Patterns of childhood adversity and health outcomes in early adolescence: Results from the Generation XXI cohort

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A B S T R A C T

This longitudinal population-based birth cohort study aims to identify childhood adversity patterns over the first 13 years of life and to examine its association with health-related behaviours and outcomes in early adolescence. Using data from the Portuguese birth cohort Generation XXI, we performed latent class analysis to explore the underlying patterns of adversity from birth to early adolescence, using 13 adversity items assessed in five time points. Health-related behaviours and outcomes were evaluated at 13 years. Adjusting for parental unemployment, logistic regression models were performed to determine the association between adversity patterns and outcomes. Among 8647 participants, three adversity patterns were identified: "low adversity" (56.1%), "household dysfunction" (17.2%) and "multiple adversities" (26.7%). For the "household dysfunction" pattern, girls and boys showed associations with increased odds of alcohol/tobacco use (adjusted odds ratio [AOR]: 1.78; 95% confidence interval [CI]: 1.32–2.40; AOR:1.84; CI:1.38–2.46, respectively) and depressive symptoms (AOR:2.34; CI:1.58–3.48; AOR:5.45; CI:2.86–10.38, respectively). Boys also presented low consumption of fruits/vegetables (AOR:1.51; CI:1.04–2.19). For the "multiple adversities" pattern, both girls and boys showed an increased probability of alcohol/tobacco use (AOR:1.82; CI:1.42–2.33; AOR:1.63; CI:1.30–2.05, respectively) and depressive symptoms (AOR:3.41; CI:2.46–4.72; AOR:5.21; CI:2.91–9.32, respectively). Boys also revealed increased odds of low consumption of fruits/vegetables (AOR:1.67; CI:1.24–2.23). Childhood adversity patterns are associated with unhealthy behaviours and depressive symptoms in early adolescence. Public policies and early interventions targeting vulnerable children, families and communities can potentially reduce the detrimental effects of adversities on health and promote individual and community resilience.

1. Introduction

Childhood adversity is the experience of negative and potentially traumatic events occurring in early life, including psychological, physical, and sexual abuse, household dysfunction, and financial hardship (Bynum et al., 2010; Felitti et al., 1998). These experiences are related to the disruption of normal psychosocial development and increased vulnerability to poor physical and mental health in later life through multidimensional pathways (El-Khoury et al., 2021; Exley et al., 2015; Felitti et al., 1998; Soares et al., 2020; Su et al., 2015; Tracy et al., 2019). Children who experienced adverse events have an increased risk of developing depressive and anxiety disorders in young adulthood (El-Khoury et al., 2021; Tracy et al., 2019; Wickrama et al., 2014), and for having cardiovascular and respiratory diseases, cancer and diabetes later in life, as well as for dying prematurely (Exley et al., 2015; Felitti et al., 1998; Kelly-Irving et al., 2013a; Kelly-Irving et al., 2013b).

Exposure and vulnerability to adversity emerge from the different environmental and social conditions in which individuals are born, grow and live. Their effects on health can be mediated by biological, behavioural and psychosocial factors (Bell, 2017; Ben-Shlomoa and Kuh, 2002). The biological stress response system is more likely to collapse when confronted with multiple stressors overtime, leading to changes in the development of nervous, endocrine, and immune systems, resulting in impaired cognitive and socioemotional functioning and increased physiological damage (Kelly-Irving et al., 2013b; Fraga et al., 2021). Children exposed to severe and chronic toxic stress are prone to adopt unhealthy behaviours to reduce tension and cope with stress (Felitti, 2009; Rothman et al., 2008; Su et al., 2015). Psychosocial maladjustment (i.e., low self-esteem, depressive and anxiety symptoms, and lack of self-control) to environmental and social challenges can also play an

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important role in the pathway between childhood adversity and adult health (Lei et al., 2022).

Childhood adversities tend to co-occur, be persistent over time, and negatively affect children's lives (Evans et al., 2013). Some types of adversity are usually clustered together, such as child maltreatment and adverse household conditions, highlighting that the experience of one adverse event increases the probability of exposure to additional adversities (Dong et al., 2003). This accumulation of multiple adversities impacts health later in life (Lacey et al., 2022; Suglia et al., 2018). Literature has also emphasised the importance of looking at the type of adversity instead of only the number of events, showing that the increased number of adversities did not increase the odds of having a disease; rather, different exposures were associated with different health outcomes (Soares et al., 2022; Schilling et al., 2008).

However, previous studies used cross-sectional designs that relied on adults' retrospective reporting and an overall count of childhood adversities. These assumptions increase the probability of recall bias, do not allow to assess the timing or persistence of childhood adversity and do not consider the type of adversity, assuming that each adverse event is equally important and disregarding the specific patterning of adversities and its importance for the outcomes (Lacey and Minnis, 2020; Schafer et al., 2011; Schilling et al., 2008). The Adverse Childhood Experiences (ACEs) score approach considers the accumulation of adversities independently of their quality, assuming that a widespread event, such as parental divorce, has the same impact as a very severe traumatic event, such as sexual abuse. Thus, there is a need to explore the effects of different adversities and to understand how and which adversities co-occur, allowing us to understand the mechanisms linking adversities to health outcomes (Lacey and Minnis, 2020).

Longitudinal studies using person-centered approaches revealed the best way to explore the health consequences of ACEs by disclosing the clustering of multiple stressors in vulnerable groups of children over time (Evans et al., 2013; Lacey and Minnis, 2020; Rod et al., 2020). Identifying adversity trajectories throughout childhood allows the classification of individuals according to the accumulation, timing and duration of their adverse experiences (Tracy et al., 2019). This knowledge will help to early identify vulnerable children and families and inform effective public health policies and interventions aiming to buffer the effect of ACEs and promote children's health and well-being later in life. Aiming at building resilient communities and families, those actions can include reducing family poverty, creating health-enhancing school and family environments, provide learning opportunities and parenting education, promoting resilient family relationships and positive parenting, providing support services and community-based interventions (Bell, 2017; Shonkoff and Fisher, 2013). Thus, this study aims to identify patterns of adversity over the first 13 years of life and to examine its association with health-related behaviours and outcomes in early adolescence.

2. Methods

2.1. Participants and study design

Participants are children and their mothers from the prospective Portuguese population-based birth cohort - Generation XXI. During 2005–2006, 8647 participants were recruited in public maternity units in Porto, Portugal (Alves et al., 2012). All children were invited to participate in all study waves (Fig. 1). Data confidentiality and
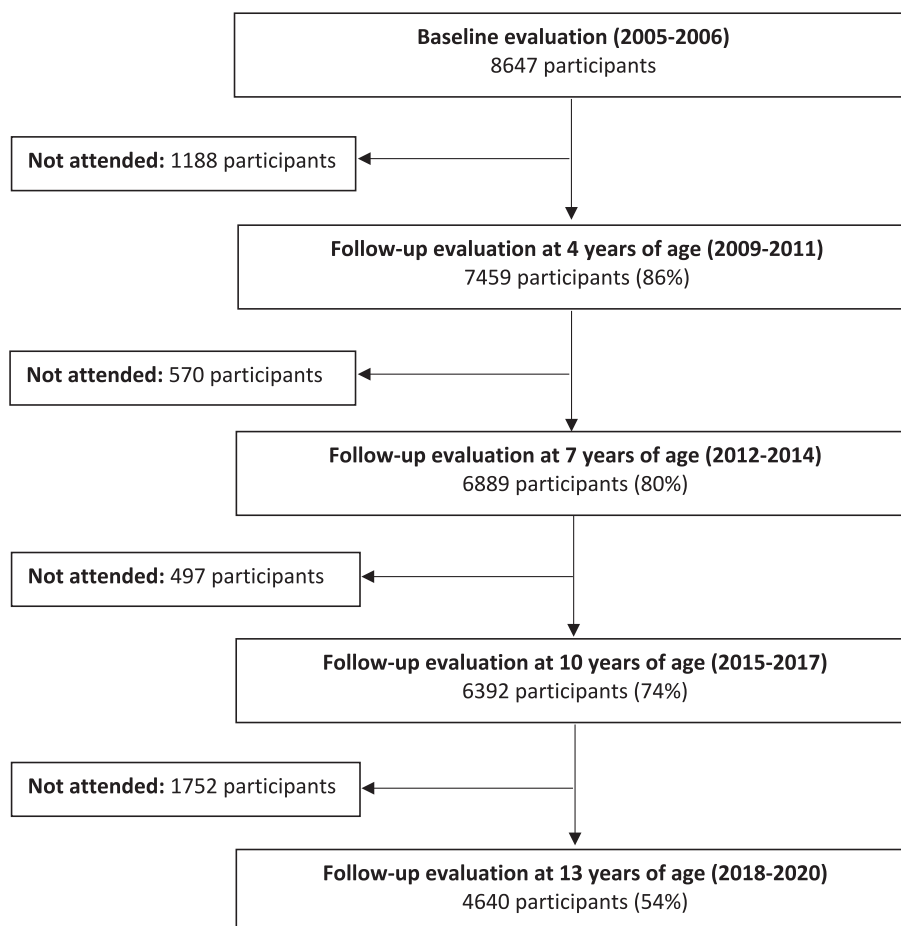

Baseline evaluation (2005-2006)
8647 participants

Not attended: 1188 participants

Follow-up evaluation at 4 years of age (2009-2011)
7459 participants (86%)

Not attended: 570 participants

Follow-up evaluation at 7 years of age (2012-2014)
6889 participants (80%)

Not attended: 497 participants

Follow-up evaluation at 10 years of age (2015-2017)
6392 participants (74%)

Not attended: 1752 participants

Follow-up evaluation at 13 years of age (2018-2020)
4640 participants (54%)

Fig. 1. Flow-chart of children participants from the Portuguese birth cohort Generation XXI evaluated in each follow-up.

protection were guaranteed according to the Declaration of Helsinki. Informed consent was obtained for all children, signed by their legal tutor.

2.2. Data collection and variables

2.2.1. Outcomes

At the 13-year follow-up, participants were asked, through self-reported questionnaires, if they smoked or they had ever smoked, and if they drank or they had ever tried alcoholic beverages. We computed a dichotomous variable of alcohol/tobacco use, considering "yes" if participants answered yes to tobacco and/or alcohol use and "no" when they answered no to the two variables.

Physical activity was measured by asking adolescents the frequency they practice regular sports activity. Using the World Health Organization's (WHO) guidelines (WHO, 2020), we considered low physical activity if participants practice sports less than three times a week.

The consumption of fruits and vegetables was assessed by asking adolescents about their daily intake of fruits, vegetable soup, and boiled and raw vegetables. Following the recommendations of WHO, this information was used as a proxy to measure healthy eating habits (Subar et al., 1995). We considered low consumption if participants reported eating < 5 portions of fruits and/or vegetables a day.

Depressive symptoms were assessed through the Portuguese version of the Beck Depression Inventory-II (Campos and Gonçalves, 2011) and a cut-off point of 13 was used (Coelho et al., 2002). The medical diagnosis of cardiovascular conditions and asthma was collected by asking parents if the child was ever diagnosed with hypertension/cardiac disease and asthma.

Trained researchers collected anthropometric measures. Body mass index (BMI) was computed as an age- and sex-specific BMI standard deviation score (z-score) (WHO, 2018). We used a dichotomous variable, "obesity", defined as having a BMI z-score $> +2\,\mathrm{SD}$.

2.3. Adversity indicators

Mothers completed questionnaires throughout all study waves (5 time points), reporting on their experiences of life events, behaviours, and socioeconomic circumstances and on children's characteristics. Data on parental divorce, household financial hardship, child's health conditions, difficulties at school, illness and death of family members/close friends was reported at the baseline, four years and seven years' follow-ups.

At ten and 13-year follow-ups children/adolescents answered a self-administered questionnaire on ACEs (Felitti et al., 1998; Finkelhor et al., 2013). To identify patterns of adversity, we used available data on ACEs items reported at each time point. Based on previous work (Felitti et al., 1998; Finkelhor et al., 2013) and the prevalence ($> 3\%$), 13 adversity domains were included (Supplementary Table 1).

2.3.1. Other co-variates

Information on maternal education, household income, parent's employment status and family structure were reported by parents at the baseline assessment.

Maternal education was measured as the number of years of formal schooling and categorised as 9 years or less, 12 years, and > 12 years (UNESCO Institute of Statistics, 2012).

The household income included salaries and other sources. Categories were defined as having $\leq 1000€$ disposable per month, representing a situation of both parents receiving at least a minimum national wage (557€ before taxes, in 2017 (PORDATA, 2021)); between 1001€ and 2000€; and $> 2000€$ per month.

Parental unemployment status was used to assess whether one or both parents were unemployed. Data on the family structure was assessed by asking participants whom the child lives with: both parents, only mother/father, or neither mother/father.

2.4. Statistical analysis

Latent class analysis (LCA) was performed to identify patterns of adversity, from birth to 13 years of age, across the 13 binary ACEs items (Nylund-Gibson and Choi, 2018). The number of latent classes (patterns) was identified according to the Bayesian information criterion (BIC), the Akaike information criterion (AIC) and theoretical interpretability.

Considering that adversity variables were assessed across 5 time points, considerable amount of data were missing. We compared the study participants with ($n = 3572$) and without ($n = 5075$) complete data for ACEs (Supplementary Table 2) and found that missing data were related to sociodemographic variables. Consistently to previous studies, children without complete data on ACEs had less educated mothers, lower household income, unemployed parents and lived with only one parent or neither mother nor father (< 0.001) (Tracy et al., 2019). To reduce potential biases, full information maximum likelihood estimation was used to handle missing data, assuming missing at random, which allows the classification of all individuals, even with missing items. This analysis was compared to the complete data analysis, with similar conclusions (Supplementary Table 3). Children were assigned to each class according to the highest probability of class membership. Pearson's chi-squared test was used to compare proportions across patterns. The association between the adversity patterns and outcomes was calculated using odds ratio (AOR) and 95% confidence intervals (CI), adjusting for parental unemployment. A statistically significant interaction was observed by sex in the association between adversity patterns and outcomes ($p < 0.05$), and analyses were stratified by sex.

The softwares IBM SPSS V.25.0 and R Statistical Programming Language version 3.2.2 were used.

3. Results

3.1. Patterns of childhood adversity

By inspecting the scree plot with BIC values from LCA (Fig. 2), the Supplementary Table 4 with statistics, and considering theoretical meaning, the best model was the one identifying three classes (Nylund-Gibson and Choi, 2018).

Figure 3 presents the three emerging patterns of childhood adversity. The "low adversity" pattern represents participants with a low probability of experiencing the assessed adverse events; the experience of parental divorce characterises the "household dysfunction" pattern; and the "multiple adversities" pattern is characterised by the experience of several events of adversity throughout time, such as violence at home and in school, difficulties at school, financial hardships, and illness and death of family members or close friends.

Participants presenting a pattern of "low adversity" (56.1%) are mainly girls, live in a household with 1001€-2000€ of monthly income, have both parents employed and lived with both parents (Table 1). The sociodemographic characteristics of the participants presenting a pattern of "household dysfunction" (17.2%) and "multiple adversities" (26.7%) are very similar, more than 50% of them are boys, mainly living in a household with $\leq 1000€$ or 1001€-2000€ per month and having both parents employed. However, adolescents presenting a pattern of "household dysfunction" mainly live with only one or none of the parents (94.5%), while those presenting the pattern of "multiple adversities" live with both parents (87.4%) (Table 1).

3.2. Adolescents' health-related behaviours and outcomes by adversity pattern

The use of alcohol or/and tobacco, low consumption of fruits/vegetables, as well as depressive symptoms, were more frequently reported by adolescents who presented a pattern of "household dysfunction" or "multiple adversities" (Table 2).

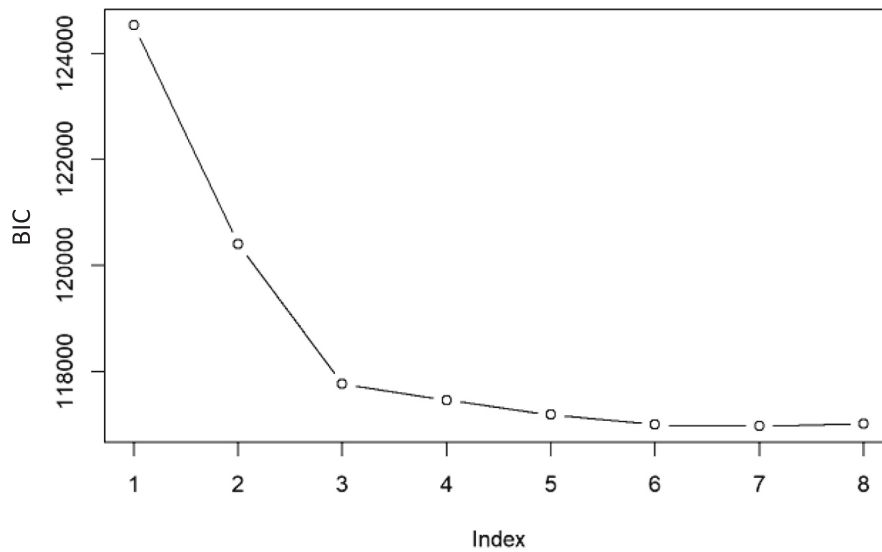Girls presenting a "household dysfunction" pattern had increased

Fig. 2. Scree plot for the Bayesian information criteria (BIC) values from Latent Class Analysis.
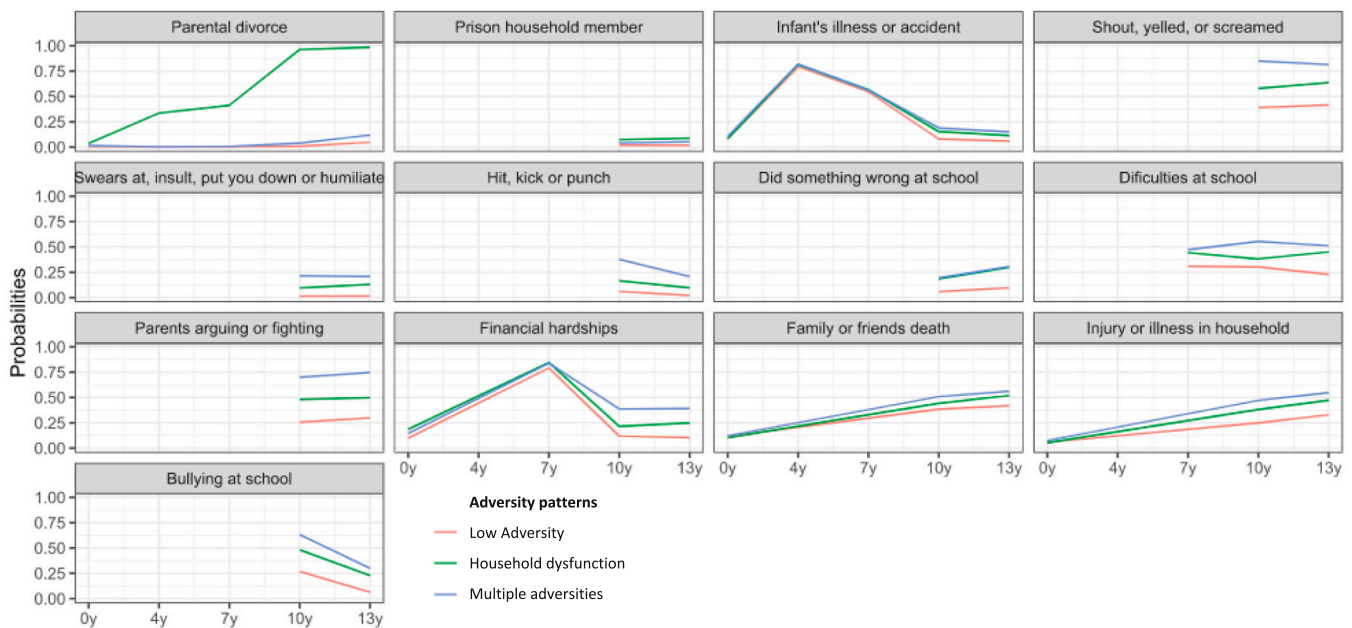

Fig. 3. Patterns of childhood adversity from birth until the age of 13, in the Portuguese birth cohort Generation XXI ($n = 8647$).

odds of alcohol/tobacco use (AOR, 1.78; CI, 1.32–2.40) and depressive symptoms (AOR, 2.34; CI, 1.58–3.48) when compared to those with low adversities, after adjustment for parental unemployment. On the other hand, boys presented increased odds of alcohol/tobacco use (AOR, 1.84; CI, 1.38–2.46), low consumption of fruits/vegetables (AOR, 1.51; CI, 1.04–2.19) and depressive symptoms (AOR, 5.45; CI, 2.86–10.38). Adolescents presenting the pattern of "multiple adversities" presented higher odds of alcohol/tobacco use (AOR, 1.82; CI, 1.42–2.33 among girls; AOR, 1.63; CI, 1.30–2.05 among boys) and depressive symptoms (AOR, 3.41; CI, 2.46–4.72 among girls; AOR, 5.21; CI, 2.91–9.32 among boys) than those in the pattern of "low adversity". Additionally, boys presenting this pattern also showed a higher probability for low consumption of fruits/vegetables (AOR, 1.67; CI, 1.24–2.23) (Table 3).

4. Discussion

This study identified three patterns of childhood adversity from birth to early adolescence. Although most of the participants presented a pattern of "low adversity", more than a quarter had a pattern of "multiple adversities", and 17.2% had a pattern of "household dysfunction". These two last patterns were associated with higher odds of having unhealthy behaviours and depressive symptoms at 13 years of age, suggesting the existence of specific groups of children at risk of developing unhealthy behaviours and poor health already in early adolescence.

Contrary to previously described, boys from this study tended to report more adversity than girls (Felitti et al., 1998; Baglivio et al., 2014). In contrast with prior studies, sexual abuse was not included in our assessment by being considered a hypersensitive issue to be asked at

Table 1

Sociodemographic characteristics of participants from the Portuguese birth cohort Generation XXI according to the patterns of childhood adversity (n = 8647).

		Low adversity n (%)	Household dysfunction[a] n (%)	Multiple adversities[b] n (%)	p
		4849 (56.1)	**1490 (17.2)**	**2308 (26.7)**	
Child and household sociodemographic characteristics					
Sex	Girl	2537 (52.3)	729 (48.9)	971 (42.1)	**<0.001**
	Boy	2312 (47.7)	761 (51.1)	1337 (57.9)	
Maternal education at baseline	≤9 years	2372 (49.3)	714 (48.3)	1142 (49.7)	
	10–12 years	1281 (26.6)	411 (27.8)	608 (26.4)	0.893
	>12 years	1160 (24.1)	354 (23.9)	549 (23.9)	
Household montlhy income at baseline	≤1000€	1617 (39.0)	562 (43.6)	845 (42.3)	
	1001–2000€	1870 (45.1)	534 (41.5)	851 (42.6)	**0.019**
	>2000€	663 (16.0)	192 (14.9)	303 (15.2)	
Parental unemployment at baseline	None of the parents	1908 (67.2)	486 (57.6)	924 (65.0)	**<0.001**
	At least one of the parents	933 (32.8)	358 (42.4)	497 (35.0)	
Family structure at 13 years' follow-up	Both parents	2073 (92.4)	48 (5.5)	1300 (87.4)	**<0.001**
	Only mother or father/ neither mother nor father	170 (7.6)	831 (94.5)	188 (12.6)	

[a] In the household dysfunction pattern there was an increased probability of parental divorce.

[b] In the multiple adversity pattern there was an increased probability of violence at home and in school, difficulties at school, financial hardships, illness and death of family members or close friends.

Table 2

Health-related behaviours and outcomes of participants from the Portuguese birth cohort Generation XXI, at 13 years of age, according to the patterns of childhood adversity (n = 4640).

		Low adversity n (%)	Household dysfunction[a] n (%)	Multiple adversities[b] n (%)	P
Adolescents'health-related behaviours					
Alcohol/tobacco use	No	1251 (56.5)	385 (43.7)	622 (42.3)	**<0.001**
	Yes	965 (43.5)	496 (56.3)	847 (57.7)	
Low physical activity (<3 times a week)	No	954 (62.4)	279 (56.9)	576 (60.4)	0.090
	Yes	574 (37.6)	211 (43.1)	377 (39.6)	
Low consumption of fruits and vegetables (<5-a-day)	No	526 (23.8)	160 (18.3)	281 (19.2)	**<0.001**
	Yes	1683 (76.2)	716 (81.7)	1179 (80.8)	
Adolescents' health status					
Diagnosis of cardiovascular conditions	No	2154 (96.1)	846 (95.4)	1412 (95.1)	0.290
	Yes	87 (3.9)	41 (4.6)	73 (4.9)	
Diagnosis of asthma	No	2036 (91.3)	793 (89.7)	1328 (89.5)	0.163
	Yes	195 (8.7)	91 (10.3)	155 (10.5)	
Obesity	No	2038 (90.8)	798 (89.2)	1335 (89.2)	0.223
	Yes	207 (9.2)	97 (10.8)	161 (10.8)	
Depressive symptoms	No	2063 (93.5)	736 (84.0)	1180 (80.8)	**<0.001**
	Yes	144 (6.5)	140 (16.0)	280 (19.2)	

[a] In the household dysfunction pattern there was an increased probability of parental divorce.

[b] In the multiple adversity pattern there was an increased probability of violence at home and in school, difficulties at school, financial hardships, illness and death of family members or close friends.

such younger ages. Since sexual abuse tends to be more reported by girls than boys (Hanson et al., 2008), this methodological approach may explain these opposing results. Moreover, a recent study not including sexual abuse did not find a significant difference in the average number of ACEs or the timing or duration of adversity exposure among boys and girls (Jones et al., 2022).

Additionally, results show that boys are more prone than girls to present the pattern of "multiple adversities". The higher likelihood of boys being involved in violent behaviours, such as bullying, is well described (Fraga et al., 2022). Being exposed to or witnessing violence at home may increase their susceptibility to adopting violent behaviours, as children might see it as an acceptable way to manage interpersonal conflicts (Fraga et al., 2022; Lereya et al., 2015). In addition, boys presenting the patterns of "multiple adversities" and "household dysfunction" were at higher odds of having a low consumption of fruits/vegetables than those presenting "low adversity". Child emotion dysregulation can be a mechanism by which early adversity increases unhealthy eating behaviours (Huffhines et al., 2020). Also, findings showed that socially disadvantaged children (i.e., living in households with lower income and parental unemployment) are more prone to have these two last patterns. Considering ACEs are strongly socioeconomically patterned, there is a need to look at the socioeconomic context as an enhancer of social adversity (Ellis and Dietz, 2017; Walsh et al., 2019). Thus, improving social and economic environments in which children grow up, live, and learn, may lead to reductions in health and developmental inequalities which span the entire life-course.

We found that having the adversity pattern of "household dysfunction", characterised by having divorced parents, increased the probability of adolescents being involved in smoking and/or alcohol intake. According to the crisis model from the divorce stress adjustment perspective (Amato, 2000), participants' risky behaviours can be explained as a short-term stress response to their parents' marital dissolution. This model argues that parental divorce only temporarily disturbs children's lives, with negative consequences in the first two years (Amato, 2000, 2010). However, according to the chronic strain model, many children can experience the negative effects of that event for many years (Amato, 2000, 2010; Sillekens and Notten, 2020). Previous studies have shown a link between parental divorce in childhood and externalising problems in youth and adulthood (e.g., use of drugs, alcohol abuse, and absence from work) (Amato, 2010; Sillekens and Notten, 2020). Considering that divorce is very common in today's society, it is important to reflect on the inclusion of this experience as a type of adversity. Because family functioning can moderate the negative impact of adversity on adolescent health and well-being (Balistreri and Alvira-Hammond, 2016), as well as the increasing number of children growing up in marital dissolved households, there is a need to explore further the resilient factors that might reduce its impact on the development of problematic behaviours.

We observed that children presenting the "multiple adversities" pattern also had shown higher odds of developing poor health-related behaviours in adolescence. The family environment is very important for learning processes and the development of resilience skills, making children who grow up in a context of violence more prone to use substances in adolescence as a way to deal with such experiences (James et al., 2018).

Table 3

Associations (Odds Ratio and 95% Confidence Interval, OR (95%CI)) of adolescents' health-related behaviours and health status with patterns of childhood adversity, in the Portuguese birth cohort Generation XXI, stratified by sex (n = 4640).

Patterns of childhood adversity	Adolescents' health-related behaviours								Adolescents' health status			
	Alcohol/tobacco use				Low consumption of fruits and vegetables (< 5-a-day)				Depressive symptoms			
	Unadjusted OR (95% CI)		Adjusted OR* (95% CI)		Unadjusted OR (95% CI)		Adjusted OR* (95% CI)		Unadjusted OR (95% CI)		Adjusted OR* (95% CI)	
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
Low adversity	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)	1.00 (ref.)
Household dysfunction[a]	1.61 (1.28–2.02)	1.70 (1.36–2.12)	1.78 (1.32–2.40)	1.84 (1.38–2.46)	1.27 (0.97–1.67)	1.52 (1.14–2.03)	1.24 (0.87–1.77)	1.51 (1.04–2.19)	2.48 (1.84–3.34)	5.07 (3.04–8.46)	2.34 (1.58–3.48)	5.45 (2.86–10.38)
Multiple adversities[b]	1.98 (1.63–2.41)	1.56 (1.30–1.88)	1.82 (1.42–2.33)	1.63 (1.30–2.05)	1.07 (0.85–1.34)	1.56 (1.23–1.98)	0.91 (0.69–1.19)	1.67 (1.24–2.23)	3.69 (2.86–4.75)	5.28 (3.30–8.45)	3.41 (2.46–4.72)	5.21 (2.91–9.32)

* Adjusted for parental unemployment.
[a] In the household dysfunction pattern there was an increased probability of parental divorce.
[b] In the multiple adversity pattern there was an increased probability of violence at home and in school, difficulties at school, financial hardships, illness and death of family members or close friends.

Our results support the idea of adversities being clustered together and having a pattern of childhood adversity increases the odds of adolescents adopting unhealthy behaviours. Considering that behaviours are well-known modifiable risk factors for non-communicable diseases (World Health Organization, 2011), these adolescents are at higher risk for developing poor health outcomes in adulthood and premature death (Rod et al., 2020). In this study, adversity patterns were not associated with the diagnosis of cardiovascular conditions (i.e. hypertension or cardiac disease), probably by the fact that at the age of 13, most of the cardiovascular conditions are related to congenital heart disease, which, are not expected to be related with ACEs. However, the underlying atherosclerotic process has a long asymptomatic phase of development that often starts during early childhood, tracks over time and can predict the onset of disease several years later. Thus, considering the early start of deviant behaviours and its related healthcare costs, public policies and interventions aiming at early detection and prevention of ACEs should be focused on vulnerable children and their families and tackle not only risky-health behaviours but also macroenvironmental factors (e.g., income and education), physical and social environment and access to health and social care (Sillekens and Notten, 2020; Crombie et al., 2005). Trauma-informed care, Cognitive Behavioural therapy, Eye Movement Desensitization and Reprocessing treatment, peer support programs, two-generation, family-focused initiatives and community-based interventions are examples of effective approaches to mitigate the effects of ACEs (Dugan et al., 2020; Shonkoff and Fisher, 2013; van der Kolk et al., 2007).

Depression and BMI are other important pieces in the pathway between childhood adversity and adult physical illness. Early socioeconomic adversity exerts a persistent maladaptive impact on health over the life course indirectly through depressive symptoms and BMI trajectories, considered psychophysiological mediators (Wickrama et al., 2014). Although the absence of association with BMI, the two last adversity patterns were associated with increased odds of depressive symptoms at 13 years, consistent with previous studies (Dunn et al., 2013; Tracy et al., 2019). The increase in adaptive challenges of the adolescence period caused by early adversities contributes to the development of depressive symptoms (Wickrama et al., 2014). In addition, girls presenting "multiple adversities" have higher odds of developing depressive symptoms than those experiencing "household dysfunction". On the other hand, boys in these two patterns presented a higher probability of developing depressive symptoms than girls. These results highlight the need to consider not only the differential impact of specific types of adversity on girls' mental health but also the higher susceptibility of boys who experienced any adversity to develop poor mental health in adolescence. Even though this tendency is likely to be inverted in adult life, with women being globally diagnosed with depression at significantly higher rates than men (Vos et al., 2020), the negative consequences of ACEs on males' mental health need to be acknowledged and attended. Additionally, our results showed that probabilities of children having certain adversity widened over time between adversity patterns in some adversities (e.g., parental divorce, injury or illness in the household, death of a family member or friend), which highlights the need to consider the accumulation of ACEs and their potential impact on later health. Future research should focus not only on the number of adversities but also on the type of events children experience and the gender-differences of their impact on health to target those in more vulnerable positions.

The ACEs being assessed in a large sample of children participating in a birth-cohort is a strength of this study. The 13 variables used for analysing adversity patterns were collected through different methods across 5-time points. In some variables, we have the perspective of the child/adolescent, and in others, we have the views from the child/adolescent and from the legal tutors, which can lead to some bias. However, having the report from children's tutors can be an advantage because children may not have a level of maturity and understanding to recognise some adversities. Additionally, we had 58.7% of cohort

participants without complete information in all ACES, with differential loss of follow-up among those with poor socioeconomic conditions. To retain these losses, we used multiple imputation. Considering that individuals in poor socioeconomic positions tend to experience more adversities, we can be underestimating adversity proportions, losing the ability to understand the patterns of the most vulnerable children. However, the association between the adversity patterns and socio-demographic and health-related characteristics of children with complete information is very similar to the total sample (Supplementary Table 3).

Societies should invest in social policies and families' support interventions to improve the community resilience, providing children with a better start for better health. "Upstream" factors identified during childhood seem to represent meaningful opportunities to prevent adversity and improve health since they are modifiable risk factors that should be targeted in local and global public health interventions to attenuate or reduce inequalities and their effects on health, starting at early ages. Given the impossibility of preventing all adverse exposures, social supports for vulnerable children, families and communities should be provided. Multicomponent and intersectoral interventions focusing on improving parenting skills, strengthening economic support to families, providing quality care and education in early life, mental health treatment, and social service referrals can mitigate ACEs impacts on health (Ellis and Dietz, 2017; Lorenc et al., 2020; Marie-Mitchell and Kostolansky, 2019).

5. Conclusions

From birth to early adolescence, we identified adversity patterns associated with the odds of developing negative health-related behaviours and depressive symptoms. Our study findings highlight the impact of the accumulation of adversities over time on health-related outcomes. There is a need to design and develop public policies and early interventions tackling macroenvironmental factors, social and physical environment and health-related behaviours to reduce social inequalities, prevent the detrimental effects of childhood adversities and improve the resilience of children, promoting their health and quality of life.

Ethical considerations

All data collection waves were approved by the Portuguese Data Protection Authority and by the ethics committee of Centro Hospitalar Universitário de São João. Written informed consent was obtained for all participating children, signed by their legal tutor.

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CRediT authorship contribution statement

Mariana Amorim: Conceptualization, Methodology, Formal analysis, Writing – original draft. **Sara Soares:** Methodology, Formal analysis, Writing – review & editing. **Arminé Abrahamyan:** Data curation, Writing – review & editing. **Milton Severo:** Methodology, Formal analysis, Writing – review & editing. **Sílvia Fraga:** Conceptualization, Methodology, Supervision, Writing – review & editing.

Declaration of Competing Interest

None to declare.

Data availability

Data is available upon request to the cohort's coordination.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ypmed.2023.107500.

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