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Adverse childhood experiences (ACEs) and juvenile violent delinquency in multiple successive birth cohorts

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Abstract
Early-life adversities are associated with juvenile violent offending, but temporal and gender differences in this association remain unclear. This study used data from multiple successive birth cohorts (1,006,028 individuals) born in Finland between 1987 and 2003, followed until age 17. Register-based adverse childhood experiences (ACEs) measured at ages 0–14 included parental social assistance recipiency, unemployment, substance abuse, psychiatric disorders, violent offending and parental death. We investigated absolute and relative differences in violent crime at ages 15–17 between children exposed and unexposed to ACEs. Our results show that all individual ACEs were positively associated with juvenile violent offending. Parental violent crime and social assistance recipiency demonstrated the strongest associations, with odds ratios (OR) across cohorts fluctuating from 4.24 (95% CI = 3.65–4.91) to 5.85 (95% CI = 4.98–6.87) and 3.65 (95% CI = 3.26–4.08) to 6.07 (95% CI = 5.23–7.04), respectively. The ACE sum score showed a clear graded relationship with violent offending, evident on both absolute and relative scales. For those without ACEs, the offending prevalence ranged between the cohorts from 0.60% to 1.14%. For individuals with ≥ 4 ACEs, offending prevalence fluctuated from 5.40% to 8.59%. Associations between individual and cumulative ACEs with violent delinquency remained relatively constant over time, for both genders, underscoring the need for tailored interventions.

Keywords
crime, violence, adolescent, birth cohort, adverse childhood experiences

A substantial body of research spanning several decades has shown that early life adversities increase the risk of both immediate and long-term negative outcomes compared to peers who do not experience such adversities. These studies have relied upon various theoretical concepts such as childhood adversity, traumatic childhood experiences, and toxic stress, each with slightly different definitions (McLaughlin, 2016; Keels, 2024). Since Felitti et al.'s landmark research in 1998, the concept of Adverse Childhood Experiences (ACEs) has gained prominence. Most ACE studies include both direct forms of child maltreatment—such as abuse and neglect—and a broader range of family-related issues, often also referred to as household dysfunction, including parental mental health issues, substance abuse, violent behavior, and incarceration. Despite the growth in ACE research, definitions of ACEs remain highly variable; however, a key feature emphasized in these studies is the cumulative, dose-dependent harmful impact of multiple adversities (Hughes et al., 2017).

Regardless of the theoretical framework, research consistently reports a connection between childhood adversities and an increased risk of criminal behavior later in life. Among all age groups, youth are the most studied in research exploring the links between adversities and crime (Pettus, 2023). The universal relevance of ACEs to adolescent delinquency is highlighted in Malvaso et al.'s (2022) systematic review, where across 13 Western and non-Western countries the odds of experiencing at least one adverse or traumatic experience were over 12 times higher for justice-involved youth compared to their non-system-involved peers. Adversities seem to be associated not only with the initiation and persistence of a criminal career (e.g. Baglivio et al., 2015; Brown & Shillington, 2017; Craig et al., 2017; Graf et al., 2021; Jahanshahi et al., 2022; Meldrum et al., 2022; Reese et al., 2023), but also with its violent nature. In a large U.S. sample of delinquent youth, each additional adverse experience increased the risk of becoming a serious, violent or chronic juvenile offender by 35%, even when controlling for other risk factors for criminal behavior (Fox et al., 2015). Furthermore, a Swedish study (Björkenstam et al., 2019) found that each childhood adversity, as captured from register data, was associated with an elevated risk of violent offending in young adulthood, most strongly with child welfare intervention (a proxy for various household problems) and parental criminality. Cumulative childhood adversity (4+ ACEs) was associated with a fivefold increase in the risk of violent offending and this risk was even higher for adolescents with a psychiatric disorder. However, the specific relationship between violent crime and ACEs remains relatively underexplored compared to more general delinquency.

Several studies suggest there are gender differences in the impact of early-life adversities, hypothesized to stem from socialization (Kushner & Leban, 2024) or psychobiological differences, such as variations in how traumatic experiences affect the central nervous system (e.g., Klabunde et al., 2017). However, findings regarding gender differences in the association between adversities and future offending are mixed (Kushner & Leban, 2024). Some studies suggest a gendered association between offending and ACEs that is stronger for boys (Gajos et al., 2023; Leban et al., 2020), others for girls (Björkenstam et al., 2019), and some finding no discernible gender differences (Jones et al., 2023; Leban & Delacruz, 2023). Differences between the studies may relate to differences in the measurement of ACEs (parent-reported vs. registry-based) or outcome focus (general delinquency vs. violent delinquency), or the type of adverse experiences examined. In a recent study, household-related adversities predicted delinquency more strongly in girls compared to boys, whereas adversities occurring outside the home environment showed no significant gender differences (Kushner & Leban, 2024).

While the literature on the impact of childhood adversities is extensive, the studies related to the "ACEs framework" have faced methodological criticisms. One point of criticism relates to relying solely on ACE sum score and indicators of cumulative exposure, even when assessing ACEs individually could pinpoint the specific ACEs that play a central role to certain outcomes, including delinquency and violent crime (Reidy, 2021). For example, in a Scottish cohort study of children (Jahanshahi et al., 2022) familial involvement with the criminal justice system and maltreatment by parents were significant predictors of childhood delinquency, whereas household dysfunction, such as familial substance abuse and family trauma, were not independently significant predictors. A single-adversity approach enables linking specific adversities to outcomes of interest, as well as comparing the effects of different adversities, which is why researchers have called for this approach rather than relying on ACE scores only (Lacey & Minnis, 2020). Further criticism has related to neglecting the effects of socioeconomic adversities in the context of ACEs, and both unemployment (Judd et al., 2023; Knaappila et al., 2019) and poverty (Jahanshahi et al., 2022; Taylor-Robinson et al., 2018) are associated with ACEs and delinquent involvement.

Although the general association between ACEs and delinquency is well-replicated, there is a need to consider potential changes in risk over time. While the link between various individual and family-level factors and criminal behavior later in life is well-documented, it remains uncertain whether these predictors preserve their strength across different historical contexts. The impact of social change is a crucial yet often overlooked element in understanding future criminal involvement (Montana et al., 2023). Recent U.S. studies involving a multicohort sample of individuals born between the 1970s and 1990s suggest that the predictive power of certain risk factors, such as poverty, in determining the likelihood of arrest in young adulthood has declined over time (Montana et al., 2023; Neil et al., 2021). Further, recent data shows a flattening in the age-arrest curve from 1960 to 2018, suggesting that the peak of criminal behavior in late adolescence is less pronounced in younger cohorts compared to older ones, potentially linked to societal changes in the acquisition of adult roles (Bersani & Doherty, 2024). Similar findings were previously observed in Scotland (Matthews & Minton, 2018). On the other hand, a Finnish study (Knaappila, 2020) identified a significant widening of the disparity in delinquency and substance abuse between adolescents facing the highest and lowest levels of socioeconomic adversities over the period from 2000 to 2015. It has been proposed that this, and some related findings on polarization of mental health disparities (Ross, 2017), reflect a Western societal trend where overall well-being of youth has improved, but the benefits have not been uniformly distributed across the population.

Correspondingly, one could argue that the association between individual adversities, as well as cumulative ACEs, and violent delinquency might have changed over time. Historically, many of the adverse experiences were hidden, stigmatized and rarely discussed (Finkelhor, 2013). Shifts in public awareness, cultural norms, policies, and public health initiatives over time may have influenced how societies perceive and respond to various ACEs, thereby potentially also shaping their consequences to individuals. Additionally, changes in the availability of support systems and professional interventions could also play a role in modifying these exposure-outcome associations. Testing this hypothesis requires a study design which compares the associations between ACEs and delinquency between multiple birth cohorts. We were able to find only one study that estimated birth cohort differences in the associations between ACE and subsequent outcomes. Dube et al. (2003) found that ACEs heightened the likelihood of various health risks and risk

behaviors in a consistent and graded manner across four successive cohorts (1900–1931, 1932–1946, 1947–1961, and 1962–1978) in a retrospective survey in San Diego, California, suggesting that the impact of ACEs on health-related outcomes remained constant despite societal changes. Related findings have been observed for mortality in Finland (Martikainen ym., 2020). However, Dube et al.'s (2003) study did not look at delinquency related outcomes, and assessed ACEs retrospectively, making the results vulnerable to recall bias. In terms of practical implications, understanding potential cohort differences has important ramifications for risk assessment (Montana et al., 2023) and the increased utilization of ACE questionnaires as long-term risk assessment tools (Finkelhor et al., 2013).

Thus, to summarize, the key gaps in the current literature include a strong reliance on the ACE sum score approach, mixed findings regarding gender differences in the association between adversities and future offending, and the neglect of possible cohort effects. With this in mind, the primary objective of this study is to examine the associations between ACEs and violent juvenile delinquency, and whether the associations across multiple successive birth cohorts have remained stable or changed over time. We examine police reported violent crime and its relations to cumulative ACE scores as well as individual ACE experiences among Finnish adolescents born between 1987 and 2003, followed until 2020. After describing the changes in general trends in violent delinquency between the cohorts, we turn to our specific research questions, which are:

1. What are the associations between *individual* ACE experiences and violent delinquency, and how have these associations changed over time, for boys and girls?
2. What are the associations between *cumulative* ACEs and violent delinquency, and have these associations changed over time, for boys and girls?

Method

Study population

Our analysis was based on multi-cohort data encompassing the entire population of children born in Finland between 1987 and 2003 (n = 1,006,028), followed until the age of 17. The dataset contains annual sociodemographic information for each individual, as well as for all their biological parents. For parents who moved abroad or deceased during the study period, we included all available observations for these participants in our analyses.[1] Socioeconomic and criminal history data were derived from administrative registers maintained by Statistics Finland, and health-related data were obtained from the Care Register for Health Care, maintained by the Finnish Institute for Health and Welfare, classified according to versions 9 and 10 of the International Classification of Diseases and Causes of Death. The data structure was established by linking records from the registers using unique and pseudonymized personal identification numbers.

Approval for the use of this data was granted by the Statistics Finland Board of Statistical Ethics and the Social and Health Data Permit Authority (Findata) under permission numbers TK-53-1490-18 and THL/2180/14.02.00/2020, respectively. In Finland, register-

based studies do not necessitate additional informed consent if participants are not directly contacted.

Study variables

Adverse experiences, selected based on relevant literature and register availability, were measured from birth to age 14, and included parental social assistance recipiency, parental unemployment, parental substance abuse treatment, parental mental health treatment, parental death, and parental conviction for violent crime. ACE sum scores, ranging from 0 to 6, were grouped into four categories (0, 1, 2, and ≥4) for analysis. The outcome variable, juvenile violent delinquency, was defined as a police report involving assault or homicide-related crimes and robberies. Definitions and sources of study variables are presented in Table 1.

Table 1. Variable definitions and data sources

Adverse Childhood Experience	Definition	Data source
Parental death	At least one biological parent deceased when the child was 0–14 years old.	Causes of Death Register; Statistics Finland
Parental substance abuse treatment	At least one inpatient hospitalization for alcohol or narcotics related substance abuse when the child was 0–14 years old, defined by ICD classification codes ICD9 (1987–1995): 2650A, 291, 292, 303, 3040–3045, 3049, 3050, 3052, 3575, 4255, 5307, 5353, 5710–3, 5770D–F, 5771C–D, 965, 967, 9680–9, 969, 9701, 980: ICD10: (1996–): B171, B182, E244, E52, F10–F16, F18–F19, F55, G312, G4051, G621, G721, I426, K292, K70, K852, K860, R780, R781–5, T36, T40, T423, T424, T426, T427, T430–T435, T438–439, T507, T51, Z502, Z503, Z714, Z715, Z721, Z722	Care Register for Healthcare; Finnish Institute of Health and Welfare
Parental violent offending	Conviction of homicide/bodily injury under Chapter 21 of the Finnish Criminal Code, when the child was 0–14 years old.	Statistics on Offences and Coercive Measures; Statistics Finland
Parental psychiatric treatment	At least one inpatient hospitalization for a psychiatric disorder when the child was 0–14 years old, defined by ICD classification codes ICD-9 codes (1987–1995): 295–302, 306, 307, 308, 309, 311, 312, 313, 314; ICD-10 codes (1996–): F20–F29, F30–F39, F40–F49, F50–F59, F90–F98, F99.	Care Register for Healthcare; Finnish Institute of Health and Welfare
Household living on social assistance	Parental public social assistance provided for a minimum of three years when the child was 0–14 years old.	Income Distribution Statistics; Statistics Finland
Parental unemployment	Parent unemployed for a minimum of three years when the child was 0–14 years old.	Employment statistics; Statistics Finland
Violent juvenile delinquency	Police report of a robbery or suspected homicide/bodily injury under Chapter 21 of the Finnish Criminal Code at ages15 to 17.	Statistics on Offences and Coercive Measures, Statistics Finland

Note: All parental measures measured from biological mothers and fathers in combination

Statistical analysis

We examined both absolute and relative differences in violent crime among children exposed or not exposed to ACEs. First, we calculated the cohort-specific proportions of children suspected of violent crime separately for each independent variable and the ACE sum variable. Risk differences (absolute metric) were calculated based on these proportions. Second, we examined relative differences with odds ratios by fitting a logistic regression model with violent crime as an outcome and main and interaction effects of birth cohort and the adverse experience. We then contrasted the unexposed group to the exposed group and calculated cohort-specific odds ratios for the ACE variable based on the joint model. In essence, the results correspond to results that would have been obtained by fitting cohort-specific logistic regressions. The logistic models were repeated for all the individual ACE experiences and for the ACE sum score. For the ACE sum score, we additionally calculated predicted probabilities based on the logistic model to examine changes over time in absolute terms. All these steps were additionally repeated for boys and girls separately.

Results

Of the sample (n = 1,006,028), 41% were exposed to at least one ACE. The most prevalent ACEs were living on social assistance (30%) and parental unemployment of at least three years between the ages 0 and 14 (24%). A total of 17,621 (1.8%) adolescents had a police report of violent delinquency at ages 15 to 17 (Table 2). The proportion of children experiencing long-term parental unemployment has decreased markedly between the cohorts, and a similar albeit smaller decrease can be seen for social assistance recipiency. Consequently, the proportion of children experiencing none of the adversities has increased, whereas the proportion of experiencing 3 or 4+ ACEs has remained more stable.

Table 2. Prevalence of adverse experiences and violent delinquency

Variable	1987–1992 n (%)	1993–1998 n (%)	1999–2003 n (%)	Total n (%)
Social assistance	23.5%	22.2%	19.7%	221605 (22.0%)
Parental unemployment	35.0%	28.4%	24.1%	298562 (29.7%)
Parental psychiatric disorder	6.5%	6.6%	6.5%	65632 (6.5%)
Parental substance abuse	5.3%	4.9%	4.4%	49555 (4.9%)
Parental violent crime	5.1%	5.7%	6.4%	56938 (5.7%)
Parental death	3.2%	2.9%	2.5%	29442 (2.9%)
Cumulative number of adversities at age 0–14				
0	54.4%	59.8%	64.2%	593340 (59.0%)
1	23.9%	20.8%	18.5%	214788 (21.4%)
2	13.9%	12.1%	10.3%	123630 (12.3%)
3	4.9%	4.6%	4.3%	46769 (4.67%)
4+	2.8%	2.8%	2.7%	27501 (2.7%)
Juvenile violent delinquency at 15–17	2.0%	1.8%	1.3%	17621 (1.8%)

When examining the magnitude of the associations, all individual adversities were associated with violent offending based on their respective odds ratios (ORs), however,

the strength of these associations varied among the adversities and, to a lesser degree, over time (Figure 1) Parental involvement in violent crime and parental reliance on social assistance demonstrated the highest ORs, ranging across time from 4.24 (95% CI =3.65–4.91) to 5.85 (95% CI = 4.98–6.87) and 3.65 (95% CI =3.26–4.08) to 6.07 (95% CI =5.23–7.04), respectively. For social assistance, an increase in odds ratios beginning from 1994 was observed. Conversely, the odds ratios for parental death were the lowest, ranging from 1.52 (95% CI 1.16–1.99) to 2.49 (95% CI 1.85–3.34). Risk differences, on the other hand, have generally decreased across birth cohorts. As the overall prevalence of violence has decreased, the absolute risk of violence has for the most part also decreased also among adolescents who experience ACEs. Prevalences of violent delinquency in all cohorts, by type of adversity, along with odds ratios and risk differences, are detailed in Appendix A.

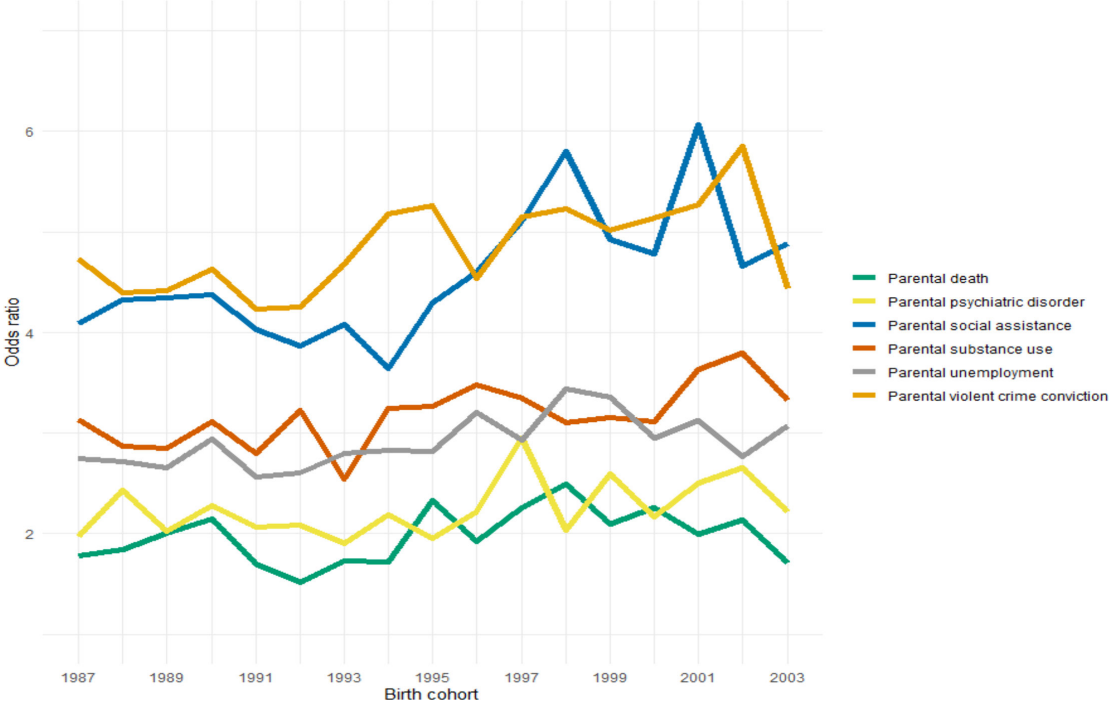

Figure 1. Odds ratios for violent offending for each individual ACE category

In Figure 2, the predicted probabilities of violent delinquency are shown across ACE sum score categories, showing a graded association with cumulative ACEs. For individuals with 0 ACEs, these probabilities of delinquency convert to percentages ranging from 0.60% to 1.14% across the years. For those with four or more ACEs, the probabilities correspond to percentages between 5.40% and 8.59%. The association remained relatively stable over time for individuals with 0 to 2 ACEs, but was more volatile for those with three or ≥ four ACEs. There was a peak among those with four or more adversities in cohorts born in 1994 and 1995, however, given the small sizes of the groups with the most ACEs, this likely reflects random fluctuations in the data. To quantify the magnitudes of the associations, odds ratios (ORs) for violent offending with 95% confidence intervals were calculated, using 0 ACEs as the reference category. In logistic regression models the ORs again demonstrated a clear graded association with violent offending (Figure 2). For those with four or more ACEs, the ORs ranged from 7.10 (95% CI =5.71–8.71) to 10.5 (95% CI 8.14-13.6).

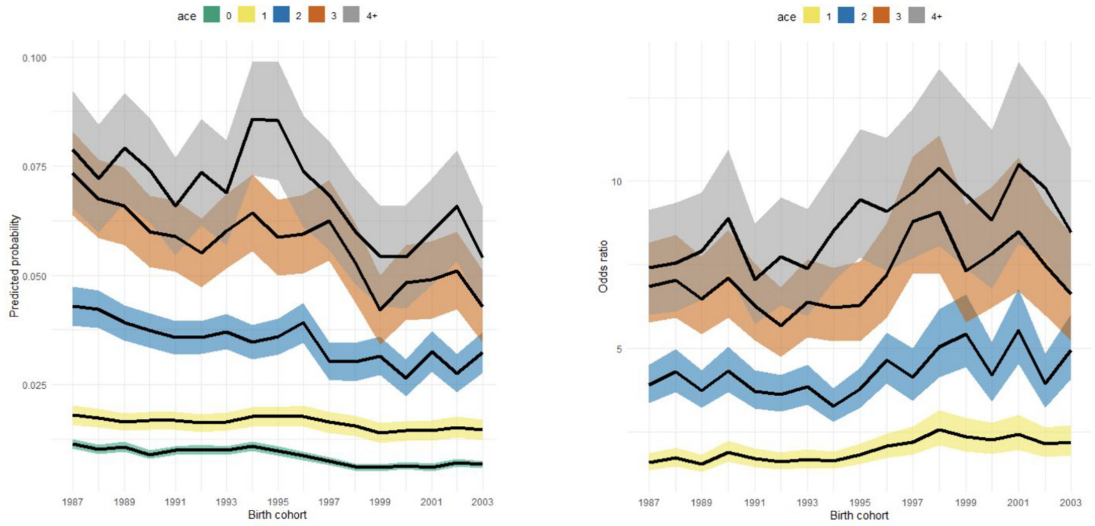

Figure 2. Predicted probabilities of violent delinquency at ages 15-17 by ACE sum score categories (left) and odds ratios for violent offending by ACE sum score with ACE = 0 as the reference category (right), with 95% confidence intervals

Subsequently, all analyses were conducted separately for boys and girls. Absolute percentages, odds ratios, risk differences, and violent offending by ACE score are presented in Appendix B. Among both girls and boys, the strongest relative risks were linked to the same adversities observed in the entire dataset, namely parental violent criminality and income support. The fluctuations in ORs over time were more pronounced among girls, however, the fluctuations again need to be interpreted in light of the small size of this group in any given cohort. Absolute risk differences were larger among boys, and they also displayed a more consistent graded relationship between ACEs and subsequent violent behavior.

Discussion

The aim of this study was to investigate the associations between adverse childhood experiences and violent juvenile delinquency across multiple successive birth cohorts of Finnish adolescents, focusing both on individual ACE experiences and on cumulative ACE scores. Thus far, only few studies have explored the effects of social changes on future delinquency comparing different birth cohorts (Montana et al., 2023).

In our investigation of individual ACEs, we found that all six adversities were associated with violent offending. These associations were relatively stable over time, despite societal changes in responses to ACEs due to attitude changes and growing knowledge. For example, in recent decades, various preventive interventions and even legislative changes in the Nordic countries have aimed to enhance the consideration of patients' children in substance abuse and mental health services (Solantaus et al., 2010; Stavnes et al., 2022). It is sobering, however, that despite these endeavors, the associations between ACEs and violent crime have remained consistent. Examining the relative risks posed by each adversity, the strong association between parental violent criminality and violent juvenile delinquency aligns with prior studies (Björkenstam et al., 2019; Besemer, 2014), and likely reflects a complex intergenerational transmission process influenced by social learning, criminogenic environments, labeling, and genetic predispositions (Besemer et al., 2017). Additionally, the strong ORs associated with receiving social assistance underscore the critical importance of uncovering the relationships between low socioeconomic status,

adverse childhood experiences (ACEs), and adverse outcomes in both research and policy domains (Walsh et al., 2019), all the while exercising caution regarding causal claims (Sariaslan et al., 2021). Our findings regarding the associations of individual ACEs and violent delinquency, along with all of our subsequent results, apply to both boys and girls in a similar manner.

Our study, like several others (e.g. Fox et al. 2015; Björkenstam et al., 2019), indicates that experiencing multiple types of ACEs has a particularly strong relationship to the risk of violent delinquency and that this applies to both boys and girls. Moreover, the graded association between cumulative ACEs and violent delinquency is relatively consistent over time. Previously a similar time persistent association was observed between cumulative ACEs and negative health related outcomes in successive birth cohorts from 1900 to 1978. The durable impact of cumulative ACEs on violent delinquency may, for example, reflect the stable effect of ACEs on criminogenic individual factors such as self-control, which has emerged as a mediator in the link between ACEs and delinquency (Wolff et al., 2020; Meldrum et al., 2022; Jones et al., 2023; Reese et al., 2023). Further, the findings may reflect the stability of gene-environment correlations across cohorts, since adverse outcomes for children with ACE exposure may partially reflect pre-existing genetic risks (Baldwin et al., 2023; Connolly & Kavish, 2019). Finally, our findings do not point towards polarization, where the differences in the proportion of individuals involved in violent crime among those unexposed and exposed to ACEs would diverge over time. Polarization of various aspects of youth well-being is a topic of debate in the Nordic countries, however, very few studies have properly investigated and supported this assertion especially in relation to criminal behavior (Sivertsson et al.,2019).

The primary strength of this study was its utilization of a large population-based register dataset, which overcomes challenges such as non-response and recall bias – common limitations in many survey-based ACE-related studies, including the only previous one assessing potential cohort differences in ACE studies in the U.S. (Dube et al., 2003). However, despite the substantial sample size, a few subgroups still displayed a small number of cases, consequently leading to limited statistical power to detect possible modest associations in certain analyses. Regarding other limitations, while there is no universally agreed-upon list of ACEs, the lack of direct measures of child maltreatment – due to limitations in the available register data for the time-period of interest – is a significant constraint in understanding changes over time across the full spectrum of adversities. While our variable measuring parental convictions for violent crimes covers some cases of violence against children, it also encompasses other types of violent acts and, conversely, fails to capture many instances of child abuse and neglect. Furthermore, the definition of certain variables may impact the findings. Our categorical approach was not able to capture the effects of intensity of adverse experience or their recurrence. Violent criminality was evaluated based on police reports. Not all instances of adolescent violence are brought to the attention of police, and not all violent occurrences reported to the police are ultimately categorized as delinquent acts; moreover, these patterns may vary across demographic groups. Using hospitalization discharges as proxies for mental and substance abuse disorders captures only the most severe cases, potentially introducing bias by overlooking less severe and untreated cases.

Despite its limitations, our study's comprehensive dataset offers rare insights into the long-term associations between ACEs and violent delinquency. Subsequent studies can build upon our findings, for example, by integrating additional ACEs. Future studies might also address the impact of ACEs considering in more detail the duration over which ACEs

are measured. In a recent prospective study, early childhood ACEs showed no correlation with delinquency but became significant predictors when assessed throughout childhood or adolescence, suggesting a nuanced relationship between ACEs and delinquency that depends on the assessment age (Leban & Delacruz, 2023). Further investigation could also shed light on how ACEs influence the dynamics of the offender-victim relationship. For example, Baglivio et al. (2021) demonstrated that accumulation of ACEs is associated with a higher likelihood of victimizing family members, authority figures, and multiple groups, while reducing the probability of targeting strangers. Finally, emerging literature underscores the need to explore how protective factors, such as positive self-concept, supportive relationships and school connectedness, can influence and mitigate the risk of offending in adolescence (e.g. Baglivio& Wolff, 2020; Bergquist et al., 2024 ; Almeida et al., 2024).

Overall, our results show that individuals with a history of ACEs represent a vulnerable group concerning violent offending in adolescence, and these vulnerabilities have persisted over time, underscoring the need for recognition by social and mental health professionals, policymakers, and service developers in designing preventive interventions. Effective intervention must address various levels and include multiple sectors, such as mental health services to manage youth emotion dysregulation, police staff training in trauma-informed practices, and system-level changes including intervention at the instance of the very first ACE documentation, for example a parent's arrest (Folk et al., 2021; Keels, 2024). Given the strong link between ACEs and youth recidivism (Astridge et al., 2023; Yohros, 2023), the implementation of tertiary prevention programs within the child welfare or criminal justice system could also benefit from targeting the effects of ACEs on youth. In practice, this may include measures such as addressing sensitivity to rejection (Mozley et al., 2018) or reducing hostile interpretation of social cues (Ren et al., 2021) to attenuate violent behavior.

Data availability

The data underlying this article may be obtained by applying for data access from Statistics Finland and Findata.

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Notes

1. As the mean of the parental information available spanned a period of at least 17.5 years across birth cohorts, exclusions were not deemed necessary.

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