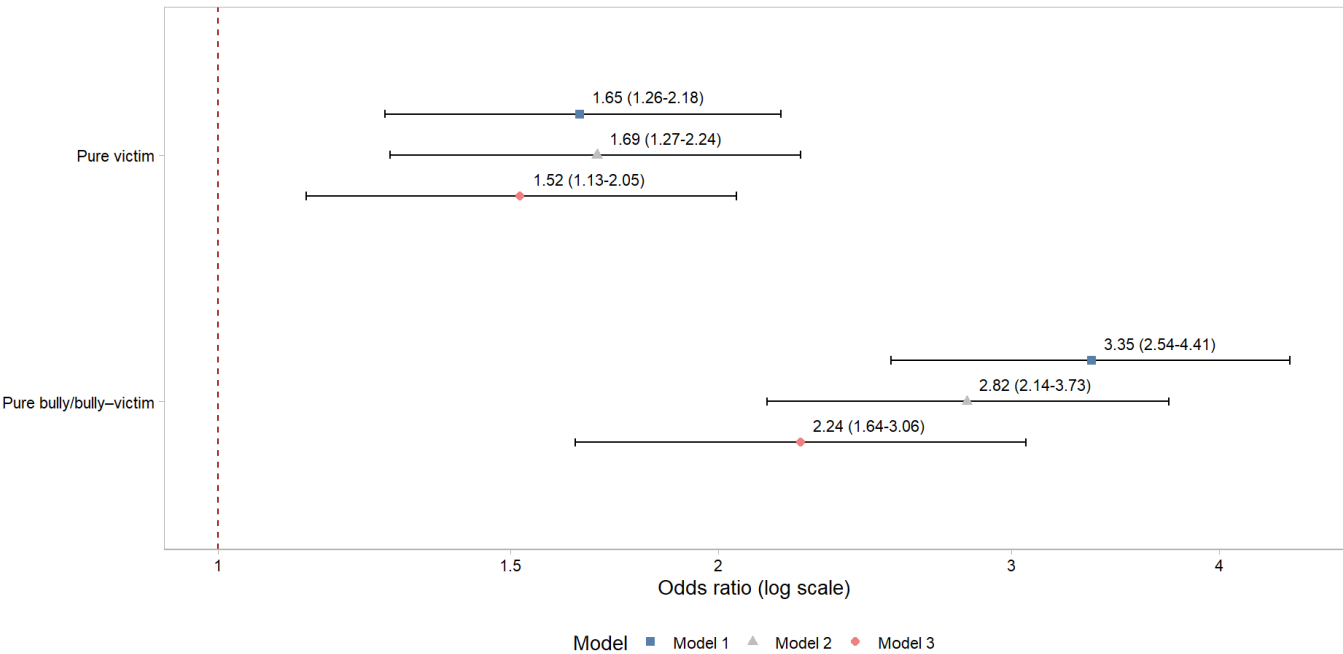
Model 1	Unadjusted
Model 2	Adjusted for sex and ethnicity
Model 3	Adjusted for sex, ethnicity, SDQ, BPD, exposure to ACEs, maternal education, maternal age at delivery, household financial difficulties, maternal smoking during pregnancy, IMD, FSM eligibility, KS1 attainment, and parental educational engagement

Across all models (Models 1–3), there was strong evidence of an association between bullying involvement between ages 8 and 12 years and weapon carrying. Children who reported involvement in bullying, as victims, perpetrators, or both, were between 1.5 and more than two times more likely to report carrying a weapon compared to children who did not report any involvement in bullying (Model 3; OR = 1.52 for pure victims and 2.24 for pure bullies or bully–victims).

Sensitivity analyses using the more stringent definition of bullying, restricted to very frequent bullying (occurring at least once a week), showed similar patterns to the main analyses (Appendix 20); however, the effect estimates were smaller. Children who reported bullying others (pure bullies or bully–victims) were approximately 1.5 times more likely to report carrying a weapon (Model 3; OR = 1.55) than those not involved in bullying. While those who reported being bullied (pure victims) were 1.21 times (Model 3) more likely to report carrying a weapon than those not involved in bullying; however, the CIs spanned the null (0.93–1.58). In complete-case analyses, all bullying roles were associated with weapon carrying (Appendix

20). Associations with weapon carrying were slightly larger in complete-case analyses than in the imputed analyses, but the direction of the results was consistent with the main analysis.

Figure 9: Odds ratios and 95% confidence intervals for the association between bullying involvement and self-reported weapon carrying



RQ 4: What is the association between physical bullying perpetration or victimisation and (i) self-reported violent behaviour and (ii) official sanction for serious violence?

We examined associations between physical bullying involvement between ages 8 and 12 years and subsequent self-reported and police-recorded violence. Appendix 21 presents ORs and 95% CIs from logistic regression models, and Figure 10 summarises these results.

We report results from three models:

Model 1	Unadjusted
Model 2	Adjusted for sex and ethnicity
Model 3	Adjusted for sex, ethnicity, SDQ, BPD, exposure to ACEs, maternal education, maternal age at delivery, household financial difficulties, maternal smoking during pregnancy, IMD, FSM eligibility, KS1 attainment, and parental educational engagement

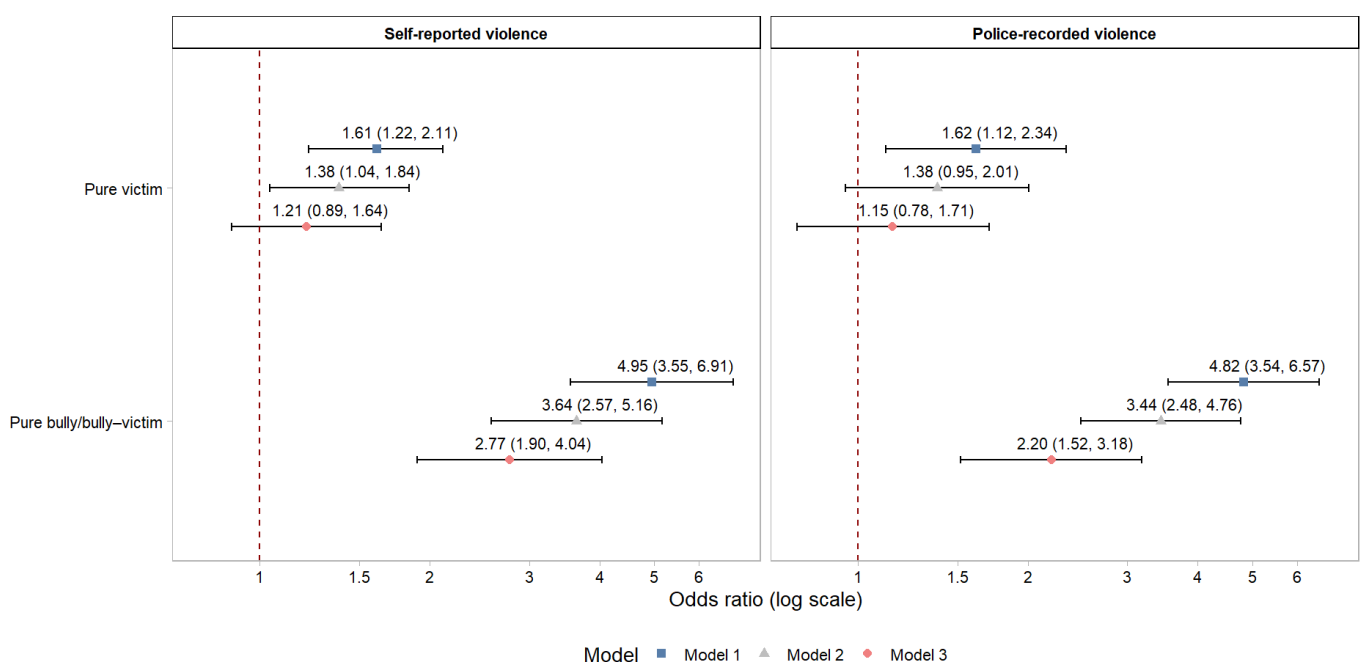
Children who reported being physically bullied (pure victims) between ages 8 and 12 years had 1.61 times higher odds of reporting violent behaviour (Model 1) compared with those who were not involved in physical bullying (Figure 10). After adjusting for sex and ethnicity

(Model 2), the OR attenuated (OR = 1.38), and after adjusting for all confounders (Model 3), there was no longer evidence of an association between physical bullying victimisation and self-reported violence. There was evidence of an association with police-recorded violence in unadjusted analyses (Model 1); however, in the fully adjusted analyses (Model 3), there was no longer evidence of an association between physical bullying victimisation and police-recorded violence.

Physical bullying perpetration was associated with both self-reported and police-recorded violence. Children who reported physically bullying others, either as pure bullies or bully–victims, were almost five times more likely to self-report violence or to have a police record for violence (Model 1; OR = 4.95 for self-reported violence and 4.82 for police-recorded violence), compared with those who were not involved in physical bullying between ages 8 and 12 years. After adjustment for confounders, this risk attenuated. In fully adjusted models, children were more than two times more likely to self-report violence or to have a police record for violence (Model 3; OR = 2.77 for self-reported violence and 2.20 for police-recorded violence) than those who were not involved in physical bullying.

Sensitivity analyses using the more stringent definition of physical bullying, restricted to very frequent physical bullying (occurring at least once a week), were consistent with the main analyses (Appendix 21), with similar effect sizes. In complete-case analyses, there was no evidence of an association between (pure) physical bullying victimisation and self-reported or police-recorded violence, consistent with the main analysis (Appendix 21). Pure bullies and bully–victims of physical bullying had more than three times the odds of violence outcomes compared with non-involved peers, although CIs were wider (due to reduced sample size) and included the null for the outcome police-recorded violence (Model 3; OR = 3.47, 95% CI 0.95–12.59, $p = 0.059$).

Figure 10: Odds ratios and 95% confidence intervals for the association between physical bullying involvement and self-reported and police-recorded violence



Exploratory analyses by sex

Exploratory analyses focused on the available and complete-case data rather than multiply imputed data, as our sample was not large enough to impute stratified by sex. Therefore, descriptive statistics for bullying and violence are based on available-case data, meaning only those who completed the relevant questionnaires were included, while interaction effects and subsequent sex-stratified analyses are based on complete-case data.

Between ages 8 and 12 years, 71.4% of 2,617 boys and 63.9% of 2,650 girls reported involvement in bullying. Among boys reporting involvement in bullying during this period, 43.8% were pure victims and 27.7% were perpetrators (pure bully/bully-victim). Among girls, 48.4% were pure victims and 15.5% were perpetrators. During this period, 33.9% of 2,269 boys reported involvement in physical bullying; 20.9% were pure victims, and 13.0% were perpetrators. In contrast, 13.8% of 2,270 girls reported involvement in physical bullying; 11.2% were pure victims, and 2.6% were perpetrators. Further information is available in Appendix 22.

For violence outcomes, 14.2% of 1,700 boys reported engaging in violent behaviour in the past 12 months at age 17 or 18 years, 6.7% of 5,044 had a police record for serious violence between ages 13 and 24 years, and 12.8% of 2,049 reported carrying a weapon at age 15 years. In contrast, 6.1% of 2,374 girls reported engaging in violent behaviour in the past 12 months, 2.0% of 4,900 had a police record for serious violence between ages 13 and 24 years, and 3.9% of 2,263 reported carrying a weapon at age 15 years.

We tested interaction effects to explore whether the association between bullying and violence differs by sex. Overall, there was no evidence of any sex differences in the association between bullying involvement and self-reported violence and bullying involvement and weapon carrying (research questions 1 and 3). Numbers were too small to explore timing and cumulative effects on violence by sex (research question 2). There was evidence of an interaction effect ($p < 0.01$) for the association between physical bullying and self-reported violence (research question 4). Sex-stratified analyses demonstrated that the association between physical bullying perpetration and self-reported violence was stronger among girls than boys after adjustment for ethnicity, SDQ, ACEs, maternal age at delivery, financial difficulties, maternal smoking during pregnancy, IMD, FSMs, and KS1 educational attainment. However, due to the small number of girls involved in both physical bullying and violence, the 95% CIs were very wide, and, therefore, these results should be interpreted with caution.

Conclusions and implications

Summary findings

This report examines the associations between bullying victimisation and perpetration and later self-reported and police-recorded serious violence. We also explored the cumulative and timing effects of bullying, the relationship between bullying involvement and weapon carrying in adolescence, and the specific effects of physical bullying. Analyses included sensitivity checks using a more stringent definition of bullying.

In summary, there was strong evidence that bullying perpetration, but not victimisation, was associated with both self-reported and police-recorded violence after accounting for child-, family-, and area-level factors. Results also indicated cumulative and timing effects of bullying perpetration on later violence. Bullying involvement – as a victim, perpetrator, or both – was associated with weapon carrying, while physical bullying perpetration, but not victimisation, was associated with both self-reported and police-recorded violence after accounting for child-, family-, and area-level factors.

The prevalence of bullying and violence differed between boys and girls, and exploratory analyses suggested the association between physical bullying perpetration and self-reported violence could be stronger among girls than boys. However, these findings should be interpreted with caution due to small sample sizes. Further research with larger samples is needed to confirm these results.

The results are summarised in Table 10.

Table 10: Summary of results

Research question	Results
What is the association between bullying perpetration or victimisation and (i) self-reported violent behaviour and (ii) official sanction for serious violence?	After adjustment for child-, family-, and area-level factors, there was strong evidence of an association between bullying perpetration (pure bully or bully–victim) and both self-reported and police-recorded violence but not for bullying victimisation (pure victim). Children who reported bullying others between ages 8 and 12 years were more than twice as likely to self-report violence and almost 1.5 times more likely to have a police record for violence compared with those not involved in bullying during this period. Sensitivity analyses using a more stringent definition of bullying (restricted to very frequent bullying, i.e. at least once a week)

	showed similar patterns to those of the main analyses.
Does the association between bullying involvement and violence differ depending on (i) the accumulation of exposure to bullying involvement across multiple time points (i.e. is there a cumulative risk?) or (ii) when the bullying involvement is experienced (i.e. are there timing-related associations?)?	Results indicate associations between both timing and the cumulative patterns of bullying perpetration and later violence. Children who reported bullying others had, on average, a 43% increase in the odds of police-recorded violence for each additional time point of involvement in bullying perpetration between ages 8 and 12 years. Sensitive periods at ages 8 and 12 years were observed for the outcome of self-reported violence. Children who reported bullying others at age 8 were more than twice as likely to report violence, and those involved at age 12 were 1.7 times more likely. Those involved at both time points were more than three times more likely to report violence compared with children not involved in bullying perpetration at these ages.
What is the association between bullying involvement and self-reported weapon carrying in adolescence?	Children who reported involvement in bullying – either as victims, perpetrators, or both – were between 1.5 and more than twice as likely to report carrying a weapon compared with those who did not report any involvement in bullying between ages 8 and 12 years. Sensitivity analyses using a more stringent definition of bullying (very frequent bullying, at least once a week) showed similar patterns.
What is the association between physical bullying perpetration or victimisation and (i) self-reported violent behaviour and (ii) official sanction for serious violence?	After adjustment for child-, family-, and area-level factors, there was no strong evidence of an association between physical bullying victimisation and either self-reported or police-recorded violence. However, children who reported physically bullying others between ages 8 and 12 years were more than twice as likely to self-report violence and to have a police record for violence compared with those not involved in physical bullying perpetration during this period. Sensitivity analyses using a more stringent definition of physical bullying

	(occurring at least once a week) were consistent with the main analyses.
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Interpretation and implications

The association between bullying perpetration – but not victimisation – and later violence is consistent with previous literature showing that victimisation alone is not associated with subsequent violent behaviour after accounting for confounding factors (Sourander et al., 2007; Ttofi and Farrington, 2010; Sourander et al., 2011; Wolke et al., 2013; Fergusson et al., 2014; Klomek et al., 2015; Tiiri et al., 2023). Our study extends previous research by examining both victimisation and perpetration, including bully–victims – a group that has received limited attention in relation to later violence.

To our knowledge, this is the first study to explore both the timing and cumulative patterns of bullying involvement in relation to later violent outcomes, providing a novel contribution to the literature. We found clear associations between repeated bullying perpetration (as pure bullies or bully–victims) and serious violence and between the timing of bullying perpetration and self-reported violence. Specifically, repeated involvement in bullying between ages 8 and 12 years was associated with increasingly higher odds of later police-recorded violence, while bullying perpetration at ages 8 and 12 was associated more strongly with self-reported violence. These findings suggest that both the persistence and timing of bullying behaviours contribute to an increased risk of violent behaviour later. Consistent with our identification of age 8 as a sensitive period, previous research has also found that children who were both perpetrators and victims of bullying at age 8 were more likely to engage in repeated violent offending in later life (Sourander et al., 2007). However, that study examined bullying at only a single time point and did not account for cumulative exposure. Our findings, therefore, provide a more comprehensive picture, highlighting that bullying perpetration in both early and later childhood (ages 8 and 12) confers the greatest risk for later self-reported violence. The stronger associations demonstrated at these two ages could be an artefact of the data or could reflect important developmental or transitional periods, which warrants further investigation.

We found evidence that children involved in bullying – whether as victims, perpetrators, or both – had a higher likelihood of carrying a weapon in adolescence than those not involved in bullying. This finding aligns with previous research demonstrating that all forms of bullying involvement are associated with an increased risk of weapon carrying (Simckes et al., 2017; Valdebenito et al., 2017; Lu et al., 2020). Our results extend this literature by showing that these associations are also evident in a UK cohort among both males and females, where such evidence has been limited.

Our findings support existing evidence that aggressive behaviour in childhood often persists into adolescence and adulthood (Farrington, 1991; Huesmann et al., 2002; Pepler et al., 2008; Kokko et al., 2009). Consistent with previous research, we found that physical bullying

perpetration was strongly associated with later violence, whereas victimisation alone was not. One previous study reported that physical bullying among males was a stronger predictor of self-reported violence in adulthood than other forms of bullying (Bender and Losel, 2011). Our results support and extend these findings by demonstrating that physical bullying perpetration was associated with more than twice the odds of both self-reported and police-recorded serious violence, even after adjustment for multiple confounders.

Sensitivity analyses applying a more stringent definition of bullying – occurring very frequently (at least once a week) – showed broadly similar associations. In fact, estimates were smaller for some analyses when bullying was defined as occurring very frequently. We did not find stronger associations or clear dose–response patterns to suggest that more frequent bullying involvement confers a greater risk of violence. While a previous review suggested some evidence that greater involvement in bullying is associated with worse outcomes (Wolke et al., 2013; Klomek et al., 2015), the frequency of bullying involvement has rarely been examined and formally compared. Moreover, evidence regarding dose–response relationships with criminal or violent outcomes remains limited, as studies have rarely compared different frequencies of bullying or victimisation.

Implications

Our findings demonstrate that childhood bullying perpetration is an important and robust risk factor for later violence. These results highlight that the consequences of bullying extend beyond immediate harm, contributing to behaviours with serious legal and safety implications.

We observed the cumulative risk of bullying perpetration over time on subsequent serious police-recorded violence, but bullying perpetration at age 10 was not associated with later self-reported violence, in contrast to bullying at ages 8 and 12 years. We examine below how this observation could be the result of measurement issues. However, it could also reflect two well-known pathways to offending: life-course-persistent and adolescent-limited (Moffitt, 1993). In this taxonomy, young people who begin to offend early (8 to 10 years) tend to continue offending for prolonged periods. This group often experience a range of childhood adversities, learning difficulties, and externalising behavioural problems (Farrington, 2020). A separate group of offenders commences offending later – in their early teens – but do so for only a short period. For this adolescence-limited group, offending is likely brought on by increased freedom, the opportunity to reshape identity, and new peer groups that come with the transition to secondary education (Moffitt, 1993). At the peak age for offending in the mid-to-late teens, individuals on these differing trajectories may be indistinguishable, but their offending likely has different causes and solutions. Our observations – and the lack of an association at age 10 – are consistent with this taxonomy and could suggest that bullying is a forerunner to offending. If true, the association between bullying and later violence may not be causal, but a reflection of other criminogenic factors that emerge at different ages.

Nonetheless, because it is often detected by teachers and parents, bullying may serve as an important warning sign for emergent offending.

Many of the features of bullying mirror those of childhood abuse and neglect, but the association between bullying victimisation and later violence does not match the association between childhood adversity and later offending that has been observed repeatedly (Yohros, 2023). Potential explanations for this inconsistency are that the nature of childhood adversity may be more diverse or that abuse may be more pervasive than bullying victimisation. Furthermore, an inability to escape abuse in the home may have more traumatising effects, resulting in longer-lasting effects on violence. Finally, the perpetrator – often a parent or guardian in child abuse but a sibling or peer in bullying – may affect how the adversity is experienced and interpreted by the victim. This finding, therefore, provides stronger support for a trauma theory of the adversity–offending link than for a social learning theory of this association.

Notably, bullying victimisation did not predict violence but did predict weapon carrying, whereas bullying perpetration predicted both violence and weapon carrying. This suggests that weapon carrying and violence may not be driven by the same mechanisms. These findings offer support for a dual-function theory of weapon carrying: weapons serve both protective and aggressive functions, and these functions can extend for years beyond their immediate instrumental purpose (Brennan and Moore, 2009). Although Brennan (2023) found that worry about victimisation in 10- to 25-year-olds did not predict weapon carrying one year later, the lasting harm of bullying may still influence fear of crime in other ways that could result in weapon carrying. Research should examine whether there is a taxonomy of weapon carrying driven by victimisation and perpetration factors, respectively, or if weapon carrying is, more simply, a long-term response to an uncertain and violent environment.

Overall, our research highlights the importance of viewing bullying as a serious public health concern with long-term consequences. Preventing and addressing bullying in childhood is not only crucial for the immediate well-being of children but may also serve as a key strategy in reducing violence over the life course. If causal, our findings on the progressively higher risk of violence associated with cumulative bullying perpetration and potential sensitive periods around ages 8 and 12, alongside associations between bullying victimisation and weapon carrying, indicate a need for interventions targeting both primary- and secondary-school-aged children. Such interventions should aim to build resilience, reduce the risk of victimisation among vulnerable children, and reduce trauma among victims (Arseneault, 2018; Hikmat et al., 2024) while also addressing bullying perpetration. Previous evidence that children who begin bullying at a younger age are at higher risk of persistent offending (Moffitt, 1993) highlights the importance of early intervention to break the cycle of aggressive behaviour.

Weapon carrying among victims may reflect a self-protection or coping response to perceived threats (van Geel et al., 2014). Experiences of victimisation and fear for safety may influence decisions to carry a weapon; reducing weapon carrying, therefore, likely requires not only preventing bullying exposure but also addressing the underlying mechanisms, such as fear,

perceived lack of safety, and distrust in safeguarding organisations. In addition, low family income, exposure to domestic violence between parents, conduct problems, mental health difficulties, substance use, and school exclusion have been identified as additional risk factors for weapon carrying in the UK Millennium Cohort Study (Villadsen and Fitzsimons, 2023). Successful interventions to prevent weapon carrying also need to take into account the broader family environment and individual-level factors.

Given the evidence linking parenting styles and the family environment to both bullying perpetration and victimisation – and the greater likelihood that both bullies and victims are exposed to abusive, harsh, or unsupportive home environments (Barker et al., 2008; Kljakovic and Hunt, 2016) – effective interventions should extend beyond the school setting to support children growing up in adversity. In addition, conduct, social, and school problems have been identified as risk factors for bullying perpetration among adolescents, suggesting that bullying is driven by a range of individual, family, and social factors. Interventions therefore need to be contextually informed and multilevel, addressing not only behaviour within schools but also the broader environments in which bullying develops, in order to prevent these behaviours from accumulating and to mitigate future risks of violence. Although there is some evidence that bullying perpetration diminishes for some children as they transition to secondary school (Kljakovic and Hunt, 2016), our findings of strong associations between early bullying perpetration at age 8 and later violence suggest that even early, potentially time-limited bullying behaviours warrant attention. Further research is also needed to examine risk factors for childhood-onset and adolescent-onset bullying, as well as patterns of bullying involvement across multiple time points, to better identify opportunities and avenues for intervention.

Caveats and limitations

This study has several notable strengths. First, to our knowledge, this is the first study to examine the longitudinal associations between bullying involvement and later violence using detailed prospective assessments. The use of longitudinal prospective data allowed us to establish temporality. In contrast, other studies often rely on retrospective cross-sectional designs that focus on individuals who have already experienced the outcome and may retrospectively report about bullying experiences. Furthermore, the availability of a range of early-life factors enabled us to adjust for child-, family-, and area-level confounders.

Second, our study captures one of the most comprehensive measures of bullying, including different types of overt and relational behaviours, their frequency, and bully–victim roles.

Third, we leveraged multiple repeated assessments of bullying and applied advanced statistical methods to examine timing and cumulative patterns of bullying in relation to later violence, going beyond previous literature in this level of detail.

Fourth, we supplemented self-reported violence outcomes with official police records, reducing the bias commonly associated with self-reports. Police-recorded outcomes,

however, rely on criminal behaviour being detected and an individual being arrested, meaning they capture only a subset of offences, typically more serious or reported crimes. Self-reported data, in contrast, can capture lower-level offending but depends on participants responding to surveys accurately and honestly, and is subject to the interpretation of the questions. By examining both self-reported and police-recorded violence, we captured a broader range of violent behaviour while mitigating the limitations of each method of assessment.

Finally, we addressed missing data among high-risk individuals who were more likely to have police-recorded violence but missing self-reported violence or bullying data by using multiple imputation, with several auxiliary variables included in the model. Previous research using ALSPAC data showed that those with a police record for violence were less likely to provide self-reported data, and they had lower participation in ALSPAC questionnaires, suggesting that missing self-report information is not random but systematically differs from those with complete data (Cornish et al., 2025). By using multiple imputation, we were able to retain these high-risk individuals in the analyses, reducing potential bias.

There are several limitations to consider. First, police-recorded violence relied on linkage with the A&SP data, which include charges and cautions for violent offences occurring within that area. Consequently, serious violence offences occurring outside Avon and Somerset will not have been captured in our study. However, a previous pilot linkage with the PNC, which records cautions and convictions across England and Wales, found that most offences (86%) committed by ALSPAC participants occurred within Avon and Somerset, suggesting that the majority of relevant offences would be captured (Boyd et al., 2020). We further restricted our sample to individuals who had lived in the Avon and Somerset area at least once within each of the following age periods: 13–16, 17–20, and 21–24 years, or who had an A&SP violence record. This approach aimed to minimise misclassification by ensuring that individuals classified as not having a record of violence were living in an area where, had they committed a violent offence, it would likely have been captured by the A&SP data. However, by excluding some individuals, we may have reduced our sample size and potentially introduced selection bias if those excluded differed systematically in their risk of violence compared to those included. Future linkage with the PNC, which would capture police-recorded violence outcomes in England and Wales, may mitigate the limitations of linkage to A&SP data only.

Second, the assessments and definitions of bullying in ALSPAC are somewhat dated. With the growing use of social media, cyberbullying – manifestations of online harassment, threats, or the non-consensual sharing of images – is now more pervasive and may have different impacts on later violence (Smith et al., 2008; Santre, 2023). As such, our findings may not fully reflect the contemporary landscape of bullying, and the effects of modern bullying, including cyberbullying, on later violence may differ from the effects observed.

Third, our data-driven approach to examining the timing-related associations of bullying using SLCMA was constrained by the available assessment ages, which may not align with distinct developmental periods. Consequently, the identified timing-related patterns may partly

reflect the timing of measurement rather than true sensitive periods in development when bullying has the greatest impact. Although additional child-, parent-, and teacher-reported assessments of bullying are available in ALSPAC at other ages, the questionnaire wording differs, and these measures are less comprehensive than those at ages 8, 10, and 12 years. Moreover, to enable meaningful comparison of timing and cumulative patterns, we prioritised using measures that were consistent across time points.

Fourth, a key limitation of this study is the substantial proportion of missing data in our analytic variables (32.5% for bullying across all three time points and approximately 50–59% for self-reported outcomes). Although multiple imputation has been shown to reduce bias even with high levels of missingness (up to 90%) when the imputation model is correctly specified and includes sufficient auxiliary variables (Madley-Dowd et al., 2019), this approach relies on the MAR assumption and correct model specification. Imputing both exposure and outcome variables further increases reliance on the imputation model to estimate the associations of interest. Reassuringly, complete-case analyses yielded effect estimates similar in direction and magnitude to those from the multiply imputed analyses, although with reduced precision due to the smaller sample size.

Fifth, while we adjusted for a range of confounders, residual confounding is likely to remain (Hammerton and Munafò, 2021). As a result, the estimates should not necessarily be interpreted as causal. In addition, the extended temporal gap between the assessment of bullying (ages 8–12) and violence outcomes (ages 13–24) increases the potential for unmeasured time-varying confounders to influence the observed associations, further limiting causal inference.

Sixth, because of low cell counts, we combined the bullying perpetration groups (pure bullies and bully–victims). As a result, we were not able to examine these groups separately, and therefore cannot distinguish whether the observed associations are driven specifically by pure perpetrators, bully–victims, or both. Further research on larger samples is needed to examine these two groups separately. Similarly, we also used binary exposure when examining the timing and accumulation of exposure, which, while methodologically necessary for SLCMA, may have resulted in a loss of some granularity regarding different bullying experiences. In parallel, the sensitivity analysis, restricted to very frequent bullying, may also be affected by the composition of the reference category, which included children with frequent (but not weekly) exposure alongside those reporting none or infrequent involvement in bullying. As frequent bullying may still confer elevated risk, this heterogeneity reduces group contrast and may partially obscure a true dose–response relationship.

Finally, ALSPAC is based in a geographical area that is more affluent than the general population of England, and this is reflected in the study cohort, which is overrepresented by those from more affluent families with higher educational attainment at age 16 years, while there is an underrepresentation of ethnic minorities (96% of ALSPAC cohort children are of White ethnicity, compared to 87% in the general population) (Boyd et al., 2013; Fraser et al., 2013). In addition, our analytic sample was restricted to participants residing in Avon and

Somerset during adolescence and early adulthood, which may have excluded individuals who migrated for education or employment. Exclusion due to item non-response may also have disproportionately affected more disadvantaged participants, though multiple imputation mitigates this bias to some extent. These multiple selection processes may operate in different directions, making their combined impact on prevalence estimates and associations difficult to determine. As such, the prevalence of bullying and violence, and their associations, may not fully reflect those observed in more socioeconomically and ethnically diverse populations. However, attrition is a common issue in longitudinal cohort studies, which is often socially patterned, with greater loss to follow-up among more disadvantaged participants (Cornish et al., 2020). Previous work on ALSPAC suggests that even with substantial attrition (>50%), qualitative conclusions regarding the direction and approximate magnitude of associations are largely preserved (Howe et al., 2013). As such, we do not expect the direction of the associations to differ in other contexts.

Directions for future research

There are several avenues for future research that could strengthen the evidence base on the association between bullying and violence.

First, future research should aim to distinguish between pure bullies and bully–victims, as their pathways to later violence may differ. Larger, more diverse cohorts would allow for separate analyses of these groups and elucidate whether the observed associations are driven primarily by persistent perpetrators, by those who are simultaneously victimised, or by both. Similarly, more frequent longitudinal assessments of bullying could help identify sensitive developmental periods during which bullying is more strongly associated with violence, enabling the identification of important windows for intervention.

Second, the landscape of bullying has transformed; while we incorporated a range of bullying behaviours into our definition, our analysis was based on children born in 1991–92. Cyberbullying and other forms of modern harassment represent an important emerging context that may have distinct implications for later violent behaviour, weapon carrying, and the conceptualisation of bullying, warranting further investigation.

Third, research should examine mechanisms and moderators linking bullying involvement to later violence outcomes. Perpetration and victimisation may influence violence and weapon carrying through different pathways. Future studies could test the pathways and assess the roles of the family environment (e.g. abusive, harsh, or unsupportive home environments; family instability; and maltreatment), individual risk factors (e.g. conduct problems), peer networks, and socioeconomic factors as mediators or moderators of risk. In addition, investigating resilience factors, such as supportive parent, teacher, or peer relationships or effective coping skills, could also highlight targets for intervention to prevent escalation from childhood bullying to later violence.

Fourth, we found some evidence that the association between physical bullying perpetration and self-reported violence was stronger among girls than boys. Further longitudinal research using larger samples is needed to test the robustness of these findings.

Finally, extending research to more diverse and representative populations is critical. ALSPAC participants are predominantly White and from more affluent backgrounds, which may limit generalisability. Replication in cohorts with greater ethnic, socioeconomic, and geographic diversity would strengthen the robustness of the findings. Additionally, linking longitudinal self-report data with national criminal records could provide a more complete picture of the long-term violence and other offending consequences of bullying.

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Appendices

Appendix 1: Linkage of ALSPAC to the Police National Computer

Achieving linkage of ALSPAC to the Police National Computer (PNC) was one of the aims of this project. Unfortunately, this has not yet been achieved. Details on the progress we have made are given below.

Brief history of ALSPAC linkage to crime data

When ALSPAC participants reached the age of 18 years they were informed of ALSPAC's intention to link to their health and routine administrative records and given a clear means to opt-out. With regards crime records, the intention was to link to the Police National Computer (PNC), a national (England and Wales) database of convictions and cautions. A pilot linkage to the PNC was achieved in 2013, but for various reasons this did not proceed to a full linkage. Analysis of the anonymous PNC extract obtained through the pilot showed that the majority (86%) of offences committed by the ALSPAC participants had taken place in Avon & Somerset (A&S), the policing area local to ALSPAC. Linkage to A&S Police data was therefore pursued and finally achieved in July 2021.

The A&S police data have many strengths but also some limitations:

- They only include offences that took place in A&S
- They do not include conviction data (only charges, cautions, and other out of court disposals)
- They do not include many pre-2007 records (which were in paper format)
- They are likely missing early records for minor offences (as police forces cannot retain records indefinitely, as per Management of Police Information (MoPI) rules).

We therefore resumed contact with the Ministry of Justice (MoJ) in 2022 with the aim of achieving a full linkage of ALSPAC to the PNC. The MoJ data team was positive about the potential of such a linkage; however, they informed us that they were not currently accepting new applications due to a lack of capacity in their team. They also stated that they would only share data for a *single and well-defined project*, which meant we would not be able to re-use the data for any other research. When applications re-opened the following year, we did not have the capacity in our team to develop a full research proposal.

Linkage to PNC in this current project

In early 2024, we developed this bullying and serious violence project and felt it was a suitable project for an application to the MoJ for linkage of ALSPAC to the PNC. We planned to examine three outcomes: (1) self-reported violence; (2) local police recorded violence; and (3) PNC recorded violence. We also planned to examine differences between what is recorded in local police versus national crime data.

We submitted a full application to the MoJ in early 2025 for this specific bullying and violence project. Our application was positively received overall. We received reviewers' comments, which we addressed and then resubmitted our application in June 2025. We were then advised by the MoJ to submit our application to the Home Office (HO) and were provided with a contact - the HO's liaison with the police through the National Police Chief's Council (NPCC). Their data team were supportive of our project. They and the Data Protection Advisor to the Deputy Chief Constable were satisfied with

the description of the project, and with our Information Governance and Security. They were also happy to allow us to retain a copy of the data for other, future research projects. The linkage of ALSPAC to the PNC to produce a data resource for future research (not limited to the bullying and violence project) was agreed and signed off at the highest level - by the Deputy Chief Constable (July 2025). We have now been connected with the Head of Police Engagement in the National Crime and Justice Lab, which is a joint policing and HO analytical unit that uses police and other data.

Unfortunately, as of March 2026, our application has not proceeded any further. A major update of the PNC is currently underway. The HO have encountered issues related to new technical and security systems, and we have been informed that they need to redirect their resources to addressing those. Therefore, they are unable to consider providing data for our project until the second quarter of 2026. They advised that they have declined all external data requests for the foreseeable future.

Appendix 2: Measurement and coding of study exposures, outcomes, confounders

Study variable	Coding	Reporting source
Exposure		
Bullying ages 8, 10, 12 years (six categorical variables)	Definition for primary analysis: <u>Any type of bullying occurring frequently (more than 4 times in the past 6 months but less than once a week) or very frequently (at least once a week) in the past 6 months.</u> For each time point of assessment (ages 8, 10, 12 years), we derived a categorical variable: No (0) = no bullying involvement. Pure victim (1) = only victimisation (no reports of perpetration of bullying). Pure bully/bully-victim (2) = only perpetration of bullying or both perpetration and victimisation (bully-victim). Definition for secondary analysis: <u>Any type of bullying occurring very frequently (at least once a week) in the past 6 months.</u> A set of three variables were derived and coded as above for a more stringent definition of bullying.	Child self-reported

Bullying ages 8-12 years (two categorical variables)	Definition for primary analysis: <u>Any type of bullying occurring frequently (more than 4 times in the past 6 months but less than once a week) or very frequently (at least once a week) in the past 6 months.</u> No (0) = no bullying involvement at any time point: ages 8, 10, and 12 years. Pure victim (1) = only victimisation (no reports of perpetration of bullying) at any time point. Pure bully/bully-victim (2) = only perpetration of bullying at any time point, or both perpetration and victimisation (bully-victim) at any time point. Definition for secondary analysis: <u>Any type of bullying occurring very frequently (at least once a week) in the past 6 months.</u> A second categorical variable was derived and coded as above for a more stringent definition of bullying.	Child self-reported
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Physical bullying ages 8-12 years (two categorical variable)	Definition for primary analysis: <u>Physical bullying occurring frequently (more than 4 times in the past 6 months but less than once a week) or very frequently (at least once a week) in the past 6 months.</u> No (0) = no physical bullying involvement at any time point: ages 8, 10, and 12 years. Pure victim (1) = only physical bullying victimisation (no reports of perpetration of bullying) at any time point. Pure bully/bully-victim (2) = Only perpetration of physical bullying at any time point, or both perpetration and victimisation of physical bullying (bully-victim) at any time point. Definition for secondary analysis: <u>Physical bullying occurring very frequently (at least once a week) in the past 6 months.</u> A second categorical variable was derived and coded as above for a more stringent definition of bullying.	Child self-reported
Variables for Structured Life Course Modeling (SLCMA) [§] Definition: <u>Bullying occurring frequently (more than 4 times in the past 6 months but less than once a week) or very frequently (at least once a week) in the past 6 months.</u>		
Bullying age 8, 10, 12 years (three binary variables)	For each time point of assessment (ages 8, 10, 12 years), we derived a binary variable: No (0) = No bullying involvement or victimisation only (pure victim). Yes (1) = Pure bully/bully-victim: only perpetration of bullying or both perpetration and victimisation (bully-victim).	Child self-reported

Cumulative exposure	Pure bully/bully-victim age 8 + Pure bully/bully-victim age 10 + Pure bully/bully-victim age 12 0 = No bullying involvement/pure victim at any time point 1 = Pure bully/bully-victim at one time point 2 = Pure bully/bully-victim at two time points 3 = Pure bully/bully-victim at all three time points	Derived from child self-reported assessments
Outcome		
Self-reported weapon carrying at age 15 years	Yes (1)/No (0)	Child self-reported
Self-reported violence ages 17-18 years	Yes (1)/No (0)	Child self-reported
Police-recorded violence ages 13-24 years	Yes (1)/No (0)	Linkage with A&SP
Confounders		
Sex	Male (1)/Female (0)	Mother reported
Ethnicity	White (1)/non-white (0)	Mother reported
Strengths and Difficulties Questionnaire (SDQ) at age 6 years	Continuous variable; score 0-40 Parent version of the Strengths and Difficulties Questionnaire by Goodman (1997). The responses were used to create an overall behaviour score (0-40).	Mother reported

Borderline Personality Disorder (BPD) at age 11 years	BPD is made up of four clusters of nine criteria symptoms: <u>Affective mood symptoms</u> Inappropriate anger, or difficulty controlling anger (e.g., frequent displays of temper, constant anger, recurrent physical fights). Chronic feelings of emptiness. This can be more or less profound at times. It is not “numbness” or trying to block out feelings. Affective instability due to marked reactivity of mood (e.g., intensive episodic dysphoria [e.g., depression and sorrow; anger and rage; anxiety and panic; and feelings of helplessness, hopelessness, worthlessness, emptiness, and loneliness], irritability, or anxiety usually lasting a few hours and only rarely more than a few days) <u>Interpersonal relations symptoms</u> A pattern of unstable or intense interpersonal relationships characterised by alternating between extremes of idealization and devaluation. They may use both idealization and devaluation to negotiate intimacy. Frantic efforts to avoid real or imagined abandonment (not including suicidal or self-mutilation attempts) <u>Cognitive symptoms</u> Identity disturbance: marked and persistently unstable self-image or sense of self. They may change their goals or values depending on those with whom they are closest. Their sense of self may also shift from feeling basically OK and then quickly to feeling they are bad, worthless or evil. Transient stress related paranoid ideation or severe dissociative symptoms, feeling of suspiciousness or experiences of depersonalisation (i.e. feelings that self is unreal) or derealization (i.e. feeling that the world is	Child clinical assessment (Focus at 11+ at age 11.5 years)
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	unreal). These feelings get worse under pressure or may only occur under pressure. <u>Impulsive symptoms</u> Recurrent suicidal behaviour, gestures or threats or self-mutilation behaviour. Borderline patients may cut and burn themselves because they are dissociated and need to "feel real," or because they need to relieve a tremendous amount of anxiety; they also hurt themselves as a way of managing an extreme degree of frustration and rage. A pattern of at least two impulsive behaviours that are potentially self-damaging. A person has to meet five out of the nine criteria to be diagnosed as having BPD as defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV. The Childhood Interview for DSM-IV Borderline Personality Disorder (CI-BPD)— the first semi-structured interview designed specifically to assess DSM-IV BPD in latency-age children and adolescents was developed by Mary Zanarini. This was adapted by Jeremy Horwood and Dieter Wolke to be used at Focus 11+ and was administered as a face-to- face interview. The purpose of the interview was to record the prevalence of the identified behaviours and emotions (not to try and diagnose a child as having a Borderline Personality). The interview was split into 9 sections identifying each of the symptom criteria. Every question was asked, but further probing questions may then have needed to be asked to clarify whether a symptom was present or checking that the child had the right understanding of the asked behaviour and how often the behaviour may have been taking place. The impulsive questions were scored according to the number of times the behaviour had been carried out in the past two years.	
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	Once all the questions had been asked for that criteria, including further probing questions, a judgement needed to be made as to whether the symptom was present or not. [2] indicates that the symptom was definitely present and significant, [1] indicates that it was probably present and [0] indicates that the symptom was absent. The following were guidelines used for scoring a 2 for the set criteria by the tester: • Inappropriate/intense anger – only had to display one of the behaviours, but they had to be happening on a very regular basis, everyday or at least 25% of the time. • Affective Instability – intense brief episodes of sadness, anxiety or irritability, occurring at least 25% of the time. • Emptiness – If the child recognised and admitted to the feelings, not be confused with numbness or boredom • Identity Disturbance – extreme shifting sense of self at least 25% of the time. • Paranoid ideation – cognitively unstable, imagined paranoia rather than child being picked on. Dissociative symptoms – not to be confused with daydreaming or tiredness, this should be out of the child's control. Both symptoms linked to stress, not present all the time. • Abandonment – Often making efforts to avoid being left on their own, due to feelings of being abandoned, rather than just being scared to be left on their own. Do not include suicidal threats or self-mutilating behaviours. • Suicidal or self-mutilating behaviours – harming themselves to relieve pain or to express anger indirectly. Punching walls just to relieve anger was not counted. Must also have punched walls to hurt self or feel pain. Behaviours present two or more times.	
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	• Impulsivity – two behaviours must have been present five times or more over the past two years. Lashing out at someone, is the child attacking another, fistfights can be mutual. Damaging property is in private, against the law is public (this can include damaging public property). • Intense interpersonal relationships – very intense love/hate relationships, regularly changing feelings about a certain other, and/or having a series of short friendships/relationships. These turbulent relationships typically are focused on one person at a time but there may well be a history of such relationships. For this analysis a derived variables was used, this indicated whether the child is defined as a ‘case’ based on whether five or more criteria were probably/definitely present.	
Adverse childhood experiences (birth-age 5 years)	Yes (1)/No (0) Variable derived from multiple questions relating to exposure to the following between birth and age 5 years: physical abuse, emotional abuse, sexual abuse, domestic violence, bullying.	Derived from parent reports
Maternal education at 32 weeks gestation	Categorical variable: 0 = None/Certificate of Secondary Education 1 = Vocational 2 = O Level 3 = A Level 4 = Degree	Mother reported

Maternal age at delivery	Categorical variable: 1 = Under 26 years 2 = 26-28 years 3 = 29-31 years 4 = 32+ years	Derived from date of birth and date of delivery
Maternal smoking during pregnancy	Yes (1)/No (0) Maternal smoking during pregnancy was assessed using two questions. The first asked: 'Did you smoke regularly at any of the following times in the last 9 months? Before pregnancy, first 3 months of pregnancy, last 2 weeks.' Response options included: No, Yes, cigarettes, Yes, cigars, Yes, pipe, and Yes, other. The second question asked: 'Did you smoke regularly in the last 2 months of pregnancy and since having the baby? Last 2 months of pregnancy, since having the baby.' Response options included Yes or No for each type: cigarettes, pipe, cigar, and other. A binary variable was then derived to indicate any smoking (of any type) reported during either the first three months or the last two months of pregnancy (yes/no).	Mother reported
Financial difficulties at 32 weeks gestation	Scores range from 0 (no financial difficulties) to 15 (maximum difficulties), reflecting challenges in affording essentials such as food, clothing, heating, accommodation, and baby-related items. Categorical variable: 0 = None 1 = 1-2 2 = 3-5 3 = 6-15	Mother reported

IMD	Categorical variable: 1 (Least deprived) 2 3 4 5 (Most deprived)	Derived using ALSPAC correspondence address
Parental engagement (supportive towards child's learning) teacher reported during school year 3	Teachers were asked 'How much support do you think the child gets from his/her parents in regard to his/her learning? Very supportive; Somewhat supportive; Not at all supportive; Can't say' Categorical variable derived: 1 = Very supportive 2 = Somewhat supportive 3 = Not at all supportive 4 = Can't say	Teacher reported
FSM eligibility (KS2)	Yes (1)/No (0)	Linked data from NPD
Key Stage 1 attainment	Categorical variable: 0 = Low 1 = Lower middle 2 = Upper middle 3 = High	Linked data from NPD
§ SLCMA is not compatible with a 3-category exposure variables, therefore, a binary variable used for each time point of assessment		

Appendix 3: Additional confounders considered

Confounder	Reporting source
Month of birth	Mother reported
School enjoyment at age 4 years	Mother reported
Friendships at age 8 years	Child self-reported
Household social class at 18 weeks gestation	Mother and partner reported
Housing tenure at 8 weeks gestation	Mother reported
Parental engagement (during school year 3	Teacher reported
Special Educational Needs (KS2)	Linked data from NPD

Appendix 4: Missing data pattern in the bullying variables in the study sample (n=9,944)

Number of time points missing	Missing % (n)
0 (complete data on bullying at all 3 time points)	41.2 (4,094)
1 time point missing	15.8 (1,566)
2 time points missing	10.6 (1,056)
3 time points missing	32.5 (3,229)

Appendix 5: Missing data in the analysis variables in the study sample (n=9,944)

		Missing % (n)
Bullying	Bullying (age 8)	45.1 (4,488)
	Bullying (age 10)	42.8 (4,257)
	Bullying (age 12)	46.5 (4,620)
Self-reported outcomes	Self-reported weapon carrying (age 15)	56.6 (5,633)
	Self-reported violence (ages 17-18)	59.0 (5,871)
Cofounders	Sex	0
	Ethnicity	16.8 (1,671)
	SDQ	38.4 (3,814)
	BPD	48.9 (4,859)
	Any adverse childhood experiences	7.8 (775)
	Maternal education	14.7 (1,462)
	Maternal age	6.2 (619)
	Maternal smoking during pregnancy	15.3 (1,517)
	Financial difficulties	17.0 (1,691)
	IMD	28.0 (2,783)
	Parental educational engagement (supportive towards learning)	52.6 (5,228)
	FSM eligibility	9.8 (977)
	KS1 attainment	8.7 (863)

Appendix 6: Comparison of those with complete (complete data on bullying assessed at ages 8, 10, and 12, and on self-reported weapon carrying and violence) versus missing data

		Odds ratio	95% CI
Sex	Male	Reference group	
	Female	1.59	1.42-1.79
Ethnicity	White	Reference group	
	Non-white	0.82	0.59-1.15
Maternal education	None/CSE	Reference group	
	Vocational	1.10	0.85-1.43
	0 level	1.77	1.46-2.15
	A level	2.41	1.96-2.97
	Degree	3.40	2.64-4.39
Maternal age	Age in years	1.03	1.02-1.05
Social class	Professional	Reference group	
	Managerial and technical	0.80	0.64-1.00
	Skilled non-manual	0.69	0.54-0.87
	Skilled manual	0.63	0.48-0.84
	Partly skilled	0.63	0.45-0.88
	Unskilled	0.43	0.22-0.84
IMD	1 (least deprived)	Reference group	
	2	0.84	0.71-0.99
	3	0.80	0.68-0.95
	4	0.75	0.63-0.90
	5 (most deprived)	0.70	0.58-0.86
FSM eligibility	Yes	0.62	0.46-0.85
Police-recorded violence (ages 13-24)	Yes	0.51	0.33-0.79

Appendix 7: Prevalence of any bullying and physical bullying involvement by frequency and time point, available-cases

	Frequent + very frequent bullying	Very frequent bullying only
Overall bullying involvement		
Age 8	40.1 (2,169)	20.7 (1,118)
Age 10	25.0 (1,406)	11.6 (671)
Age 12	27.0 (1,431)	14.0 (743)
Ages 8-12	67.7 (3,563)	42.9 (2,050)
Physical bullying involvement		
Age 8	13.1 (719)	5.6 (309)
Age 10	5.0 (287)	1.6 (94)
Age 12	4.0 (213)	1.3 (71)
Ages 8-12	23.9 (1,088)	10.4 (453)
^Sample size ranges between 4,340 to 5,808		
Frequent + very frequent bullying: more than 4 times in past 6 months but less than once a week + at least once a week		
Very frequent bullying only: at least once a week		

Appendix 8: Prevalence of any bullying and physical bullying involvement status by frequency and time point, available-cases

	Frequent + very frequent bullying			Very frequent bullying only		
	No bullying involvement % (n)	Pure victim % (n)	Pure bully/bully-victim % (n)	No bullying involvement % (n)	Pure victim % (n)	Pure bully/bully-victim % (n)
Overall bullying involvement						
Age 8	59.9 (3,236)	31.9 (1,724)	8.2 (445)	79.3 (4,279)	17.5 (942)	3.3 (176)
Age 10	75.0 (4,219)	18.6 (1,045)	6.4 (361)	88.5 (5,137)	9.4 (545)	2.2 (126)
Age 12	73.0 (3,862)	17.0 (899)	10.1 (532)	86.0 (4,549)	9.9 (526)	4.1 (217)
Ages 8-12	32.4 (1,704)	46.1 (2,428)	21.6 (1,135)	57.1 (2,728)	32.8 (1,566)	10.1 (484)
Physical bullying involvement						
Age 8	86.9 (4,774)	9.6 (527)	3.5 (192)	94.4 (5,184)	4.4 (239)	1.3 (70)
Age 10	95.1 (5,507)	3.1 (181)	1.8 (106)	98.4 (5,700)	1.1 (66)	0.5 (28)
Age 12	96.0 (5,124)	2.4 (126)	1.6 (87)	98.7 (5,266)	0.9 (49)	0.4 (22)
Ages 8-12	76.2 (3,458)	16.0 (726)	7.8 (355)	89.7 (3,892)	7.6 (331)	2.7 (117)
^Sample size ranges between 4,340 to 5,808 Bullying involvement categories are mutually exclusive Frequent + very frequent bullying: more than 4 times in past 6 months but less than once a week + at least once a week Very frequent bullying only: at least once a week						

Appendix 9: Prevalence of different types of bullying, available-cases

Type of bullying	Frequent + very frequent bullying [£]			Very frequent bullying only [§]		
	Age 8 % (n)	Age 10 % (n)	Age 12 % (n)	Age 8 % (n)	Age 10 % (n)	Age 12 % (n)
Bullying victim						
Belongings stolen	6.2 (342)	2.6 (151)	5.7 (305)	2.1 (118)	0.8 (47)	2.5 (132)
Threatened/blackmailed	6.6 (365)	3.0 (173)	2.4 (128)	2.9 (160)	1.1 (61)	0.8 (45)
Hit/beaten up	11.9 (654)	4.2 (244)	2.8 (148)	5.1 (283)	1.3 (78)	1.0 (53)
Tricked	3.9 (212)	2.0 (114)	1.0 (55)	1.4 (79)	0.4 (24)	0.5 (24)
Called nasty names	24.5 (1,341)	17.9 (1,035)	17.4 (931)	12.2 (666)	8.4 (484)	8.8 (472)
Others wouldn't play with them to upset them	6.3 (342)	2.7 (155)	2.9 (157)	2.5 (134)	0.8 (46)	1.1 (57)
Been made to do things didn't want to	5.3 (287)	2.3 (136)	1.7 (92)	1.9 (105)	0.7 (41)	0.6 (31)

Had lies/told nasty things said about them	6.4 (343)	3.8 (218)	4.7 (250)	2.4 (127)	1.1 (62)	1.7 (91)
Had games spoilt	5.7 (307)	2.5 (146)	1.4 (72)	2.2 (120)	0.9 (53)	0.5 (29)
Bullying perpetrator						
Belongings stolen	0.3 (16)	-	1.1 (56)	0.1 (7)	-	0.5 (24)
Threatened/blackmailed	0.7 (38)	0.5 (27)	0.6 (31)	0.3 (18)	0.2 (9)	0.2 (8)
Hit/beaten up	3.5 (192)	1.9 (108)	1.6 (87)	1.3 (70)	0.5 (29)	0.4 (22)
Tricked	0.8 (44)	0.3 (17)	0.3 (18)	0.3 (17)	0.1 (7)	0.2 (10)
Called nasty names	4.2 (227)	4.4 (254)	7.7 (409)	1.6 (85)	1.5 (89)	3.0 (158)
Others wouldn't play with them to upset them	1.1 (58)	0.3 (20)	0.8 (40)	0.4 (21)	-	0.4 (23)
Been made to do things didn't want to	0.6 (32)	0.2 (13)	0.4 (19)	0.1 (6)	-	0.2 (8)
Had lies/told nasty things said about them	0.8 (45)	0.6 (34)	1.6 (84)	0.2 (12)	0.1 (5)	0.5 (29)
Had games spoilt	0.6 (31)	0.2 (11)	0.2 (12)	0.2 (11)	-	-
Cell counts <5 are suppressed; categories are <u>not</u> mutually exclusive; total sample size for each variable (type of bullying) varies (maximum sample size is 9,944)						
£ Frequent + very frequent bullying: more than 4 times in past 6 months but less than once a week + at least once a week						
§ Very frequent bullying: at least once a week						

Appendix 10: Prevalence of self-reported violence outcome in available-cases

	Male % (n)	Female % (n)	Total % (n)
Self-reported weapon carrying	12.8 (262)	3.9 (88)	8.1 (350)
Self-reported violence	14.2 (242)	6.1 (145)	9.5 (387)
Sample size ranges between 4,074 and 4,312			

Appendix 11: Violence outcomes among children involved in bullying (ages 8–12 years)

	Self-reported weapon carrying (age 15)	
	Yes %	No %
No bullying involvement	7.2	92.8
Pure victim	11.4	88.6
Pure bully/bully-victim	20.6	79.4
	Self-reported violence (ages 17-18 years)	
	Yes %	No %
No bullying involvement	10.7	89.3
Pure victim	13.6	86.4
Pure bully/bully-victim	27.1	72.9
	Police-recorded violence (ages 13-24)	
	Yes %	No %
No bullying involvement	3.3	96.7
Pure victim	3.3	96.7

Pure bully/bully-victim	8.4	91.6
^Sample size 9,944 Pooled proportions from multiply imputed data are presented for self-reported violence outcomes		

Appendix 12: Violence outcomes among children involved in bullying (ages 8–12 years), available-cases

	Self-reported weapon carrying (age 15)	
	Yes % (n)	No % (n)
No bullying involvement	4.7 (64)	95.3 (1,285)
Pure victim	8.7 (138)	91.3 (1,448)
Pure bully/bully-victim	13.7 (98)	86.3 (618)
	Self-reported violence (ages 17-18 years)	
	Yes %	No %
No bullying involvement	7.0 (83)	93.0 (1,103)
Pure victim	9.1 (130)	90.9 (1,302)
Pure bully/bully-victim	16.5 (96)	83.5 (487)
	Police-recorded violence (ages 13-24)	
	Yes %	No %
No bullying involvement	1.5 (25)	98.5 (1,679)
Pure victim	2.2 (54)	97.8 (2,374)
Pure bully/bully-victim	5.1 (58)	94.9 (1,077)
Sample size ranges between 3,201 to 5,267		

Appendix 13a: Odds ratios and 95% CIs for the association between bullying and violence

	Self-reported violence (ages 17-18 years)			Police-recorded violence (ages 13-24)		
	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Frequent + very frequent bullying						
No bullying involvement	Ref	Ref	Ref	Ref	Ref	Ref
Pure victim	1.32 (1.02-1.70) *	1.33 (1.03-1.73) *	1.18 (0.89-1.56) p=0.242	1.00 (0.72-1.39) p=0.999	1.01 (0.72-1.40) p=0.973	0.84 (0.60-1.19) p=0.327
Pure bully/bully-victim	3.11 (2.42-4.01) **	2.68 (2.07-3.48) **	2.08 (1.57-2.74) **	2.72 (2.03-3.65) **	2.25 (1.67-3.04) **	1.49 (1.08-2.07) *
Very frequent bullying						
No bullying involvement	Ref	Ref	Ref	Ref	Ref	Ref
Pure victim	1.26 (0.99-1.60) p=0.061	1.23 (0.96-1.58) p=0.097	1.05 (0.81-1.37) p=0.693	1.11 (0.81-1.52) p=0.505	1.08 (0.79-1.48) p=0.625	0.86 (0.62-1.19) p=0.350
Pure bully/bully-victim	3.07 (2.26-4.17) **	2.52 (1.83-3.47) **	1.78 (1.23-2.58) *	3.12 (2.28-4.28) **	2.46 (1.79-3.40) **	1.47 (1.02-2.12) *
Model 1: unadjusted						

Model 2: sex, ethnicity

Model 3: sex, ethnicity, SDQ, BPD, ACEs, maternal education, maternal age at delivery, financial difficulties, maternal smoking during pregnancy, IMD, FSM, KS1 attainment, parents supportive towards child's learning

*p<0.05

**p<0.001

Appendix 13b: Odds ratios and 95% CIs for the association between bullying and violence among complete-cases

	Self-reported violence (ages 17-18 years)			Police-recorded violence (ages 13-24)		
	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI) ^a
Frequent + very frequent bullying						
No bullying involvement	Ref	Ref	Ref	Ref	Ref	Ref
Pure victim	1.34 (0.91-1.97) p=0.135	1.30 (0.88-1.91) p=0.193	1.27 (0.85-1.89) p=0.242	0.85 (0.32-2.30) p=0.754	0.85 (0.31-2.29) p=0.746	0.67 (0.26-1.76) p=0.419
Pure bully/bully-victim	2.88 (1.90-4.37) **	2.46 (1.61-3.76) **	2.42 (1.57-3.72) **	3.37 (1.38-8.22) *	3.26 (1.29-8.25) *	2.38 (0.89-6.35) p=0.083

Complete-case sample size = 1,903 ; ^a Sample size = 1,577

Model 1: unadjusted

Model 2: sex, ethnicity

Model 3: sex, ethnicity, SDQ, ACEs, maternal education, maternal age at delivery, financial difficulties, maternal smoking during pregnancy, IMD, FSM, KS1 attainment

*p<0.05

**p<0.001

Appendix 14: Prevalence of confounding variables

	Available case % (n)*	Pooled proportions from multiply imputed data^ %
Sex		
Male	50.7 (5,044)	50.7
Female	49.3 (4,900)	49.3
Ethnicity		
White	95.3 (7,886)	94.8
Non-white	4.7 (388)	5.2
SDQ mean (SD/SE)	7.55 (4.81)	7.93 (0.061)
BPD	5.6 (283)	7.5
ACEs	19.8 (1,811)	19.9
Maternal education		
None/CSE	20.8 (1,768)	22.4
Vocational	10.5 (890)	10.8
0 level	36.1 (3,061)	35.7
A level	21.6 (1,836)	20.8
Degree	10.9 (928)	10.3
Maternal age		
Under 26	30.4 (2,833)	30.5
26-28	24.9 (2,317)	24.8
29-31	21.7 (2,022)	21.6
32+	23.1 (2,153)	23.0
Maternal smoking during pregnancy	29.2 (2,460)	30.1
Financial difficulties		
None	36.1 (2,976)	34.8
1-2	25.1 (2,069)	25.0
3-5	19.0 (1,564)	19.2
6-15	19.9 (1,644)	21.0
IMD		
1 (least deprived)	29.5 (2,113)	26.2
2	19.3 (1,383)	17.9
3	19.1 (1,369)	18.7
4	15.6 (1,115)	16.6
5 (most deprived)	16.5 (1,182)	20.7
Parental educational engagement (supportive towards learning)		
Very supportive	52.7 (2,487)	51.0
Somewhat supportive	37.7 (1,779)	38.1
Not at all supportive	6.0 (284)	6.9
Can't say	3.5 (167)	4.0
FSM eligibility	11.1 (996)	10.8
KS1 attainment		
Low	31.7 (2,877)	31.1
Lower middle	18.5 (1,677)	18.3
Upper middle	25.7 (2,330)	25.8
High	24.2 (2,198)	24.8
*Before mi: sample size ranges between 4637 – 9,944		
^Sample size 9,944		

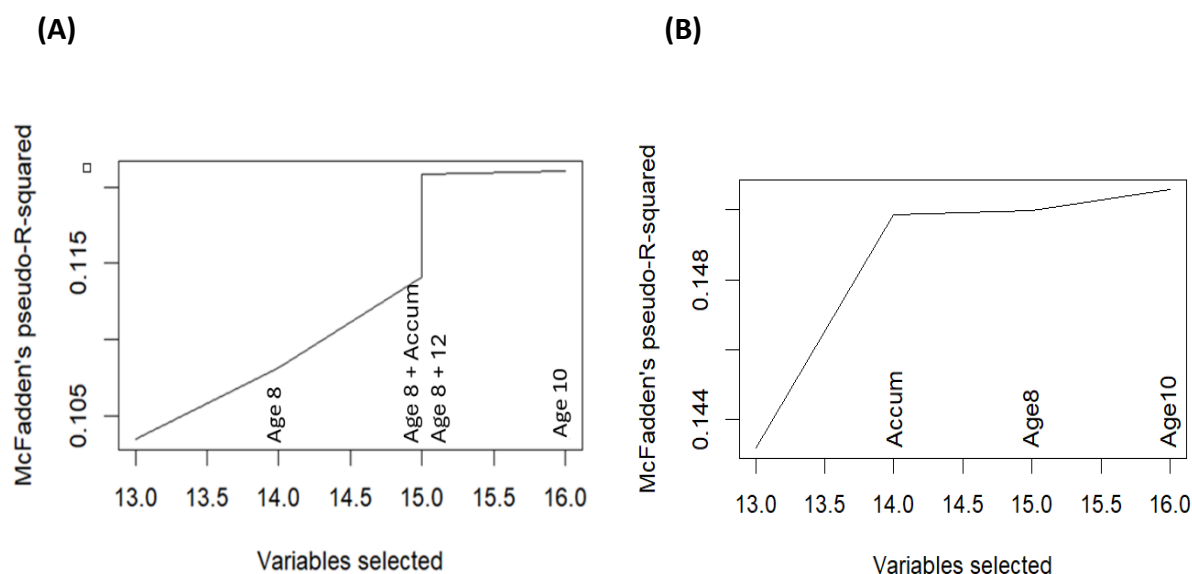
Appendix 15: Odds ratios and 95% CIs for the association between bullying by time point of assessment and violence

	Self-reported violence (ages 17-18 years)			Police-recorded violence (ages 13-24)		
	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Frequent + very frequent bullying						
Age 8						
No bullying involvement	Ref	Ref	Ref	Ref	Ref	Ref
Pure victim	1.33 (1.05-1.68) *	1.32 (1.04-1.68) *	1.16 (0.90-1.51) p=253	1.18 (0.88-1.57) p=0.273	1.17 (0.87-1.56) p=0.302	0.97 (0.71-1.33) p=0.860
Pure bully/bully-victim	3.93 (2.90-5.33) **	3.24 (2.37-4.44) **	2.64 (1.86-3.73) **	3.06 (2.19-4.27) **	2.39 (1.70-3.36) **	1.68 (1.16-2.44) *
Age 10						
No bullying involvement	Ref	Ref	Ref	Ref	Ref	Ref
Pure victim	1.36 (1.07-1.72) *	1.32 (1.03-1.69) *	1.06 (0.82-1.38) p=0.646	1.22 (0.87-1.70) p=0.243	1.17 (0.84-1.64) p=0.357	0.90 (0.63-1.29) p=0.574
Pure bully/bully-victim	2.27 (1.56-3.28) **	1.78 (1.20-2.63) *	1.20 (0.77-1.86) p=0.413	3.55 (2.52-5.00) **	2.75 (1.93-3.91) **	1.63 (1.07-2.46) *
Age 12						
No bullying involvement	Ref	Ref	Ref	Ref	Ref	Ref
Pure victim	1.36 (1.03-1.78) *	1.42 (1.07-1.89) *	1.32 (0.97-1.78) p=0.077	0.80 (0.55-1.18) p=0.257	0.83 (0.56-1.22) p=0.336	0.70 (0.46-1.05) p=0.086
Pure bully/bully-victim	2.54 (1.93-3.34) **	2.35 (1.78-3.12) **	2.02 (1.48-2.75) **	1.97 (1.40-2.76) **	1.75 (1.24-2.47) *	1.36 (0.93-1.99) p=0.118
Model 1: unadjusted Model 2: sex, ethnicity Model 3: sex, ethnicity, SDQ, BPD, ACEs, maternal education, maternal age at delivery, financial difficulties, maternal smoking during pregnancy, IMD, FSM, KS1 attainment, parents supportive towards child's learning *p<0.05 **p<0.001						

Appendix 16: Correlations of bullying perpetration by time point of assessment

	Age 8	Age 10	Age 12
Pure bully/bully-victim			
Bullying age 8	1.0		
Bullying age 10	0.6	1.0	
Bullying age 12	0.5	0.5	1.0

Appendix 17: Elbow plots showing hypotheses on timing and accumulation of bullying perpetration for (A) self-reported and (B) police-recorded violence outcomes



Elbow plots for variable selection testing timing and accumulation of bullying perpetration. The elbow plot shows the outcome variance explained by a model after adding each additional hypothesis (variable). The first peak in the plot indicates the optimal number of variables. Additional variables added beyond this point bring diminishing returns in the amount of outcome variance explained.

Appendix 18: Best-fitting life course hypotheses and corresponding odds ratios, 95% CIs, and p-values for the association between bullying involvement (pure bully/bully-victim) and self-reported and police-recorded violence (unadjusted model results)

	Self-reported violence	
Best-fitting hypothesis/hypotheses	Odds ratio (95% CI)	p-value*
Age 8 + Accumulation of exposure	Age 8: 1.70 (1.38-2.10)	<0.001
	Accumulation of exposure: 1.73 (1.55-1.93)	<0.001
	Police-recorded violence	
Accumulation of exposure	2.05 (1.82-2.31)	<0.001
*Bonferroni correction is applied to p-values to adjust for model selection Reference group is no bullying involvement or pure victim		

Appendix 19: AIC across three models

	Mean AIC	SD
Age 8	7473.67	173.83
Age 8 + accumulation	7453.32	174.91
Age 8 + age 12	7437.74	173.91

Appendix 20a: Odds ratios and 95% CIs for the association between bullying and weapon-carrying

Self-reported weapon carrying (age 15)			
	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Frequent + very frequent bullying			
No bullying involvement	Ref	Ref	Ref
Pure victim	1.65 (1.26-2.18) **	1.69 (1.27-2.24) **	1.52 (1.13-2.05) *
Pure bully/bully-victim	3.35 (2.54-4.41) **	2.82 (2.14-3.73) **	2.24 (1.64-3.06) **
Very frequent bullying			
No bullying involvement	Ref	Ref	Ref
Pure victim	1.43 (1.12-1.82) *	1.40 (1.09-1.80) *	1.21 (0.93-1.58) p=0.160
Pure bully/bully-victim	2.74 (1.96-3.83) **	2.18 (1.54-3.09) **	1.55 (1.05-2.31) *
Model 1: unadjusted Model 2: sex, ethnicity Model 3: sex, ethnicity, SDQ, BPD, ACEs, maternal education, maternal age at delivery, financial difficulties, maternal smoking during pregnancy, IMD, FSM, KS1 attainment, parents supportive towards child's learning *p<0.05 **p<0.001			

Appendix 20b: Odds ratios and 95% CIs for the association between bullying and weapon-carrying among complete-cases

Self-reported weapon carrying (age 15)			
	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Frequent + very frequent bullying			
No bullying involvement	Ref	Ref	Ref
Pure victim	1.82 (1.21-2.74) *	1.76 (1.16-2.66) *	1.70 (1.11-2.59) *
Pure bully/bully-victim	3.91 (2.55-6.01) **	3.34 (2.16-5.17) **	2.95 (1.88-4.63) **
Complete-case sample size = 2,196 Model 1: unadjusted Model 2: sex, ethnicity Model 3: sex, ethnicity, SDQ, ACEs, maternal education, maternal age at delivery, financial difficulties, maternal smoking during pregnancy, IMD, FSM, KS1 attainment *p<0.05 **p<0.001			

Appendix 21a: Odds ratios and 95% CIs for the association between physical bullying and violence

	Self-reported violence (ages 17-18 years)			Police-recorded violence (ages 13-24)		
	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Frequent + very frequent bullying						
No physical bullying involvement	Ref	Ref	Ref	Ref	Ref	Ref
Pure victim	1.61 (1.22-2.11) *	1.38 (1.04-1.84) *	1.21 (0.89-1.64) p= 0.225	1.62 (1.12-2.34) *	1.38 (0.95-2.01) p= 0.093	1.15 (0.78-1.71) p= 0.475
Pure bully/bully-victim	4.95 (3.55-6.91) **	3.64 (2.57-5.16) **	2.77 (1.90-4.04) **	4.82 (3.54-6.57) **	3.44 (2.48-4.76) **	2.20 (1.52-3.18) **
Very frequent bullying						
No physical bullying involvement	Ref	Ref	Ref	Ref	Ref	Ref
Pure victim	1.73 (1.21-2.47) *	1.58 (1.10-2.29) *	1.22 (0.81-1.84) p= 0.346	1.60 (0.99-2.60) p= 0.056	1.45 (0.90-2.36) p= 0.129	0.98 (0.58-1.65) p=0.945
Pure bully/bully-victim	4.49 (2.59-7.77) **	3.34 (1.87-5.98) **	2.22 (1.13-4.34) *	5.23 (3.54-7.73) **	3.77 (2.52-5.66) **	1.95 (1.23-3.09) *
Model 1: unadjusted Model 2: sex, ethnicity Model 3: sex, ethnicity, SDQ, BPD, ACEs, maternal education, maternal age at delivery, financial difficulties, maternal smoking during pregnancy, IMD, FSM, KS1 attainment, parents supportive towards child's learning *p<0.05 **p<0.001						

Appendix 21b: Odds ratios and 95% CIs for the association between physical bullying and violence among complete-cases

	Self-reported violence (ages 17-18 years)			Police-recorded violence (ages 13-24)		
	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI) ^a
Frequent + very frequent bullying						
No physical bullying involvement	Ref	Ref	Ref	Ref	Ref	Ref
Pure victim	1.67 (1.07-2.60) *	1.44 (0.90-2.30) p=0.134	1.29 (0.79-2.09) p=0.304	1.91 (0.71-5.17) p=0.201	1.96 (0.70-5.49) p=0.198	1.42 (0.48-4.21) p=0.524

Pure bully/bully-victim	5.23 (3.14-8.70) **	3.84 (2.22-6.64) **	3.74 (2.11-6.62) **	4.46 (1.48-13.41) *	4.38 (1.27-15.07) *	3.47 (0.95-12.59) p=0.059
Complete-case sample size = 2,009; ^a Sample size = 1,665						
Model 1: unadjusted						
Model 2: sex, ethnicity						
Model 3: sex, ethnicity, SDQ, ACEs, maternal education, maternal age at delivery, financial difficulties, maternal smoking during pregnancy, IMD, FSM, KS1 attainment						
*p<0.05						
**p<0.001						

Appendix 22: Prevalence of bullying involvement among males and females, by age and frequency (available-cases)

	No bullying involvement % (n)	Pure victim % (n)	Pure bully/bully-victim % (n)	Any bullying involvement % (n)	No bullying involvement % (n)	Pure victim % (n)	Pure bully/bully-victim % (n)	Any bullying involvement % (n)
Frequent or very frequent bullying [§]								
	Male				Female			
Age 8 years	56.2 (1,496)	32.1 (856)	11.7 (312)	43.8 (1,168)	63.5 (1,740)	31.7 (868)	4.9 (133)	36.5 (1,001)
Age 10 years	71.7 (1,984)	18.9 (523)	9.5 (262)	28.4 (785)	78.3 (2,235)	18.3 (522)	3.5 (99)	21.7 (621)
Age 12 years	72.3 (1,874)	15.9 (412)	11.8 (306)	27.7 (718)	73.6 (1,988)	18.0 (487)	8.4 (226)	26.4 (713)
Ages 8-12 years	28.6 (748)	43.8 (1,145)	27.7 (724)	71.4 (1,869)	36.1 (956)	48.4 (1,283)	15.5 (411)	63.9 (1,694)
Very frequent (only) bullying [^]								
	Male				Female			
Age 8 years	76.3 (2,027)	18.9 (503)	4.8 (127)	23.7 (630)	82.2 (2,252)	16.0 (439)	1.8 (49)	17.8 (488)
Age 10 years	86.1 (2,466)	10.2 (293)	3.7 (105)	13.9 (398)	90.7 (2,671)	8.6 (252)	0.7 (21)	9.3 (273)
Age 12 years	84.8 (2,197)	10.1 (261)	5.1 (133)	15.2 (394)	87.1 (2,352)	9.8 (265)	3.1 (84)	12.9 (349)
Ages 8-12	52.1 (1,232)	33.8 (798)	14.1 (333)	47.9 (1,131)	62.0 (1,496)	31.8 (768)	6.3 (151)	38.1 (919)

years								
	Physical bullying &							
	Frequent or very frequent physical bullying §							
	Male				Female			
Age 8 years	81.6 (2,212)	12.7 (344)	5.8 (156)	18.4 (500)	92.1 (2,562)	6.6 (183)	1.3 (36)	7.9 (219)
Age 10 years	92.5 (2,635)	4.1 (118)	3.3 (95)	7.5 (213)	97.5 (2,872)	2.1 (63)	0.4 (11)	2.5 (74)
Age 12 years	93.5 (2,448)	3.6 (95)	2.8 (74)	6.5 (169)	98.4 (2,676)	1.1 (31)	0.5 (13)	1.6 (44)
Ages 8-12 years	66.2 (1,501)	20.9 (473)	13.0 (295)	33.9 (768)	86.2 (1,957)	11.2 (253)	2.6 (60)	13.8 (313)
* Any victimisation or perpetration § More than 4 times in the past 6 months but less than once a week + at least once a week ^ At least once a week & Includes other forms of bullying Males: sample size ranges between 2,119 to 2,864 Females: sample size ranges between 2,221 to 2,946 Prevalence of very frequent (only) physical bullying is not presented by sex due to small numbers.								