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ABSTRACT

Objectives Adverse childhood experiences (ACEs) show strong cumulative associations with ill-health across the life course. Harms can arise even in those exposed to a single ACE type but few studies examine such exposure. For individuals experiencing a single ACE type, we examine which ACEs are most strongly related to different health harms.

Design Secondary analysis of combined data from eight cross-sectional general population ACE surveys.

Setting Households in England and Wales.

Participants 20 556 residents aged 18–69 years.

Measures Ten self-reported outcomes were examined: smoking, cannabis use, binge drinking, obesity, sexually transmitted infection, teenage pregnancy, mental well-being, violence perpetration, violence victimisation and incarceration. Adjusted ORs and percentage changes in outcomes were calculated for each type of ACE exposure.

Results Significance and magnitude of associations between each ACE and outcome varied. Binge drinking was associated with childhood verbal abuse (VA), parental separation (PS) and household alcohol problem (AP), while obesity was linked to sexual abuse (SA) and household mental illness. SA also showed the biggest increase in cannabis use (25.5% vs 10.8%, no ACEs). Household AP was the ACE most strongly associated with violence and incarceration. PS was associated with teenage pregnancy (9.1% vs 3.7%, no ACEs) and 5 other outcomes. VA was associated with 7 of the 10 outcomes examined.

Conclusion Exposure to a single ACE increases risks of poorer outcomes across health-harming behaviours, sexual health, mental well-being and criminal domains. Toxic stress can arise from ACEs such as physical and SA but other more prevalent ACEs (eg, VA, PS) may also contribute substantively to poorer life course health.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Sample size permitted the identification of groups of individuals who had only experienced a single type of adverse childhood experience (ACE) during childhood.
⇒ ACEs were self-reported and measured retrospectively and therefore may have been misremembered or otherwise misreported.
⇒ Although compliance rates were consistent with other ACE studies, the participation level was 49.3% (face-to-face and telephone surveys), creating a potential for self-selection bias among respondents.
⇒ Findings relate to single ACE exposures which are reported by large proportions of general populations, but which have received relatively little attention.

INTRODUCTION

Recent decades have seen a substantial increase in studies describing the impact of adverse childhood experiences (ACEs) on individuals' health and behaviour across the life course.[1] ACEs are stressful experiences suffered in childhood such as exposure to child maltreatment (eg, physical abuse (PA), verbal abuse (VA) and sexual abuse (SA)) and stressors within the home environment (eg, parental mental illness (MI), substance use and domestic violence (DV)).[2] Typically, exposure to different ACEs has been shown to have strong cumulative relationships with negative health and social behaviour outcomes. Thus, alcohol, drug use and sexual risk taking have all been shown to increase with exposure to increasing numbers of ACEs types (ie, ACE counts).[3–5] Moreover, ACE counts have also been shown to be strongly related to increased risks of some of the most common non-communicable diseases including cancer and heart disease as well as health harms such as poor mental health during adulthood.[4–6] Further, increased exposure to ACEs is also related to criminal and antisocial outcomes such as violence, criminal activity and consequent incarceration.[7–9] Although most studies

have been undertaken in high-income countries, similar findings have been reported from those in low-income and middle-income countries.[10–12]

Using cumulative ACE counts as a predictor of adverse outcomes has been an important feature of ACE research since it was first instigated.[2 13] ACE counts have not only acted as strong predictors of adverse outcomes in childhood and later life but also created a measure of childhood stressors that incorporates aspects of multiple disciplines (eg, health, social, criminal justice). Such measures have helped facilitate multiagency ownership and consequently, multisectoral responses to ACEs and their impacts at all levels from policy to intervention.[14 15] In particular, a focus on cumulative ACEs has exposed how higher ACE counts (typically experiencing 4+ ACE types) is associated with substantive negative impacts to health and well-being.[16] However, a focus on 4+ ACE can detract from harms across the life course that may arise from exposure to fewer ACEs or even a single ACE type. Critically, across Europe and North America, more than one in five adults report suffering only a single ACE type during their childhood.[17] Although higher ACE counts typically result in greater harms, studies suggest increases in risks of, for instance, smoking, violence and poorer mental health may arise from a single ACE (vs 0 ACEs).[4 5] With such high proportions of individuals reporting exposure to just a single ACE, it is critical to understand how such experiences may affect health and behaviour.

The impact of a single ACE type on health and well-being may vary depending on the type of ACE experienced. Studies using ACE counts as predictors of health risks do not usually identify whether increased risks are associated with exposure to any specific ACE type, or if exposure to a particular ACE (in the absence of others) alters risks of harmful outcomes to a greater or lesser extent than other ACE types. Although numerous studies have examined single ACEs (eg, SA[18]), often they do not collect data on, control for, or compare the impacts of other ACEs that may have occurred in the same population. Those that do typically examine such impacts use models that control for, but do not exclude, exposure to other ACE types. As a result, such studies can confound the impacts of a specific type of ACE type in the absence of other ACEs (ie, those experiencing a single ACE type) with experiencing an ACE type in combination with others (ie, those experiencing multiple ACEs). Consequently, there is a paucity of information on differential health and behavioural risks associated with each type of ACE in individuals experiencing only one ACE type. With high proportions of individuals internationally reporting exposure to just a single ACE type, it is critical to study and understand how single ACE exposure may affect health and behaviour. Using a UK dataset developed from eight different ACE surveys, here we examine changes in health-harming and antisocial behaviours and mental well-being (MWB) associated with exposure to different ACE types in the absence of exposure to other ACEs. We test the hypotheses that exposure to each single ACE type is associated with increases in negative outcomes across the life course and that such associations vary with ACE type and outcome considered.

METHODS

Data from eight cross-sectional ACE studies undertaken across various geographies in England and Wales between 2012 and 2022 were combined. Online supplemental appendix table 1 provides summary information on each study. Five studies were conducted face to face at participants' households, three using nationally representative samples (England n=1, Wales n=2) and two using locally representative samples in English local authorities. All household surveys used stratified random sampling approaches, with lower super output area (LSOA; small geographical areas with a mean population of 1500) as the sampling unit. LSOAs within each study area were categorised to a quintile of deprivation using the English[19] or Welsh[20] Indexes of Multiple Deprivation as appropriate. Sample selection was stratified by geographical region (where relevant; see online supplemental appendix table 1) then deprivation quintile, and households in sampled LSOAs were randomly selected for inclusion. Face-to-face interviews were undertaken by a professional market research company using computer-assisted personal interviewing, with sensitive questions able to be self-completed. The other three studies were conducted by telephone and/or online, due to their implementation during the COVID-19 pandemic when face-to-face interviewing was not appropriate. Two were telephone surveys, conducted at national level in Wales and local level in England. Both used stratified sampling approaches across landline and mobile telephone contacts obtained from a commercial sample provider. Contacts were stratified by region (national sample) then deprivation quintile and age group. Telephone interviews were undertaken by a professional market research company. Due to difficulty accessing younger age groups by telephone, both studies were extended to include an online survey, with participants recruited via an online panel (individuals paid to participate in online research) accessed through a commercial provider. The online panels included all age groups proportionate to population demographics in each area. The remaining study was conducted online with participants recruited via a panel obtained from a commercial provider, targeted to represent national demographics. Age and gender quotas were used for all telephone and online samples.

The inclusion criteria for all studies were: resident in the study area, within the study age range (18–69, 18–70 or 18+ years; see online supplemental appendix table 1) and cognitively able to participate. In all studies, potential participants were informed of the nature and purpose of the study including its voluntary, anonymous and confidential nature. Informed consent was recorded electronically as part of survey questionnaires. Weighted average compliance across the five household surveys was

55.7% (online supplemental appendix table 1). The telephone participation rate across the two studies using this approach was 33.3% of eligible individuals who met quota sampling or 32.4% of all eligible individuals contacted. It was not possible to measure participation rates for the online surveys. The total sample across all eight studies was 22 361 (online supplemental appendix table 1). For the purpose of this study, data were restricted to individuals aged 18–69 years with complete demographic and ACE data. This resulted in a final sample of 20 556 (female 56.7%; age (years), 18–29, 20.7%; 30–39, 19.7%; 40–49, 20.3%; 50–59, 19.2%; 60–69, 20.2%; deprivation quintiles, from 1 (least deprived) to 5 (most deprived), 21.1%, 19.2%, 19.8%, 19.3%, 20.4%).

All surveys used the Center for Disease Control and Prevention short ACE tool[21] to measure participants' exposure to nine ACEs before the age of 18 years: (1) PA, (2) VA, (3) SA, (4) parental separation (PS) or divorce, (5) DV and household member, (6) MI, (7) alcohol problem (AP), (8) drug use and (9) incarceration. An adapted question was used to measure SA in the telephone/online surveys. The full questions used to measure each ACE are shown in online supplemental appendix table 2. Studies included a range of self-reported health-related outcomes and the questions used to measure the ten outcomes included in this study, and any variation in wording between studies, are also shown in online supplemental appendix table 2. Current smoking and lifetime cannabis use were measured in all eight studies. Weekly binge drinking was measured in seven studies, with binge drinking defined as consuming either six or more (four studies) or five or more (three studies) alcoholic drinks in one session. Obesity (body mass index (BMI)≥30) was measured in four studies, with BMI calculated from individuals' self-reported height and weight. Having ever had a sexually transmitted infection (STI) was measured in seven studies and teenage pregnancy in four studies, with participants asked if they had accidentally got pregnant or got someone else pregnant before the age of 18. Low MWB was measured in five studies using the Short Warwick-Edinburgh Mental Wellbeing Scale (SWEMWBS).[22] Scores from the seven SWEMWBS items were summed and transformed to a metric score according to guidelines, with scores <20 categorised as low MWB. Violence perpetration and violence victimisation in the last 12 months were measured in seven studies, and lifetime incarceration (having ever spent a night locked up in a prison, jail or police station) was measured in five studies. The studies in which each outcome was measured are shown in online supplemental appendix table 1.

In order to analyse the impact of each individual ACE in the absence of exposure to other ACE types, data were limited to those reporting no ACEs (control group) and those only reporting a specific ACE type (exposed groups, for example, VA without exposure to any other ACE types) for each set of analyses. The exposed groups containing those only reporting the ACEs household member drug use (n=53) or incarceration (n=56) were considered too small for analysis (see table 1). However, exposure to either of these ACEs was still considered exclusion criteria for control group membership. Each exposed group (by single ACE type) was not intended or expected to be representative of the general population and each is considered here only as a subset of individuals exposed to a single type of ACE. Analyses used χ^2 tests for initial bivariate examination of relationships between each ACE and measured outcomes. However, in order to adjust for demographic and other potentially confounding differences between each exposed group and controls, binary logistic regression (LR) was used to examine the independent contributions of single ACE types to outcomes. Thus, LR included study membership (to adjust for potential differences between studies) and demographic factors, age, sex and deprivation. Ethnicity was not included as a separate variable as individual ethnicities other than white were insufficiently represented for the purposes of analysis. The results of LRs are presented as adjusted ORs with 95% CIs and p values. For each ACE-outcome combination, the best-fitting LR model was used to estimate means (percentage reporting outcomes in control and exposed groups) adjusted to average sample characteristics (estimated marginal means). Statistics were undertaken in SPSS V.27.

Table 1 Proportion and ACE counts of participants reporting each ACE

	Have each ACE		Distribution across ACE count		
ACE	%	n	1	2–3	4+
Physical abuse	15.9	3266	9.8	40.1	50.1
Verbal abuse	20.7	4250	14.8	40.4	44.8
Sexual abuse	7.4	1512	19.2	30.2	50.6
Parental separation	21.9	4507	33.5	32.1	34.4
Domestic violence	15.5	3190	13.9	35.1	51.0
Household member:					
Mental illness	14.6	3005	20.4	34.9	44.7
Alcohol problem	11.7	2402	11.7	32.8	55.5
Drug use	4.5	919	5.8	24.5	69.7
Incarceration	3.7	753	7.4	26.2	66.4

Total sample n=20 556.
ACE, adverse childhood experience.

Patient and public involvement

The study did not involve patients. Study findings were made publicly available to participants and the general public through the production of study reports and open access journal articles.

RESULTS

Child maltreatment ACEs

Exposure to the single ACE of PA was significantly associated with having ever used cannabis, had an STI or been incarcerated, as well as violence perpetration in the last

12 months in both bivariate (table 2) and LR (table 3) analyses. Exposure to PA was also significantly associated with binge drinking in bivariate analysis. However, using LR analyses to adjust for other variables, binge drinking was no longer significant while teenage pregnancy (not significant using bivariate analysis) reached significance. Modelled prevalence of cannabis use rose from 10.8% in those with no ACEs to 17.3% in those exposed only to PA (figure 1). For STIs, the equivalent rise was from 0.8% to 2.0% and for violence perpetration and incarceration modelled prevalence rose from 1.3% to 3.4% and 2.4% to 5.0%, respectively.

In both bivariate and LR analyses, exposure to the single ACE of VA was significantly associated with increased risk of all outcomes except smoking, obesity and having had an STI (tables 2–3). Modelled prevalence of binge drinking rose from 13.6% in those with no ACEs to 17.7% in those exposed to VA (figure 1). Cannabis use showed a rise from 10.8% to 19.9% and low MWB rose substantively from 14.6% to 21.4%. The prevalence of violence perpetration and victimisation also rose significantly from 1.3% to 3.1% and 1.9% to 3.6%, respectively, while incarceration rose from 2.4% to 4.4%.

Experiencing SA as a single ACE was positively associated, in both bivariate and LR analyses, with obesity, cannabis use, both sexual health measures (STI, teenage pregnancy) and lower MWB (tables 2–3). Modelled prevalence of obesity rose from 15.9% in those with no ACEs to 22.5% in those exposed to SA (figure 1). Experiencing SA more than doubled the prevalence of cannabis use (10.8%, no ACEs; 25.5% SA) along with the prevalence of having had an STI or teenage pregnancy (0.8%–2.1% and 3.7%–7.5%, respectively). Modelled estimates for lower MWB also rose significantly from 14.6% to 23.1%.

Other household ACEs

In both bivariate and LR analyses, PS was significantly associated with increased risks of smoking, binge drinking, cannabis use, STI, teenage pregnancy and incarceration (tables 2–3). Although violence victimisation was also associated with PS in bivariate analysis, the relationship failed to reach significance using LR. Smoking rose from a modelled estimate of 16.6% (no ACEs) to 24.2% (with PS; figure 1). For cannabis use, the equivalent increase with exposure to PS was from 10.8% to 16.1% and for teenage pregnancy from 3.7% to 9.1%.

DV was associated with incarceration in bivariate analyses (table 2) and was additionally associated with cannabis use and lower MWB using LR analyses (table 3). Modelled estimates identify an increase in cannabis use from 10.8% (no ACEs) to 14.5% (DV alone; figure 1). Equivalent increases for lower MWB and incarceration were from 14.6% to 19.6% and 2.4% to 4.3%, respectively.

Reporting household MI as a single ACE was significantly associated, in bivariate analyses, with binge drinking, obesity, lower MWB, cannabis use, STI and incarceration. However, binge drinking failed to reach significance when demographics and sample membership were accounted for using LR analyses (tables 2–3). In modelled estimates, obesity rose from 15.9% (no ACEs) to 21.5% (MI), cannabis use from 10.8% to 15.8% and lower MWB from 14.6% to 25.8% (figure 1).

In both bivariate and LR analyses, the single ACE of household AP was significantly associated with binge drinking, cannabis use, teenage pregnancy, violence perpetration or victimisation and incarceration (tables 2–3). Having had an STI was significantly related to AP only in bivariate analysis, while smoking was significant only using LR. Modelled prevalence of binge drinking rose from 13.6% (no ACEs) to 20.3% (with AP), while violence perpetration and victimisation rose from 1.3 to 4.7% and 1.9% to 4.1%, respectively (figure 1). The prevalence of incarceration was also more than doubled from 2.4% (no ACEs) to 5.6% (with AP).

Other factors

Using LR analyses, deprivation quintile was significantly associated with many outcomes studied. Thus, likelihood of smoking, lower MWB and incarceration all consistently increased with increasing deprivation. Females had significantly lower likelihoods of violence involvement (perpetrator or victim) or of incarceration. Females also reported lower likelihoods of smoking, binge drinking and cannabis use. Likelihood of smoking or cannabis use also reduced with increasing age, while obesity increased in older age groups (online supplemental appendix tables 3–9).

DISCUSSION

Multiple studies have established that ACEs routinely cooccur.[5 16 23] To examine the impact of such co-occurrence on life course health, studies often employ a cumulative measure of the number of ACEs experienced (ACE count). Attempts to identify the contribution of any individual ACE often use multivariate models to account for the co-occurrence of other ACEs suffered.[24–26] However, large numbers of adults internationally do not report any co-occurring ACEs but instead identify a single ACE type experienced in childhood. With few studies focused on such individuals, there is a paucity of information on the impact that just a single ACE type may have on life course health (in the absence of exposure to other ACEs) or comparisons between the impacts different individual ACEs may have on different outcomes. Some studies have compared outcomes associated with exposure to specific individual ACEs (eg, sexual vs other forms of child maltreatment).[27 28] Often, however, these do not account for both direct (eg, child maltreatment) and indirect (eg, household MI) types of adversity. While studies are beginning to measure the potential impact of individual ACEs on selected outcomes (eg, memory loss)[29] those examining associations between single ACEs and broader life course health, in the absence of other ACEs, remain scarce. It is this deficit which this study aims to help address. We find that even exposure to a single

Table 2 Bivariate relationships between individual ACEs (vs 0 ACEs) and health-related outcomes

Outcome	0 ACEs (n)% yes	Physical abuse (n)% yes X^2, P	Verbal abuse (n)% yes X^2, P	Sexual abuse (n)% yes X^2, P	Parental separation (n)% yes X^2, P	Domestic violence (n)% yes X^2, P	Mental illness* (n)% yes X^2, P	Alcohol problem* (n)% yes X^2, P
Smoking	(10 681) 18.6%	(320) 20.9%	(628) 19.7%	(290) 18.3%	(1512) 29.0%	(443) 18.5%	(612) 16.8%	(280) 23.2%
		1.078, 0.299	0.476, 0.490	0.025, 0.875	88.557, <0.001	0.005, 0.945	1.256, 0.262	3.745, 0.053
Binge drinking	(9381) 12.0%	(289) 18.3%	(580) 20.3%	(266) 13.9%	(1324) 17.7%	(394) 13.7%	(526) 15.6%	(247) 19.0%
		10.643, 0.001	35.119, <0.001	0.919, 0.338	34.974, <0.001	1.074, 0.300	6.104, 0.013	11.228, 0.001
Obesity	(6384) 16.5%	(185) 17.3%	(322) 18.3%	(161) 26.1%	(846) 14.4%	(286) 16.8%	(295) 21.7%	(165) 13.3%
		0.078, 0.781	0.715, 0.398	10.290, 0.001	2.428, 0.119	0.013, 0.909	5.402, 0.020	1.193, 0.275
Cannabis use	(10 657) 11.1%	(320) 16.9%	(626) 22.4%	(288) 21.2%	(1509) 19.5%	(440) 13.4%	(609) 17.2%	(280) 22.1%
		10.566, 0.001	73.316, <0.001	28.647, <0.001	88.310, <0.001	2.367, 0.124	21.856, <0.001	33.375, <0.001
STI	(9358) 1.1%	(289) 2.8%	(580) 1.4%	(264) 2.7%	(1319) 2.4%	(396) 1.5%	(526) 2.7%	(247) 2.4%
		7.158, 0.007	0.453, 0.501	5.719, 0.017	17.046, <0.001	0.665, 0.415	10.843, 0.001	3.981, 0.046
Teenage pregnancy	(7079) 3.9%	(201) 6.5%	(347) 6.1%	(184) 9.8%	(921) 9.4%	(309) 5.2%	(325) 5.2%	(172) 7.6%
		3.287, 0.070	3.865, 0.049	15.729, <0.001	57.012, <0.001	1.212, 0.271	1.380, 0.240	5.747, 0.017
Low MWB	(7495) 12.8%	(221) 13.1%	(416) 21.4%	(196) 21.4%	(1022) 12.6%	(317) 16.1%	(396) 25.5%	(192) 14.6%
		0.022, 0.881	25.458, <0.001	12.625, <0.001	0.021, 0.886	2.956, 0.086	52.402, <0.001	0.543, 0.461
Violence perpetration	(10 094) 1.7%	(294) 3.7%	(546) 4.2%	(266) 2.3%	(1395) 2.3%	(425) 1.2%	(526) 2.1%	(257) 5.8%
		6.649, 0.010	17.654, <0.001	0.429, 0.512	2.262, 0.133	0.730, 0.393	0.394, 0.530	23.649, <0.001
Violence victimisation	(10 101) 2.4%	(294) 2.7%	(544) 4.8%	(269) 2.6%	(1395) 3.9%	(424) 3.3%	(526) 2.9%	(257) 5.1%
		0.146, 0.702	12.238, <0.001	0.058, 0.810	10.993, 0.001	1.481, 0.224	0.483, 0.487	7.567, 0.006
Incarceration	(8423) 3.4%	(232) 7.3%	(395) 6.3%	(209) 3.3%	(1114) 7.3%	(358) 5.6%	(408) 5.4%	(208) 7.2%
		10.526, 0.001	9.759, 0.002	0.000, 0.986	40.644, <0.001	5.041, 0.025	4.749, 0.029	8.949, 0.003

Questions used to measure each ACE are provided in online supplemental appendix table 2.
*Household member.
ACE, adverse childhood experience; MWB, mental well-being; STI, sexually transmitted infection.

Table 3 Adjusted ORs for health outcomes by individual ACEs (vs no ACEs)

	Physical abuse	Verbal abuse	Sexual abuse	Parental separation	Domestic violence	Mental illness*	Alcohol problem*
	AOR (95% CIs)	AOR (95% CIs)	AOR (95% CIs)	AOR (95% CIs)	AOR (95% CIs)	AOR (95% CIs)	AOR (95% CIs)
Outcome	P value	P value	P value	P value	P value	P value	P value
Smoking	1.24 (0.93 to 1.64)	1.19 (0.96 to 1.46)	1.18 (0.87 to 1.61)	1.63 (1.43 to 1.85)	1.02 (0.80 to 1.31)	1.04 (0.83 to 1.29)	1.43 (1.07 to 1.91)
	0.141	0.106	0.289	<0.001	0.865	0.764	0.015
Binge drinking	1.34 (0.96 to 1.86)	1.37 (1.09 to 1.73)	1.24 (0.85 to 1.80)	1.43 (1.21 to 1.69)	1.24 (0.90 to 1.70)	1.09 (0.84 to 1.42)	1.61 (1.13 to 2.29)
	0.084	0.007	0.263	<0.001	0.193	0.500	0.008
Obesity	0.96 (0.65 to 1.42)	1.13 (0.85 to 1.52)	1.55 (1.07 to 2.23)	0.99 (0.81 to 1.22)	1.03 (0.75 to 1.42)	1.44 (1.08 to 1.93)	0.76 (0.48 to 1.20)
	0.845	0.402	0.019	0.942	0.866	0.013	0.237
Cannabis use	1.71 (1.25 to 2.35)	2.07 (1.67 to 2.55)	2.80 (2.06 to 3.81)	1.61 (1.39 to 1.87)	1.40 (1.05 to 1.87)	1.54 (1.22 to 1.94)	2.30 (1.70 to 3.12)
	0.001	<0.001	<0.001	<0.001	0.024	<0.001	<0.001
STI	2.47 (1.17 to 5.21)	0.95 (0.45 to 1.97)	2.96 (1.33 to 6.55)	1.74 (1.15 to 2.63)	1.45 (0.63 to 3.34)	1.87 (1.04 to 3.35)	2.00 (0.85 to 4.66)
	0.018	0.879	0.008	0.009	0.390	0.035	0.111
Teenage pregnancy	2.00 (1.12 to 3.59)	1.70 (1.07 to 2.70)	2.15 (1.28 to 3.60)	2.70 (2.08 to 3.51)	1.46 (0.86 to 2.46)	1.31 (0.79 to 2.18)	2.13 (1.19 to 3.83)
	0.020	0.026	0.004	<0.001	0.160	0.296	0.012
Low MWB	0.97 (0.64 to 1.45)	1.59 (1.23 to 2.05)	1.74 (1.22 to 2.50)	0.95 (0.77 to 1.16)	1.41 (1.03 to 1.93)	2.02 (1.58 to 2.59)	1.10 (0.73 to 1.67)
	0.875	<0.001	0.002	0.586	0.031	<0.001	0.655
Violence perpetration	2.75 (1.44 to 5.23)	2.42 (1.53 to 3.84)	2.12 (0.91 to 4.94)	0.96 (0.65 to 1.42)	0.79 (0.32 to 1.96)	1.31 (0.70 to 2.45)	3.69 (2.10 to 6.50)
	0.002	<0.001	0.083	0.836	0.616	0.402	<0.001
Violence victimisation	1.37 (0.66 to 2.83)	1.94 (1.26 to 2.97)	1.72 (0.78 to 3.75)	1.23 (0.90 to 1.68)	1.68 (0.96 to 2.94)	1.26 (0.74 to 2.17)	2.21 (1.22 to 3.98)
	0.404	0.002	0.177	0.189	0.071	0.398	0.009
Incarceration	2.07 (1.23 to 3.49)	1.90 (1.23 to 2.94)	1.27 (0.58 to 2.78)	2.24 (1.71 to 2.93)	1.81 (1.12 to 2.93)	1.90 (1.20 to 3.01)	2.37 (1.36 to 4.14)
	0.006	0.004	0.544	<0.001	0.015	0.006	0.002

Questions used to measure each ACE are provided in online supplemental appendix table 2. Details of demographic and other independent variables included in the logistic regression models are given in online supplemental appendix tables 3–9.
*Household member.
ACE, adverse childhood experience; AOR, adjusted OR; MWB, mental well-being; STI, sexually transmitted infection.

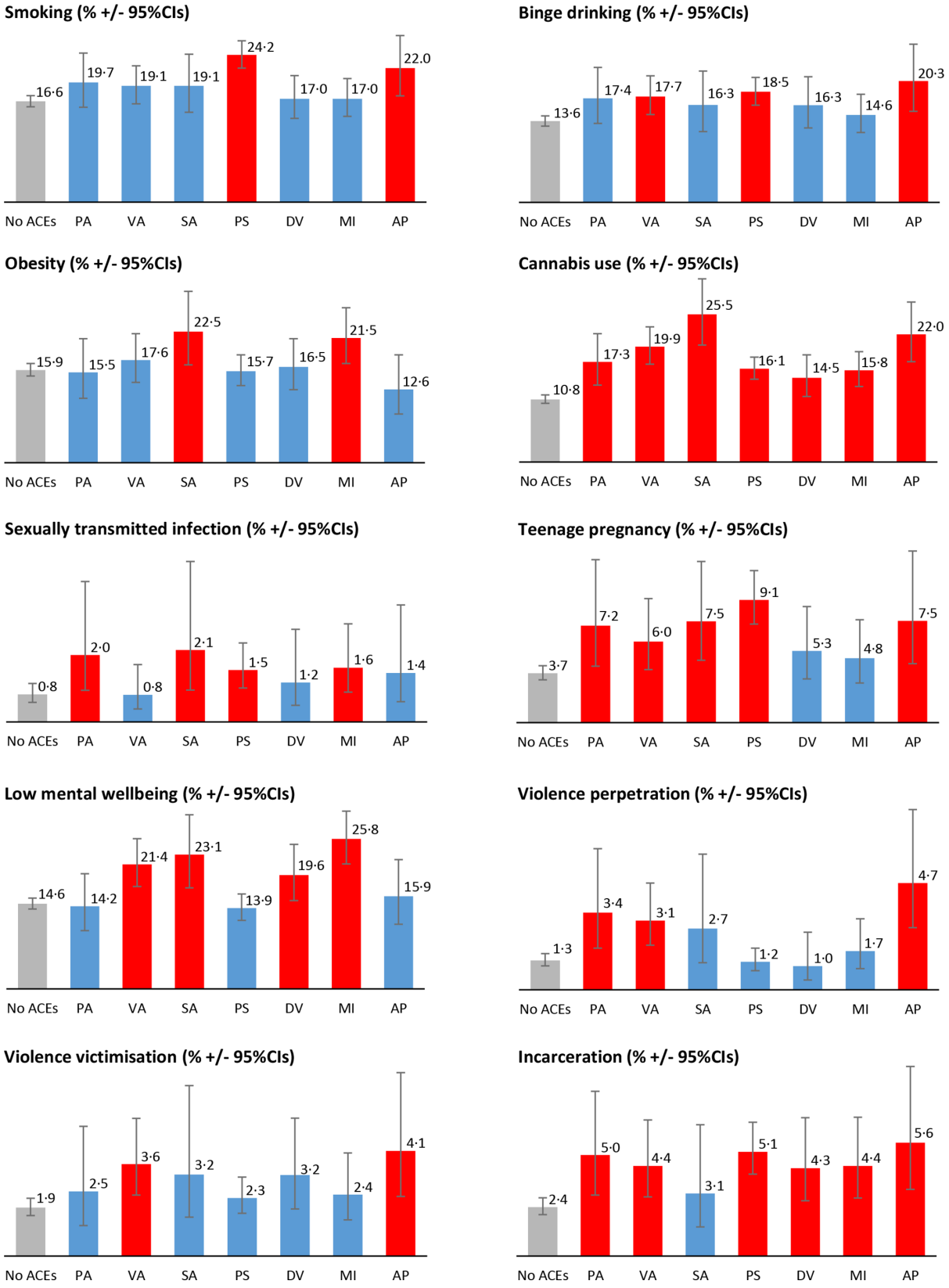

Figure 1 Adjusted mean percentage reporting each outcome by type of ACE experienced. Adjusted mean percentages are calculated using the logistic regression models, see Methods and online supplemental appendix pp3–9. Means for no ACE categories sometimes varied marginally between models for different ACEs. In these cases, a mean was calculated across no ACEs percentages for each ACE type. However, as variations between models were small, all individual no ACE values were no more than ±0.2% from displayed means. Difference not significantly different from No ACEs category P<0.05 vs no ACEs category. ACEs, adverse childhood experiences; AP, alcohol problem; DV, domestic violence; MI, mental illness; PA, physical abuse; PS, parental separation; SA, sexual abuse; VA, verbal abuse.

ACE type (eg, VA or PS) is significantly associated with multiple poorer health and behavioural outcomes and that such associations vary according to ACE type.

PA alone in childhood was associated with at least a doubling in likelihood of having had an STI, teenage pregnancy or incarceration (table 3). PA was also associated with increased risk of cannabis use. However, the largest increase in risk associated with PA in childhood was seen in violence perpetration (table 3). Exposure to other individual ACEs also showed stronger links with similar issue types in adulthood. Thus, consistent with studies elsewhere,[30 31] growing up with someone with MI was strongly related to low MWB in adulthood (table 3). Further, household AP was more strongly related to binge drinking than any other ACE, leading to an estimated increase in the prevalence from 13.6% (no ACEs) to 20.3% (AP; figure 1). There are strong and well-established links between alcohol and violence[32] and having a household alcohol ACE here was also strongly related to being involved in violence and incarcerated as an adult (table 3, figure 1).

A number of studies link verbal and emotional abuse in childhood to poor outcomes, in particular relating to mental health, and also outline social and physiological pathways through which these effects may occur.[30] Despite this, VA has received relatively little attention in comparison to other ACEs (eg, PA).[33] Results here support substantive impacts on life course health and behaviour associated with VA even in the absence of other ACEs. Thus, VA was associated with low MWB levels comparable with those reporting SA in childhood or growing up with someone with MI (figure 1). VA was also associated with higher levels of binge drinking, cannabis use, violence and incarceration; all of which can be linked with poorer mental health. Without evidence specifically on the impact of VA, parents, health and education services may underestimate the toxic impacts on children from just abusive words that arise from parents or carers. Consequently, a greater focus is required on how VA impacts child development and what interventions offer prevention and protection.

PS can be accompanied by other ACEs such as DV, substance use and family mental health issues[23] and, despite a series of studies showing detrimental impacts of PS on children,[34 35] its independent potential to result in life course harms has been discounted.[36] Critically, results here show, even in the absence of such other ACEs, substantive associations between experiencing PS as a child and poorer health and behaviour outcomes later in the life course. PS was the ACE most strongly linked with smoking, associated with an increase in prevalence from 16.6% (no ACEs) to 24.2% (figure 1); a result consistent with findings elsewhere.[31] Those who had experienced PS also showed greater substance use (binge drinking, cannabis use) and sexual risk taking (STIs, teenage pregnancies). Findings, here, relate specifically to children who were not also exposed to VA or PA, DV or household MI or substance use in childhood. Consequently, associations are likely to be related more directly with PS. However, we could not identify how much toxic stress may have arisen from non-violent but acrimonious relationships between parents prior to and after divorce or how much may be associated specifically with the act of parents separating and living apart.

The relationship between being sexually abused as a child and developing obesity across the life course was a formative observation in the development of the first ACE studies.[37] Consistent with this, results here showed a significant relationship between childhood SA and adult obesity (table 3, figure 1), with household MI being the only other ACE individually associated with obesity. SA was also associated with both sexual health measures (STIs, teenage pregnancy) as well as cannabis use and low MWB.

DV is a well-documented source of toxic stress to children within the household.[38] However, it is frequently reported with other ACEs such as PA and VA and both substance use and MI in the household.[23] Here, examining individuals only exposed to DV, results still identify associations with low MWB with estimated prevalence rising from 14.6% (no ACEs) to 19.6% (with DV; figure 1). DV was also associated with cannabis use and incarceration. While exposure to violence as a child has been associated with increased risks of violence perpetration in adulthood, results here suggest that direct childhood victimisation through physical or even VA is more strongly associated with later violence perpetration than DV (figure 1).

Limitations

All studies included in these analyses relied on adults retrospectively recalling and reporting ACEs. Recollection could be incomplete or inaccurate and participants may have chosen not to disclose some ACEs they experienced. While survey compliance levels were consistent with other ACE studies, overall compliance was 49.3% (face-to-face and telephone surveys) and we cannot rule out any self-selective bias introduced through non-compliance. Although we have excluded any individual reporting exposure to more than one ACE (including household drug use and incarceration), we cannot determine whether participants suffered other childhood adversities that were not captured in the standard ACE surveys.[39] Our results did not measure the severity of ACEs (eg, child maltreatment), the length of exposure to each ACE and frequency of occurrence or childhood age ranges over which they were experienced. Factors such as the magnitude of exposure, frequency and chronicity are important considerations for further studies. Moreover, our analyses focused specifically on individuals who had only suffered one ACE. This provides some insight into the potential impacts from each type of ACE in isolation. However, such ACEs frequently co-occur with other ACE types, and we cannot identify whether the same individual ACEs are associated with different impacts when they are experienced in individuals suffering multiple different

types of ACE. However, other studies are beginning to examine synergies between different pairs of ACEs.[16]

CONCLUSION

Even exposure to a single ACE type may result in substantive increases in risks relating to substance use, sexual health, violence and MWB. Such single ACEs include not only those that have already received individual attention in multiple studies globally (eg, PA and SA) but also others that do not necessarily receive the same public and political attention (eg, VA). Findings here suggest a focus on only those suffering multiple ACEs or those individual ACEs often regarded as most abhorrent will only help reduce part of the life-long health and social burden those exposed to ACEs often bear. This study examined British populations, but studies elsewhere identify comparable levels of ACEs experienced, and relationships with health-harming outcomes across multiple nations. Consequently, exposure to, and impacts from, single ACEs should be of international public health concern. The United Nations Convention on the Rights of the Child guarantees the right for all children to be free from violence including physical, verbal and sexual violence, neglect and exploitation. Moreover, the different types of ACEs and many of the harms emanating from them are preventable. Over recent decades, policies and programmes to prevent ACEs and mitigate their impact have been developed, tested and now contribute to a growing global evidence base.[40] The benefits to those potentially affected by ACEs, to the communities around them and from the economic savings that arise from such early prevention and intervention are immense.[17] The aspirational rhetoric around human rights and sustainable development goals that describe ending child adversity need to be made material through much greater national and international investment in policies and programmes that ensure safe and nurturing childhoods for all.

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Patient consent for publication Not applicable.

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REFERENCES

1 Struck S, Stewart-Tufescu A, Asmundson AJN, *et al*. Adverse childhood experiences (ACES) research: a bibliometric analysis of publication trends over the first 20 years. *Child Abuse Negl* 2021;112:104895.
2 Felitti VJ, Anda RF, Nordenberg D, *et al*. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The adverse childhood experiences (ACE) study. *Am J Prev Med* 1998;14:245–58.
3 Wood SK, Ford K, Madden HCE, *et al*. Adverse childhood experiences and their relationship with poor sexual health outcomes: results from four cross-sectional surveys. *Int J Environ Res Public Health* 2022;19:8869.
4 Merrick MT, Ford DC, Ports KA, *et al*. Vital signs: estimated proportion of adult health problems attributable to adverse childhood experiences and implications for prevention-25 states, 2015-2017. *MMWR Morb Mortal Wkly Rep* 2019;68:999–1005.
5 Hughes K, Ford K, Kadel R, *et al*. Health and financial burden of adverse childhood experiences in England and Wales: a combined primary data study of five surveys. *BMJ Open* 2020;10:e036374.
6 Sanderson M, Mouton CP, Cook M, *et al*. Adverse childhood experiences and chronic disease risk in the southern community cohort study. *J Health Care Poor Underserved* 2021;32:1384–402.
7 Bellis MA, Hughes K, Ford K, *et al*. Does adult alcohol consumption combine with adverse childhood experiences to increase involvement in violence in men and women? A cross-sectional study in England and Wales. *BMJ Open* 2018;8:e020591.
8 Testa A, Jackson DB, Ganson KT, *et al*. Adverse childhood experiences and criminal justice contact in adulthood. *Acad Pediatr* 2022;22:972–80.
9 Graf GH-J, Chihuri S, Blow M, *et al*. Adverse childhood experiences and justice system contact: a systematic review. *Pediatrics* 2021;147:e2020021030.
10 Satinsky EN, Kakuhikire B, Baguma C, *et al*. Adverse childhood experiences, adult depression, and suicidal ideation in rural Uganda: a cross-sectional, population-based study. *PLoS Med* 2021;18:e1003642.
11 Thai TT, Cao PLT, Kim LX, *et al*. The effect of adverse childhood experiences on depression, psychological distress and suicidal thought in Vietnamese adolescents: findings from multiple cross-sectional studies. *Asian J Psychiatr* 2020;53:102134.
12 Flores-Torres MH, Comerford E, Signorello L, *et al*. Impact of adverse childhood experiences on cardiovascular disease risk factors in adulthood among Mexican women. *Child Abuse Negl* 2020;99:104175.

13 Anda RF, Butchart A, Felitti VJ, *et al*. Building a framework for global surveillance of the public health implications of adverse childhood experiences. *Am J Prev Med* 2010;39:93–8.
14 Pachter LM, Lieberman L, Bloom SL, *et al*. Developing a community-wide initiative to address childhood adversity and toxic stress: a case study of the Philadelphia ACE task force. *Acad Pediatr* 2017;17:S130–5.
15 Welsh Government. *Review of adverse childhood experiences (ACE) policy: report*. Cardiff: Welsh Government, 2021.
16 Briggs EC, Amaya-Jackson L, Putnam KT, *et al*. All adverse childhood experiences are not equal: the contribution of synergy to adverse childhood experience scores. *Am Psychol* 2021;76:243–52.
17 Bellis MA, Hughes K, Ford K, *et al*. Life course health consequences and associated annual costs of adverse childhood experiences across Europe and North America: a systematic review and meta-analysis. *Lancet Public Health* 2019;4:e517–28.
18 Hailes HP, Yu R, Danese A, *et al*. Long-term outcomes of childhood sexual abuse: an umbrella review. *Lancet Psychiatry* 2019;6:830–9.
19 UK Government. English indices of deprivation. Available: http://www.gov.uk/government/collections/english-indices-of-deprivation [Accessed 15 Feb 2023].
20 StatsWales. Welsh index of multiple deprivation. Available: http://statswales.gov.wales/Catalogue/Community-Safety-and-Social-Inclusion/Welsh-Index-of-Multiple-Deprivation [Accessed 15 Feb 2023].
21 Centers for Disease Control and Prevention. Behavioral risk factor surveillance system ACE data. Available: https://www.cdc.gov/violenceprevention/aces/ace-brfss.html [Accessed 15 Feb 2023].
22 Stewart-Brown S, Tennant A, Tennant R, *et al*. Internal construct validity of the Warwick-Edinburgh Mental Well-Being Scale (WEMWBS): a Rasch analysis using data from the Scottish Health Education Population Survey. *Health Qual Life Outcomes* 2009;7:15.
23 Hughes K, Bellis MA, Sethi D, *et al*. Adverse childhood experiences, childhood relationships and associated substance use and mental health in young Europeans. *Eur J Public Health* 2019;29:741–7.
24 Hughes K, Bellis MA, Hardcastle KA, *et al*. The effect of multiple adverse childhood experiences on health: a systematic review and meta-analysis. *Lancet Public Health* 2017;2:e356–66.
25 Crouch E, Radcliff E, Strompolis M, *et al*. Adverse childhood experiences (ACEs) and alcohol abuse among South Carolina adults. *Subst Use Misuse* 2018;53:1212–20.
26 Wiens K, Gillis J, Nicolau I, *et al*. Capturing risk associated with childhood adversity: independent, cumulative, and multiplicative effects of physical abuse, sexual abuse, and family violence on mental disorders and suicidality. *Perm J* 2020;24:19.079.
27 Turner S, Taillieu T, Cheung K, *et al*. The relationship between childhood sexual abuse and mental health outcomes among males: results from a nationally representative United States sample. *Child Abuse Negl* 2017;66:64–72.
28 Lewis T, McElroy E, Harlaar N, *et al*. Does the impact of child sexual abuse differ from maltreated but non-sexually abused children? A prospective examination of the impact of child sexual abuse on internalizing and externalizing behavior problems. *Child Abuse Negl* 2016;51:31–40.
29 Terry RM, Schiffmacher SE, Dutcher AA, *et al*. Adverse childhood experience categories and subjective cognitive decline in adulthood: an analysis of the behavioral risk factor surveillance system. *J Osteopath Med* 2023;123:125–33.
30 Merrick MT, Ports KA, Ford DC, *et al*. Unpacking the impact of adverse childhood experiences on adult mental health. *Child Abuse Negl* 2017;69:10–9.
31 Campbell JA, Walker RJ, Egede LE. Associations between adverse childhood experiences, high-risk behaviors, and morbidity in adulthood. *Am J Prev Med* 2016;50:344–52.
32 Duke AA, Smith KMZ, Oberleitner LMS, *et al*. Alcohol, drugs, and violence: a meta-meta-analysis. *Psychol Violence* 2018;8:238–49.
33 Norman RE, Byambaa M, De R, *et al*. The long-term health consequences of child physical abuse, emotional abuse, and neglect: a systematic review and meta-analysis. *PLoS Med* 2012;9:e1001349.
34 Sands A, Thompson EJ, Gaysina D. Long-term influences of parental divorce on offspring affective disorders: a systematic review and meta-analysis. *J Affect Disord* 2017;218:105–14.
35 Auersperg F, Vlasak T, Ponocny I, *et al*. Long-term effects of parental divorce on mental health-a meta-analysis. *J Psychiatr Res* 2019;119:107–15.
36 Finkelhor D, Shattuck A, Turner H, *et al*. Improving the adverse childhood experiences study scale. *JAMA Pediatr* 2013;167:70–5.
37 Felitti VJ. Origins of the ACE study. *Am J Prev Med* 2019;56:787–9.
38 Carlson J, Voith L, Brown JC, *et al*. Viewing children's exposure to intimate partner violence through a developmental, social-ecological, and survivor lens: the current state of the field, challenges, and future directions. *Violence Against Women* 2019;25:6–28.
39 Afifi TO, Salmon S, Garcés I, *et al*. Confirmatory factor analysis of adverse childhood experiences (ACES) among a community-based sample of parents and adolescents. *BMC Pediatr* 2020;20:178.
40 Bellis MA, Wood S, Hughes K, *et al*. *Tackling adverse childhood experiences (ACES): state of the art and options for action*. Cardiff: Public Health Wales, 2023.