Journal of Public Health | Vol. 36, No. 1, pp. 81–91 | doi:10.1093/pubmed/fdt038 | Advance Access Publication 14 April 2013

Adverse childhood experiences: retrospective study to determine their impact on adult health behaviours and health outcomes in a UK population

Mark A. Bellis[1], Helen Lowey[1], Nicola Leckenby[1], Karen Hughes[1], Dominic Harrison[2]

[1]Centre for Public Health, Liverpool John Moores University, 15-21 Webster Street, Liverpool L3 2ET, UK
[2]National Health Service, Guide Business Centre, School Lane, Blackburn, Lancashire BB1 2QH, UK
Address correspondence to Mark A. Bellis, E-mail: m.a.bellis@ljmu.ac.uk

ABSTRACT

Background Studies suggest strong links between adverse childhood experiences (ACEs) and poor adult health and social outcomes. However, the use of such studies in non-US populations is relatively scarce.

Methods Retrospective cross-sectional survey of 1500 residents and 67 substance users aged 18–70 years in a relatively deprived and ethnically diverse UK population.

Results Increasing ACEs were strongly related to adverse behavioural, health and social outcomes. Compared with those with 0 ACEs, individuals with 4+ ACEs had adjusted odds ratios of the following: 3.96 [95% confidence interval (CI): 2.74–5.73] for smoking; 3.72 (95% CI: 2.37–5.85) for heavy drinking; 8.83 (95% CI: 4.42–17.62) for incarceration and 3.02 (95% CI: 1.38–6.62) for morbid obesity. They also had greater risk of poor educational and employment outcomes; low mental wellbeing and life satisfaction; recent violence involvement; recent inpatient hospital care and chronic health conditions. Higher ACEs were also associated with having caused/been unintentionally pregnant aged <18 years and having been born to a mother aged <20 years.

Conclusions ACEs contribute to poor life-course health and social outcomes in a UK population. That ACEs are linked to involvement in violence, early unplanned pregnancy, incarceration, and unemployment suggests a cyclic effect where those with higher ACE counts have higher risks of exposing their own children to ACEs.

Keywords childhood experiences, violence, substance use, wellbeing, chronic disease

Introduction

Studies are increasingly exposing relationships between childhood trauma and the emergence of health damaging behaviours and poor health and social outcomes in adulthood.[1–3] The first large-scale adverse childhood experiences (ACE) study in the USA began to quantify the impacts of ACEs on health and behaviour throughout the life course.[4] This and subsequent studies have identified a set of ACEs including: growing up in a household with someone who is depressed, mentally ill, a substance abuser or has been incarcerated in the criminal justice system; exposure to child maltreatment or domestic violence and losing a parent through divorce, separation or death.[4,5] Exposure to such ACEs has been associated with poor health outcomes including substance use, mental ill-health, obesity, heart disease and cancer, as well as unemployment and continued involvement in violence.[4,6,7] Importantly, the impact of ACEs appears to be cumulative, with risks of poor outcomes increasing with the number of ACEs suffered.[4,8,9]

The relationships between ACEs and pressures on health and social systems [e.g. from non-communicable diseases

Mark A. Bellis, Professor of Public Health
Helen Lowey, Consultant in Public Health
Nicola Leckenby, Research Assistant
Karen Hughes, Reader in Behavioural Epidemiology
Dominic Harrison, Director of Public Health

(NCDs)] should be a critical element in informing health policy and strategic investment.[10,11] That ACEs appear linked to important outcomes for other public services (e.g. criminal justice, education) means an understanding of ACEs should inform work across government departments. However, such intelligence is rare outside the USA, even in high-income countries.[11] Thus, global public health efforts are focusing on developing and implementing standardized methodologies for measuring the impact of ACEs across populations.[11] As Europe increasingly embraces a social determinants approach to health,[12] understanding relationships between deprivation, ACEs and adult outcomes becomes paramount.[13–16]

We present findings from a general population ACE study in a relatively deprived and culturally diverse part of the UK. The study was designed to examine associations between ACEs and poor health and social outcomes over the life course. Controlling for demographics and deprivation, we explore the strength of ACEs as predictors of poor behaviour, health, criminal justice and educational outcomes, and discuss the implications for health policy.

Methods

In collaboration with the National Health Service, a diverse geography covering a range of income levels and ethnic groups was identified. Its population is ~150 000, relatively young (26% of residents aged 0–17 years compared with England 21%),[17] with higher than national residential ethnic minority levels (White British 74.6%, Indian 9.2%, Pakistani 8.9%, other ethnicities 7.3%)[18] and high levels of material deprivation and child poverty.[18,19]

Questionnaire

The questionnaire used tested ACE categories and other survey tools. ACE questions were based on the Centers for Disease Control and Prevention short ACE tool[11] (Table 1). Outcomes potentially associated with ACEs were identified from US studies (substance use, sexual behaviour, exercise, disease diagnoses, health service use, employment, obesity and violence involvement)[4,7,20,21] with additional variables relating to UK health policy (diet, mental wellbeing, life satisfaction, educational attainment, incarceration; Table 2). Alcohol consumption was measured using AUDIT-C questions,[22] including information on what constitutes a standard drink (UK = 10 ml pure alcohol).[23] Heavy drinking was defined as consuming ≥6 standard drinks/occasion at least once a week. Mental wellbeing was measured using the Short Warwick-Edinburgh Mental Wellbeing Scale (SWEMWBS).[24,25] Low mental wellbeing was categorized as SWEMWBS score <23 based on a larger mental wellbeing survey undertaken in the same region.[25] This survey was also used to set the threshold for low life satisfaction as ≤5 on a 10-point Likert scale. Body mass index (BMI) was calculated based on participants' self-reported height and weight. Individuals were considered obese if their BMI was ≥30 and morbidly obese at ≥40.[26] To minimize self-diagnosis of health conditions, respondents were asked if (and when) they had ever been diagnosed by a doctor or nurse with each condition. Ethnicity was self-defined based on standard UK Census categories. The questionnaire was developed for delivery by trained researchers through face-to-face interviews or self-completion under researcher supervision.

A pilot of 152 residents in the study area resulted in the questionnaire being shortened through changes to wording and removal of superfluous questions. The final tool contained 42 questions and took 10 min to complete. The questionnaire was available in English, Urdu, Gujarati, Hindi and Polish.

Sample

The inclusion criteria were resident in the study area; aged 18–70 years and cognitively able to participate in a face-to-face interview. ACEs in the pilot ranged in prevalence from 2.6% for forced sex to 21.9% for being sworn at, insulted, and put down. Based on the pilot a sample of 1500 was identified for the survey and a random sampling methodology stratified by deprivation quintile was used to ensure an approximate match to the local population. Deprivation was based on index of multiple deprivation (IMD) 2010; a composite measure including 38 economic and social indicators.[27] The Postcode Address File®[28] was used to identify houses in each national deprivation quintile and, to allow for non-compliance as indicated in the pilot, 3000 households were selected.

Letters were sent to sampled households prior to researchers visiting, providing study information and the opportunity to withdraw (via post, email or telephone); 120 (4.0%) households opted out at this stage. Households were given a second opportunity to opt out when researchers arrived. Those that did were replaced by a neighbouring household. At least three attempted visits were made to each sampled household. A total of 2162 sampled houses were occupied when visited; of these 511 (23.6%) opted out and 151 (7.0%) were ineligible. Sampling was completed once the 1500 target was reached. Compliance was 74.6% across eligible occupied households excluding the 120 opting out at the letter stage; 70.4% including them. Under the research team's instruction, a professional survey company delivered the questionnaire

Table 1 Percentage of each adverse childhood experience (ACE) in total sample and in individuals with different ACE counts

ACE definitions: *while you were growing up, before the age of 18 years*	n	*All*	*ACE count* *1 (n = 287)*	*2–3 (n = 234)*	*4+ (n = 185)*	*Odds ratio 4+ to 1*	χ^2_{trend} [a]	P
Did you live with anyone who								
Was depressed, mentally ill or suicidal?	1497	11.10	11.50	23.10	43.40	5.90	61.207	<0.001
Was a problem drinker or alcoholic?	1494	9.40	4.90	17.90	47.50	17.63	118.861	<0.001
Used illegal street drugs or who abused prescription medications?	1495	3.90	0.70	6.40	22.80	42.03	66.856	<0.001
Was sentenced to serve time in a prison or young offenders institution?	1492	4.00	0.30	6.40	24.90	94.62	78.292	<0.001
Were your parents ever separated or divorced?	1492	23.70	48.40	43.20	65.50	2.03	9.803	0.002
Did your parents or adults in your home ever								
Slap, hit, kick, punch or beat each other up?	1487	14.10	13.20	28.20	62.80	11.06	118.265	<0.001
Hit, beat, kick or physically hurt you in any way?[b]	1491	15.20	5.60	42.70	63.60	29.64	178.338	<0.001
Swear at you, insult you or put you down?	1486	20.10	14.60	54.30	77.20	19.74	182.769	<0.001
Did anyone at least 5 years older than you (including adults)								
Ever touch you sexually?	1485	4.30	0.30	5.10	30.60	126.03	103.047	<0.001
Try to make you touch them sexually?	1485	3.40	0.30	3.00	25.30	96.84	85.667	<0.001
Force you to have sex?	1485	2.10	0.00	1.70	15.90	NC	55.435	<0.001

NC, not calculable.

[a] χ^2 for a trend measures increasing representation of each ACE in categories of higher ACE count.

[b] This excluded gentle smacking for punishment.

(August to October 2012). After explaining the voluntary and anonymous nature of the survey and its rationale, respondents could choose to complete the questionnaire through a face-to-face interview or self-complete.

As problematic substance users were likely to be underrepresented in door-to-door surveys, a specialist sample ($n = 67$) was surveyed at three substance use services in the same locality. This sample was self-selected; staff informed eligible clients of the study during routine appointments and invited them to attend survey sessions held by researchers at the services. Clients attending appointments on survey days were also invited to participate. This sample has been treated separately for analysis but is included to provide information on a group with potentially multiple ACEs likely to be missed in household surveys.[29]

Ethical approval for the household study was granted by Liverpool John Moores University Research Ethics Committee and for the substance user sample by the NHS Research Ethics Committee.

Analysis

Analyses used PASW Statistics v18. Having any ACE was highly correlated with having any other ACE (all $P < 0.001$). Therefore, in line with other studies,[4,20] an ACE count was used to classify respondents into, here, four ACE categories (0 ACEs, $n = 794$; 1 ACE, $n = 287$; 2–3 ACEs, $n = 234$; 4+ ACES, $n = 185$). Dependent variables of interest were dichotomized for the purpose of calculating adjusted odds ratios (AORs) for health and behavioural outcomes. Individuals were allocated an IMD based on the lower super output area (a nationally defined set of small geographies) containing their residential postcode and then categorized into national deprivation quintiles.[30] Bivariate analyses used χ^2. Multinomial logistic regression (LR) was used to examine independent associations between ACE counts and demographic variables (age, sex, ethnicity, deprivation; Table 3). Binary LR was used to control for such associations when calculating independent relationships between outcome measures and ACE count. In each binary LR model (Tables 4 and 5) AORs [$\pm$95% confidence intervals (CIs)] represent changes in odds of each outcome with changing ACE count after correcting for demographics.[31] Where individuals did not answer all questions adjusted sample sizes are presented.

Results

Across the population sample, 47.1% of individuals reported at least one ACE, with ACE count categories 1,

Table 2 Relationships between number of ACEs and behavioural, social and health outcomes

Outcome	*All*		*ACE count*				χ^2_{trend}	P
			0	*1*	*2–3*	*4+*		
	%	n	%	%	%	%		
Sexual behaviour								
Had/caused unintentional pregnancy <18 years	9.0	1487	5.0	8.7	11.2	24.3	60.398	<0.001
Had sex <16 years	20.5	1388	13.4	22.6	27.7	37.9	61.056	<0.001
Mental health and wellbeing[a]								
Low mental wellbeing score	18.8	1500	14.2	16.0	25.2	34.6	45.190	<0.001
Low life satisfaction	12.8	1338	8.5	9.0	17.9	29.9	54.828	<0.001
Substance use								
Current daily smoker	31.1	1494	20.5	32.2	43.2	59.5	125.663	<0.001
Drink ≥6 drinks[b] per occasion ≥1/week	12.5	1487	7.5	11.3	16.9	30.3	69.937	<0.001
Ever used cannabis	17.6	1492	9.2	15.7	28.8	42.3	132.317	<0.001
Ever used heroin or crack cocaine	2.9	1482	1.1	1.8	2.2	13.4	51.404	<0.001
Violence and criminal justice								
Been hit by someone in last 12 months	6.0	1494	3.4	3.5	8.1	18.8	52.787	<0.001
Hit someone in last 12 months	5.7	1495	2.6	3.8	8.5	18.2	62.730	<0.001
Ever spent ≥1 night in police station/prison	5.2	1491	1.9	1.7	11.1	17.2	82.049	<0.001
Diet, weight and exercise								
≤1 portion of fruit or vegetables a day	15.3	1500	12.0	15.7	18.8	24.3	20.487	<0.001
Obese (BMI ≥30)	17.9	1497	16.3	17.4	21.5	21.1	4.210	0.040
Morbidly obese (BMI ≥40)	2.7	1500	2.1	2.4	2.1	5.9	5.012	0.025
≤2 30 min sessions of exercise/week	44.8	1500	47.1	41.8	45.3	38.9	3.503	0.061
Education and employment								
No qualifications (vocational, school, other)	31.5	1500	29.8	31.4	35.0	34.1	2.519	0.113
Currently unemployed/on long-term sickness	22.4	1474	16.5	20.2	31.6	39.5	55.684	<0.001
Health								
Ever broken a bone in your own body	42.3	1500	35.3	41.1	54.7	58.9	50.333	<0.001
Spent ≥1 night in hospital in last 12 months	12.0	1494	11.0	9.1	16.7	15.3	5.357	0.021
Spent ≥6 nights in hospital ever	30.7	1496	26.6	31.7	37.2	38.8	16.068	<0.001
Ever diagnosed with								
STI	2.1	1486	0.3	2.4	3.0	8.3	43.397	<0.001
Cancer	3.6	1487	2.9	5.3	4.3	2.8	0.269	0.604
Type II diabetes	7.4	1491	8.9	5.6	6.0	5.5	4.041	0.044
Cardiovascular conditions[c]	4.4	1496	4.3	3.8	6.0	3.8	0.090	0.765
Respiratory disease	5.4	1489	4.6	4.9	6.0	9.4	5.814	0.016
Digestive/liver disease	3.3	1496	2.3	2.1	7.3	4.4	8.301	0.004

STI, sexually transmitted infection; BMI, body mass index.

[a]Low mental wellbeing was categorized as a score of <23 on the Short Warwick-Edinburgh Mental Wellbeing Scale (SWEMWBS) and low life satisfaction as ≤5 on a Likert 10-point scale (see the section Methods).

[b]A drink is a standard UK unit of alcohol equivalent to 10 ml pure alcohol.

[c]Including coronary heart disease, myocardial infarction and stroke.

2–3 and 4+ representing 19.1, 15.6 and 12.3%, respectively. Being forced to have sex by an older individual had the lowest prevalence (Table 1). ACEs involving sexual abuse, living with someone incarcerated or abusing drugs were most strongly associated with higher numbers of ACEs. Compared with those with no ACEs, individuals with >1 ACE were more likely to be aged <60 years. White British respondents were more likely to report ACEs than individuals of Indian or Pakistani ethnicity. There were no significant relationships between deprivation quintile and having

Table 3 Multinomial LR analysis of relationship between number of ACEs, deprivation and other demographics

	Total sample		*ACE count (reference category: 0 ACEs)*								
	n	%	*1*			*2–3*			*4+*		
			AOR	*95% CI*	P	*AOR*	*95% CI*	P	*AOR*	*95% CI*	P
Age (years)											
<30 (ref)	357	23.9									
30–39	319	21.3	1.28	(0.86–1.91)	0.224	1.11	(0.71–1.75)	0.639	1.08	(0.67–1.75)	0.748
40–49	327	21.9	0.56	(0.37–0.86)	0.008	0.70	(0.44–1.09)	0.112	0.74	(0.46–1.18)	0.199
50–59	223	14.9	0.77	(0.49–1.22)	0.264	0.87	(0.53–1.41)	0.560	0.64	(0.37–1.11)	0.115
60+	270	18.0	0.56	(0.36–0.86)	0.009	0.56	(0.35–0.90)	0.017	0.31	(0.17–0.55)	<0.001
Ethnicity											
White British (ref)	1038	69.2									
Pakistani	204	13.6	0.44	(0.28–0.68)	<0.001	0.37	(0.23–0.60)	<0.001	0.17	(0.09–0.33)	<0.001
Indian	166	11.1	0.40	(0.24–0.65)	<0.001	0.39	(0.23–0.66)	<0.001	0.16	(0.07–0.34)	<0.001
Other	92	6.1	0.73	(0.41–1.32)	0.301	0.59	(0.30–1.16)	0.127	0.74	(0.39–1.41)	0.361
Deprivation quintile											
(Least deprived) 1 (ref)	82	5.5									
2	153	10.2	0.69	(0.33–1.43)	0.316	1.08	(0.47–2.47)	0.859	2.30	(0.80–6.62)	0.122
3	122	8.1	0.66	(1.18–0.57)	0.657	2.41	(0.32–2.07)	0.672	1.52	(0.46–4.98)	0.494
4	216	14.4	0.98	(0.50–1.92)	0.942	1.67	(0.77–3.63)	0.195	3.08	(1.10–8.64)	0.032
(Most deprived) 5	927	61.8	1.20	(0.67–2.17)	0.537	1.81	(0.90–3.63)	0.097	3.58	(1.38–9.29)	0.009
Gender											
Female (ref)	882	60.2									
Male	584	39.8	1.08	(0.81–1.44)	0.621	1.85	(1.36–2.51)	<0.001	1.15	(0.81–1.62)	0.436

AOR, adjusted odds ratio; 95% CI, 95% confidence intervals; ref, reference category.

1 or 2–3 ACEs, yet having 4+ ACEs was strongly associated with higher deprivation (quintiles 4 and 5; Table 3).

For sexual behaviour, ACEs increased with prevalence of having (females)/causing (males) unintentional pregnancy age <18 years and having had sex <16 years (Table 2). Multivariate analysis, accounting for confounding effects, confirmed increases in both unintentional pregnancy and early sex in those with >1 ACE (reference group 0 ACEs; Table 4). Relationships between sex <16 years and having >1 ACE remained significant even when individuals whose ACEs included being forced to have sex were removed from analysis (2–3 ACEs, $P < 0.05$; 4+ ACEs, $P < 0.001$; reference group 0 ACEs).

For wellbeing, the prevalence of low life satisfaction increased from 8.5% in those with no ACEs to 29.9% in those with 4+ ACEs, with 34.6% of this ACE category also having low mental wellbeing (Table 2). Accounting for demographics, having one ACE (cv no ACEs) did not impact on life satisfaction or mental wellbeing but subsequent increases in ACEs were associated with reductions in both (Table 4).

All substance use measures increased in prevalence with increasing ACEs. The prevalence of heavy drinking increased 2-fold from 0 to 4+ ACEs (Table 2). Demographically adjusted comparisons identified no impact of one ACE on substance use, but increases in risk of heavy drinking, daily smoking and having ever used cannabis in those with >1 ACE. Odds of having used heroin or crack cocaine did not differ significantly from those with no ACEs until 4+ ACEs (Table 4).

Increasing ACEs were associated with higher prevalence of both having been hit and hitting someone else in the last 12 months (Table 2). Accounting for demographics, odds of having been hit were only significantly elevated in those with 4+ ACEs, while odds of having hit someone else were increased in those with >1 ACE (Table 4). Having spent ≥1 night in prison or a police station in the last 12 months did not increase with one ACE but were over four and eight times higher in those with 2–3 and 4+ ACEs, respectively (Table 4).

ACE counts were not associated with exercise frequency (Tables 2 and 4). However, low fruit and vegetable intake

Table 4 AORs of behavioural and social outcomes with number of ACEs suffered

Outcome measure	n	P[a]	*ACE count (reference category: 0 ACEs)*						*Demographic factors*[c]			
			1		*2–3*		*4+*					
			AOR (95% CI)	P[b]	*AOR (95% CI)*	P[b]	*AOR (95% CI)*	P[b]	*Ethnicity*	*Age*	*Gender*	*IMD*
Sexual behaviour												
Had/caused unintentional pregnancy <18 years	1452	***	1.52 (0.88–2.62)	ns	2.19 (1.27–3.78)	**	4.46 (2.73– 7.30)	***	W***	ns	F***	D*
Had sex <16 years	1355	***	1.41 (0.96–2.09)	ns	1.76 (1.17–2.63)	**	2.49 (1.65–3.77)	***	W***	Y***	M**	D*
Mental wellbeing and life satisfaction[d]												
Low mental wellbeing score	1464	***	1.20 (0.81–1.75)	ns	2.03 (1.41–2.92)	***	3.48 (2.40–5.04)	***	ns	Y***	ns	ns
Low life satisfaction	1305	***	1.04 (0.62–1.75)	ns	2.20 (1.39–3.47)	***	4.65 (2.99–7.25)	***	ns	***	ns	D***
Substance use												
Current daily smoker	1460	***	1.36 (0.98–1.90)	ns	2.08 (1.48–2.93)	***	3.96 (2.74–5.73)	***	W***	Y***	M***	D***
Drink ≥6 drinks[e] per occasion ≥1/week	1451	***	1.22 (0.75–1.98)	ns	1.74 (1.09–2.79)	*	3.72 (2.37–5.85)	***	W*	Y***	M***	ns
Ever used cannabis	1457	***	1.39 (0.90–2.15)	ns	3.00 (1.97–4.57)	***	5.48 (3.58–8.38)	***	W***	Y***	M***	ns
Ever used heroin or crack cocaine	1447	***	1.27 (0.41–3.94)	ns	1.26 (0.41–3.89)	ns	9.69 (4.24–22.10)	***	W*	ns	M***	ns
Violence and criminal justice												
Been hit by someone in last 12 months	1458	***	0.79 (0.37–1.72)	ns	1.70 (0.89–3.25)	ns	5.18 (2.87–9.36)	***	ns	Y***	M***	ns
Hit someone in last 12 months	1459	***	1.39 (0.65–2.98)	ns	2.95 (1.54–5.67)	**	7.92 (4.34–14.45)	***	ns	Y***	M***	ns
Ever spent ≥1 night in police station/prison	1455	***	0.75 (0.26– 2.14)	ns	4.28 (2.14–8.55)	***	8.83 (4.42–17.62)	***	W*	Y*	M***	ns
Diet, weight and exercise												
≤1 portion of fruit or vegetables a day	1464	**	1.35 (0.91–2.00)	ns	1.47 (0.98–2.20)	ns	2.10 (1.40–3.17)	***	ns	**	M*	D***
Obese (BMI ≥30)	1461	ns							ns	O***	ns	D**
Morbidly obese (BMI ≥40)	1464	*	1.04 (0.40–2.68)	ns	0.83 (0.28–2.51)	ns	3.02 (1.38–6.62)	**	ns	ns	ns	ns
≤2 30 min sessions of exercise/week	1464	ns							I**	O***	F**	D**
Education and employment												
No qualifications (vocational, school, other)	1464	*	1.25 (0.91–1.73)	ns	1.49 (1.06–2.10)	*	1.69 (1.16–2.45)	**	*P****	O***	F**	D***
Currently unemployed/on long-term sickness	1438	***	1.20 (0.82–1.74)	ns	2.01 (1.40–2.88)	***	2.94 (2.01–4.31)	***	ns	***	M***	D***

ns, not significant. Letters indicate direction of increasing odds: Y, youngest; O, oldest; W, White British; I, Indian; F, Female; M, Male; D, Deprived. Where there was no clear pattern only significance level is given. BMI, body mass index.

[a]*P* refers to the overall significance of association between the outcome measure and ACE counts. *<0.05, **<0.01 and ***<0.001.

[b]*P* refers to the significance of association between the outcome measure and individual ACE categories with 0 ACEs as the reference category.

[c]Gender, ethnicity and age entered as categorical variables and IMD (index of multiple deprivation) as a continuous variable.

[d]Low mental wellbeing was categorized as a score of <23 on the Short Warwick-Edinburgh Mental Wellbeing Scale, low life satisfaction ≤5 on a Likert 10-point scale (see the section Methods).

[e]A drink is a standard UK unit of alcohol equivalent to 10 ml pure alcohol.

Table 5 AORs of health outcomes with number of ACEs suffered

Outcome measure	n	P[a]	*ACE count (reference category: 0 ACEs)*						*Demographic factors*[c]			
			1		*2–3*		*4+*		*Ethnicity*	*Age*	*Gender*	*IMD*
			AOR (95% CI)	P[b]	*AOR (95% CI)*	P[b]	*AOR (95% CI)*	P[b]				
Ever broken a bone in your own body	1464	***	1.19 (0.88–1.61)	ns	1.85 (1.35–2.54)	***	2.51 (1.76–3.57)	***	W***	O**	M***	ns
Spent ≥1 night in hospital in last 12 months	1458	*	0.73 (0.45–1.19)	ns	1.63 (1.06–2.50)	*	1.52 (0.94–2.44)	ns	ns	***	F*	D**
Spent ≥6 nights in hospital ever	1460	*	1.25 (0.90–1.73)	ns	1.45 (1.03–2.04)	*	1.77 (1.22–2.57)	**	W***	O***	M*	D***
Ever diagnosed with												
STI	1451	***	8.90 (1.83–43.35)	**	11.14 (2.29–54.27)	**	30.58 (6.89–135.80)	***	ns	Y*	ns	ns
Cancer	1453	ns							ns	O***	F**	ns
Type II diabetes	1457	ns							ns	O***	ns	ns
Cardiovascular conditions[d]	1460	ns							ns	O***	ns	D***
Respiratory disease	1453	*	0.93 (0.50–1.85)	ns	1.21 (0.63–2.33)	ns	2.48 (1.32–4.65)	**	ns	O***	ns	D***
Digestive/liver disease	1460	**	0.99 (0.39–2.55)	ns	3.53 (1.77–7.05)	***	2.27 (0.96–5.37)	ns	ns	O***	ns	ns

ns, not significant. Letters indicate direction of increasing odds: Y, youngest; O, oldest; W, White British; F, Female; M, Male; D, Deprived. Where there was no clear pattern only significance level is given. STI, sexually transmitted infection.

[a]*P* refers to the overall significance of association between the outcome measure and ACE counts. *<0.05, **<0.01, ***<0.001.

[b]*P* refers to the significance of association between the outcome measure and individual ACE categories with 0 ACEs as the reference category.

[c]Gender, ethnicity and age entered as categorical variables and IMD (index of multiple deprivation) as a continuous variable.

[d]Including coronary heart disease, myocardial infarction and stroke.

was significantly more likely in those with 4+ ACEs. While obesity (BMI ≥30) was associated with increased ACE count in bivariate analyses (Table 2), this relationship disappeared when demographic confounders were accounted for (Table 4). However, even accounting for demographics, morbid obesity (BMI≥40) remained significantly higher in those with 4+ ACEs (Table 4).

Having no qualifications was not associated with ACE counts (Table 2). However, after correcting for demographics, ACE counts of 2–3 and 4+ were associated with increasing odds of having no qualifications (Table 4). Increasing prevalence of current unemployment/long-term sickness was seen with increasing ACEs (Table 2); such increases were maintained in LR but only in those with >1 ACE (Table 4).

For health outcomes, having ever had a sexually transmitted infection (STI) was strongly associated with increasing ACEs (Tables 2 and 5). Having spent ≥1 night in the last 12 months, or 6+ nights ever, in hospital was both associated with having more ACEs (Table 2). After correcting for confounders, the former showed a significant increase only in the 2–3 ACEs category (Table 5), while the latter was associated with ACE counts >1 (Table 5). Similarly, an independent increase in odds of having ever broken a bone was observed with >1 ACE. Diagnoses of cancer and cardiovascular conditions were not associated with ACE count (Table 2) but increased strongly with age (Table 5). Type II diabetes also showed no independent relationship with ACEs (Table 5). However, in bivariate analyses individuals with >1 ACE had higher levels of respiratory and digestive/liver diseases (Table 2). After correcting for confounders only 4+ ACEs remained significant for respiratory disease and a 2–3 ACE count for digestive/liver disease.

Individuals were asked their mother's age at their birth. While 10.3% of those with no ACEs were born to mothers aged <20 years, this rose with ACE count (1 ACE, 13.2%; 2–3 ACEs, 16.7%; 4+ ACEs 20.0%; $\chi^2 = 15.722$, $P < 0.001$). This association was maintained after correcting for demographics (as Table 4) with AORs being 1.40 (95% CI: 0.91–2.16), 1.99 (95% CI:1.28–3.09) and 2.55 (95% CI:1.61–4.04) for 1, 2–3 and 4+ ACE categories, respectively.

Specialist sample

Individuals in the substance use service sample showed a higher prevalence of ACEs than the general population sample (0 ACEs, 4.5%; 1 ACE, 10.4%; 2–3 ACEs 20.9%; 4+ ACEs 64.2%; $\chi^2 = 151.806$, $P < 0.001$). Demographics also differed from the general population (see Table 3) by age (≥50 years 8.5%; $\chi^2 = 22.235$, $P < 0.001$), gender (male 73.8%; $\chi^2 = 29.700$, $P < 0.001$), deprivation (poorest quintile resident 84.4%; $\chi^2 = 13.554$, $P < 0.001$) and ethnicity (White British 92.5%; $\chi^2 = 21.686$, $P < 0.001$).

Discussion

Main findings of this study

Independent of relationships with deprivation, increasing ACE counts are strongly related to adverse behavioural, mental and physical outcomes throughout the life course. Smoking, heavy drinking and cannabis use all increased with ACE counts. Increased heroin or crack cocaine use was also seen in those with 4+ ACEs; consistent with the substance user sample where 64.2% of individuals had 4+ ACEs.

Unlike previous ACE studies, we measured mental wellbeing and life satisfaction; which both reduced rapidly in participants with >1 ACE. Low mental wellbeing and life satisfaction are related to lower investment in health-promoting behaviours and increased uptake of health-harming behaviours.[25,32,33] Here, while low fruit and vegetable consumption and morbid obesity increased in those with 4+ ACEs, ACEs had no impact on obesity or infrequent exercise. However, both these can result from either life-course successes or failures (e.g. sedentary employment, long-term unemployment) confounding relationships with ACEs.[34,35]

The impacts of health-harming behaviours on injury and NCDs are likely to have contributed to the increased hospital stays in those with 4+ ACEs.[36] However, while respiratory and digestive disease showed some increases in prevalence with ACEs, other major causes of premature mortality did not: cancer, cardiovascular conditions and Type II diabetes. Across England and Wales, population size falls by around a third between ages 54 and 70 years,[17] and these three causes account for around 70% of deaths in this age group.[37] As those with most ACEs have significantly more risk factors relating to such conditions, premature mortality may have removed many from this population prior to survey.

Having had an STI increased even with a single ACE, while nearly a quarter of individuals with 4+ ACEs had/caused an unintended pregnancy <18 years. Critically unplanned, early pregnancies increase risks of ACEs against resulting children.[38] Consistent with other studies, we identified a link between ACEs and having been born to a mother <20 years.[38,39] Such results are indicative of a cycle where those suffering ACEs take sexual risks, become parents early and raise their children in environments where risks of ACEs are again high. Further our results, like others,[6,40,41] show that individuals with more ACEs are more likely to become

victims and perpetrators of violence and be incarcerated in the criminal justice system, again contributing to the next generation's ACEs. Higher ACE counts were also associated with deprivation. Those with 4+ ACEs were more likely to live in deprived areas, be unemployed/on long-term sickness and have no qualifications. These relationships suggest adverse childhoods may inhibit social movement and trap successive family generations in poverty.

What is already known on this topic

Initial ACE studies were undertaken in the USA. Consistent with findings here (Table 4), these studies identified strong links between increasing ACEs and substance use, severe obesity and low mental wellbeing in adulthood.[4,20] The use of recently developed ACE tools is largely limited to the USA with relationships between ACEs and life-course outcomes relatively untested in countries with different approaches to universal health care and child support. However, limited ACE studies have been undertaken elsewhere. Thus, in Canada, as here (Table 5), higher ACEs were linked to poorer adult health and greater health service use.[8] Our findings are also consistent with those from lower income countries with, for example, ACEs having been associated with increased risks of substance use in Nigeria[42] and sexual risk taking and early smoking initiation in the Philippines.[43]

What this study adds

Although ACEs are more likely to occur in poorer communities, independent of deprivation ACE counts correlate with worse health, criminal justice, employment and educational outcomes over the life course. The impacts of ACEs on criminality, violence, early unplanned pregnancy and retention in poverty means those with ACEs are more likely to propagate a cycle that exposes their own children to ACEs. Population surveys likely underestimate the impact of ACEs on long-term health due to premature mortality removing those with more ACEs from the population.

Limitations of this study

This first UK ACE study experienced several limitations. For those asked to participate compliance was >70%. Researcher feedback suggested lack of time, not survey content, was the main reason for non-participation. However, with no empirical information on non-participants, bias introduced through selective participation cannot be excluded. Moreover, despite reassurances of anonymity and confidentiality individuals may have deliberately or inadvertently (e.g. poor recall, blocking certain memories) provided incorrect answers.[44] Critically, although we limited our sample to those aged ≤70 years, it is likely that some individuals with high ACE counts will have already died.[45] Longitudinal studies on those with ACEs would avoid this confounder and are urgently needed to map and quantify the full impact of childhood adversity.

Conclusions

National and international policy is increasingly focused on the social determinants of long-term health.[46] However, even in deprived communities, residents' behaviours and health outcomes vary considerably.[47] ACEs are a key risk factor for poor outcomes that policy can address. Cost-effective programmes are available that help disadvantaged parents provide safe and supported childhoods (e.g. nurse home visiting, parenting programmes).[48–52] Most evaluation of these programmes has been undertaken in the USA. Further work is needed to understand the components of successful programmes necessary elsewhere, especially in countries with universal healthcare systems or limited health assets. However, sufficient evidence is already available for governments to prioritize and invest in ACE-preventing interventions. Too often the focus is on addressing the consequences of ACEs rather than preventing them in the first instance.

Acknowledgements

This study would not have been possible without the support of many colleagues in the local NHS and in voluntary sector and other community support organizations. We are grateful for their advice and time. We are grateful to Cheryl McElroy for the support received in study development and implementation. The study relied heavily on the continued efforts of Charlie Gibbons, Georgina Bellis, Olivia Sharples, Katherine Hardcastle, Mark O'Keefe, Phil McHale, Clare Perkins, Paul Duffy, Jim McVeigh and Neil Potter. We are also grateful to Howard Spivak and Lynn Jenkins at the Centers for Disease Control and Prevention for sharing their insight into US ACE studies. Finally, we are indebted to all those individuals who took time to participate in this survey. We were overwhelmed not only with their enthusiasm for the survey but often with the hospitality they showed researchers visiting their homes.

Funding

This work was supported by Liverpool John Moores University and National Health Service Research and Development Funds.

References

1 Greenfield EA. Child abuse as a life-course social determinant of adult health. *Maturitas* 2010;**66(1)**:51–5.

2 Maniglio R. The impact of child sexual abuse on health: a systematic review of reviews. *Clin Psychol Rev* 2009;**29(7)**:647–57.

3 Kessler RC, McLaughlin KA, Green JG *et al*. Childhood adversities and adult psychopathology in the WHO World Mental Health Surveys. *Br J Psychiatry* 2010;**197(5)**:378–85.

4 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(4)**:245–58.

5 World Health Organization. Adverse childhood experiences international questionnaire (ACE-IQ). http://www.who.int/violence_injury_prevention/violence/activities/adverse_childhood_experiences/en/index.html (19 December 2012, date last accessed).

6 Mair C, Cunradi CB, Todd M. Adverse childhood experiences and intimate partner violence: testing psychosocial mediational pathways among couples. *Ann Epidemiol* 2012;**22(12)**:832–9.

7 Liu Y, Croft JB, Chapman DP *et al*. Relationship between adverse childhood experiences and unemployment among adults from five US states. *Soc Psychiatry Psychiatr Epidemiol* 2012;**48(3)**:357–69.

8 Chartier MJ, Walker JR, Naimark B. Separate and cumulative effects of adverse childhood experiences in predicting adult health and health care utilization. *Child Abuse Negl* 2010;**34(6)**:454–64.

9 Dube SR, Felitti VJ, Dong M *et al*. The impact of adverse childhood experiences on health problems: evidence from four birth cohorts dating back to 1900. *Prev Med* 2003;**37(3)**:268–77.

10 Bellis MA, Hughes K, Perkins C *et al*. Protecting people, promoting health: a public health approach to violence prevention for England. Liverpool: North West Public Health Observatory, 2012.

11 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(1)**:93–8.

12 World Health Organization Regional Office for Europe. Health 2020: a European policy framework supporting action across government and society for health and well-being. Copenhagen: World Health Organization Regional Office for Europe, 2012.

13 Haatainen KM, Tanskanen A, Kylma J *et al*. Gender differences in the association of adult hopelessness with adverse childhood experiences. *Soc Psychiatry Psychiatr Epidemiol* 2003;**38(1)**:12–7.

14 Bentall RP, Wickham S, Shevlin M *et al*. Do specific early-life adversities lead to specific symptoms of psychosis? A study from the 2007 Adult Psychiatric Morbidity Survey. *Schizophr Bull* 2012;**38(4)**:734–40.

15 Corcoran P, Gallagher J, Keeley HS *et al*. Adverse childhood experiences and lifetime suicide ideation: a cross-sectional study in a non-psychiatric hospital setting. *Ir Med J* 2006;**99(2)**:42–5.

16 Friestad C, Ase-Bente R, Kjelsberg E. Adverse childhood experiences among women prisoners: relationships to suicide attempts and drug abuse. *Int J Soc Psychiatry* 2012 [Epub ahead of print].

17 Office for National Statistics. 2011 Census, population and household estimates for England and Wales—unrounded figures for the data published 16 July 2012. http://www.ons.gov.uk/ons/rel/census/2011-census/population-and-household-estimates-for-england-and-wales—unrounded-figures-for-the-data-published-16-july-2012/index.html (19 December 2012, date last accessed).

18 Office for National Statistics. Neighbourhood statistics. http://www.neighbourhood.statistics.gov.uk/dissemination/ (19 December 2012, date last accessed).

19 Department of Health, NHS. Health profiles 2012. http://www.apho.org.uk/default.aspx?QN=P_HEALTH_PROFILES (19 December 2012, date last accessed).

20 Anda RF, Felitti VJ, Bremner JD *et al*. The enduring effects of abuse and related adverse experiences in childhood. A convergence of evidence from neurobiology and epidemiology. *Eur Arch Psychiatry Clin Neurosci* 2006;**256(3)**:174–86.

21 Lu W, Mueser KT, Rosenberg SD *et al*. Correlates of adverse childhood experiences among adults with severe mood disorders. *Psychiatr Serv* 2008;**59(9)**:1018–26.

22 Frank D, DeBenedetti AF, Volk RJ *et al*. Effectiveness of the AUDIT-C as a screening test for alcohol misuse in three race/ethnic groups. *J Gen Intern Med* 2008;**23(6)**:781–7.

23 Alcohol Learning Centre. AUDIT-C. http://www.alcohollearningcentre.org.uk/Topics/Browse/BriefAdvice/?parent=4444&child=4898 (19 December 2012, date last accessed).

24 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.

25 Bellis MA, Lowey H, Hughes K *et al*. Variations in risk and protective factors for life satisfaction and mental wellbeing with deprivation: a cross-sectional study. *BMC Public Health* 2012;**12**:492.

26 World Health Organization. Global database on body mass index. http://apps.who.int/bmi/index.jsp (19 December 2012, date last accessed).

27 Department for Communities and Local Government. English indices of deprivation 2010. London: Department for Communities and Local Government, 2011.

28 Royal Mail. Postcode Address File (PAF®). http://www.royalmail.com/marketing-services/address-management-unit/address-data-products/postcode-address-file-paf?campaignid=paf_redirect (19 December 2012, date last accessed).

29 Hickman M, Taylor C, Chatterjell A *et al*. Estimating the prevalence of problematic drug use: a review of methods and their application. *Bull Narcot* 2002;**LIV(1/2)**:15–32.

30 Bellis MA, Hughes K, Wood S *et al*. National five-year examination of inequalities and trends in emergency hospital admission for violence across England. *Inj Prev* 2011;**17(5)**:319–25.

31 Kirkwood BR, Sterne JAC. *Essential Medical Statistics*, 2nd edn. Malden, MA: Blackwell Science Ltd, 2003.

32 Grant N, Wardle J, Steptoe A. The relationship between life satisfaction and health behaviour: a cross-cultural analysis of young adults. *Int J Behav Med* 2009;**16(3)**:259–68.

33 Hakkarainen R, Partonen T, Haukka J *et al*. Food and nutrition intake in relation to mental wellbeing. *Nutr J* 2004;**3**:14.

34 Church TS, Thomas DM, Tudor-Locke C *et al*. Trends over 5 decades in U.S. occupation-related physical activity and their associations with obesity. *PLoS One* 2011;**6(5)**:e19657.

35 Schunck R, Rogge B. Unemployment and its association with health-relevant actions: investigating the role of time perspective with German census data. *Int J Public Health* 2010;**55(4)**:271–8.

36 World Health Organization. Global health risks: mortality and burden of disease attributable to selected major risks. Geneva: World Health Organization, 2009.

37 Office for National Statistics. Mortality statistics: deaths registered in England and Wales (Series DR), 2011. http://www.ons.gov.uk/ons/rel/vsob1/mortality-statistics-deaths-registered-in-england-and-wales-series-dr-/index.html (19 December 2012, date last accessed).

38 Sidebotham P, Heron J. Child maltreatment in the 'children of the nineties': a cohort study of risk factors. *Child Abuse Negl* 2006;**30(5)**:497–522.

39 Stith SM, Liu T, Davies LC *et al*. Risk factors in child maltreatment: a meta-analytic review of the literature. *Aggress Violent Behav* 2009;**14(1)**:13–29.

40 Duke NN, Pettingell SL, McMorris BJ *et al*. Adolescent violence perpetration: associations with multiple types of adverse childhood experiences. *Pediatrics* 2010;**125(4)**:e778–86.

41 Miller E, Breslau J, Chung WJ *et al*. Adverse childhood experiences and risk of physical violence in adolescent dating relationships. *J Epidemiol Community Health* 2011;**65(11)**:1006–13.

42 Oladeji BD, Makanjuola VA, Gureje O. Family-related adverse childhood experiences as risk factors for psychiatric disorders in Nigeria. *Br J Psychiatry* 2010;**196(3)**:186–91.

43 Ramiro LS, Madrid BJ, Brown DW. Adverse childhood experiences (ACE) and health-risk behaviors among adults in a developing country setting. *Child Abuse Neglect* 2010;**34(11)**:842–55.

44 Dube SR, Williamson DF, Thompson T *et al*. Assessing the reliability of retrospective reports of adverse childhood experiences among adult HMO members attending a primary care clinic. *Child Abuse Negl* 2004;**28(7)**:729–37.

45 Brown DW, Anda RF, Tiemeier H *et al*. Adverse childhood experiences and the risk of premature mortality. *Am J Prev Med* 2009;**37(5)**:389–96.

46 Commission on Social Determinants of Health. Closing the gap in a generation: health equity through action on the social determinants of health. Final Report of the Commission on Social Determinants of Health. Geneva: World Health Organization, 2008.

47 Lakshman R, McConville A, How S *et al*. Association between area-level socioeconomic deprivation and a cluster of behavioural risk factors: cross-sectional, population-based study. *J Public Health* 2011;**33(2)**:234–45.

48 Olds DL, Eckenrode J, Henderson CR Jr *et al*. Long-term effects of home visitation on maternal life course and child abuse and neglect. Fifteen-year follow-up of a randomized trial. *JAMA* 1997;**278(8)**:637–43.

49 Hutchings J, Bywater T, Daley D *et al*. Parenting intervention in Sure Start services for children at risk of developing conduct disorder: pragmatic randomised controlled trial. *BMJ* 2007;**334(7595)**:678.

50 Aos S, Lieb R, Mayfield J *et al*. Benefits and costs of prevention and early intervention programs for youth. Olympia, WA: Washington State Institute for Public Policy, 2004.

51 Knapp M, McDaid D, Parsonage E. Mental health promotion and mental illness prevention: the economic case. London: Department of Health, 2011.

52 Edwards RT, O'Ceilleachair A, Bywater T *et al*. Parenting programme for parents of children at risk of developing conduct disorder: cost effectiveness analysis. *BMJ* 2007;**334(7595)**:682.