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Quantifying the health and financial burden of adverse childhood experiences in Wales, England and English regions in 2023: a pooled analysis of 10 population surveys

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ABSTRACT

Objectives To update estimates of the health and financial burden of adverse childhood experiences (ACEs) in England and Wales and generate estimates for English regions.

Design Population attributable fractions (PAFs) for ACEs were calculated for risks and causes of ill-health using data from 10 randomly stratified cross-sectional ACE studies. PAFs were applied to disability-adjusted life years (DALYs) for England, Wales and English regions for 2023, with financial costs estimated using UK statistical life year values (societal willingness to pay).

Setting Households in England and Wales.

Participants 28 449 residents aged ≥18 years.

Outcome measures PAFs for ACE exposure categories (1 ACE, 2–3 ACEs and ≥4 ACEs) for four health risks (smoking, high alcohol use, drug use and high body mass index (BMI)) and seven causes of ill health (violence, mental illness, cancer, type 2 diabetes, heart disease, respiratory disease and stroke). Annual estimated DALYs and financial costs attributable to ACEs.

Results Relative risks for all outcomes increased with ACEs, with risk ratios for ≥4 ACEs ranging from 1.063 (95% CI 1.000 to 1.129, p=0.048) for high BMI to 9.147 (95% CI 7.062 to 11.847, p<0.001) for drug use. For health risks, PAFs for ACEs were highest for drug use (Wales 60.3% and England 56.7%), while ACE-attributable costs were highest for smoking (Wales £1.8 billion and England £22.7 billion). For causes of ill health, PAFs for ACEs were highest for violence (Wales 49.2% and England 46.2%), and costs were highest for mental illness (Wales £1.8 billion and England £37.8 billion). Across all outcomes (accounting for duplication by excluding DALYs for causes linked to the four health risks), total ACE-attributable costs were £7.8 billion for Wales and £115.6 billion for England; costs for English regions ranged from £6.3 billion (North East England) to £18.0 billion (South East England).

Conclusions Findings highlight the substantial financial burden of ACEs across England and Wales and provide important information to inform regional activity. There is an urgent and economically justified need for action to prevent ACEs and support those affected by them to reduce the health and economic burden of poor-quality childhoods.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study uses additional and more recent adverse childhood experience (ACE) studies to update existing estimates of the health and financial burden of ACEs in England and Wales using an increased sample size.
⇒ Additional analyses now provide estimates of the health and financial burden of ACEs across different English regions, allowing more local interpretation and application of findings.
⇒ Financial costs were estimated using established statistical life-years approaches, which are based on societal willingness to pay for reductions in the risk of ill health and mortality and therefore include intangible costs.
⇒ ACE data were retrospectively reported and therefore may be affected by recall bias, while general household surveys are also likely to exclude some of those who have experienced the greatest harm related to ACEs (eg, homelessness, incarceration or premature death).
⇒ We used cross-sectional data and therefore cannot infer causality; thus, our estimates reflect the health and financial burden associated with, but not definitively wholly attributable to, ACEs.

INTRODUCTION

Exposure to chronic stress in childhood can disrupt children's developing neurological and physiological systems and embed vulnerability to poorer health and well-being.[1 2] Accordingly, a large body of research has identified how adverse childhood experiences (ACEs), such as child maltreatment, witnessing domestic violence and household member substance misuse, increase the risks of poorer health across the life course.[3 4] ACEs

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show dose-responsive relationships with both behavioural risk factors for ill health, such as tobacco, alcohol and drug use,[5 6] and major causes of ill health, such as mental illness, cancer and respiratory and cardiovascular diseases.[7–9] Such effects mean the health and associated financial costs of ACEs are substantial. For example, annual costs attributable to ACEs for leading health risks and causes in North America and Europe have been estimated to be equivalent to around 3% of each geography's gross domestic product (GDP).[10] Similar estimates across 28 European nations found costs equivalent to between 1% and 6% of national GDP.[11]

In England and Wales, a study using data from the 2017 Global Burden of Disease (GBD) study estimated the annual health costs attributable to ACEs at £42.8 billion (£40.6 billion in England and £2.2 billion in Wales).[12] The study combined data from five general population ACE studies in England and Wales and, in line with other estimates, used a human capital approach to value the health burden of ACEs, based on the cost of lost productivity due to people being removed from the labour force through morbidity or premature mortality. However, the health and social impacts of ACEs affect far more than economic productivity. Thus, an alternative method of valuing the burden of ACEs is through statistical life methods, which focus on the social value of—or society's willingness to pay for—small reductions in the risk of mortality.[13 14] A recent study using this approach in the USA estimated the annual economic burden of adult health conditions attributable to ACEs at US$13.9 trillion, substantially higher than equivalent estimates using GDP per capita.[15]

Understanding the financial burden of ACEs is imperative for informing early intervention and response systems and assessing the potential economic gains of preventing ACEs for future generations. Since 2017, major events such as the COVID-19 pandemic and the rising costs of living linked to global conflict have affected population health, with studies identifying ACEs as a vulnerability for greater harm.[16–19] Here, we update estimates of the costs of ACEs in England and Wales using a statistical life methods approach, data from five further ACE studies and data from the 2023 GBD. We also, for the first time, provide estimates of ACE-attributable costs for the nine administrative regions that make up England.

METHODS

Primary data sources

Data from 10 cross-sectional ACE studies conducted across various national or local geographies in England and Wales were combined. These included the five studies used in previous cost estimates (conducted 2012–2017)[20–24] and five further studies conducted between 2020 and 2024.[16 19 25 26] The initial five studies were restricted to adults aged 18–69 years, while the five further studies were extended to include all adults. Summary details of the 10 studies are provided in online supplemental table S1. 7 studies were face-to-face household studies, one of which included the option for participants to complete the survey online. All household studies used stratified random sampling approaches with lower super output areas (LSOAs; small geographical areas with a mean population of 1500) as the sampling unit, stratified by region (as appropriate to each study) and deprivation quintile (assigned using the English[27] or Welsh[28] Indices of Multiple Deprivation (IMD)). In five household studies, letters were sent to randomly selected households in sampled LSOAs in advance of an interviewer visit, providing study information and the opportunity to opt out (and a link to the online survey for the one study including this option). For the two other household studies, households in sampled LSOAs were randomly selected by interviewers, and study information was provided at the door. Interviews were conducted by a professional market research company using computer-assisted personal interviewing, with participants able to self-complete sensitive questions (eg, those on ACEs). Participation was voluntary, and informed consent was obtained from all participants. Only one resident per selected household was able to participate.

The remaining three studies included two conducted by telephone and online (due to their implementation during the COVID-19 pandemic, when face-to-face interviewing was not appropriate) and one conducted wholly online. The telephone surveys used stratified sampling methodologies, with landline and mobile telephone contacts obtained from a commercial sample provider. Telephone interviews were conducted by a professional market research company. An online survey was incorporated into these studies using a commercial online panel (individuals who are compensated for participating in online research) due to difficulty accessing younger adults by telephone. The online panels were extended to all age groups proportionate to each study area's population demographics. The final study also used a commercial online panel with participation targeted to represent national demographics. Total study sample sizes and participation rates are shown in online supplemental table S1. For analysis, data were restricted to individuals with complete ACE and demographic data, with a final sample of 28 449.

Demographic data included sex, age group, ethnicity (self-assigned using UK census categories) and deprivation quintile (based on the most recent Welsh or English IMD for each study at the time of data collection). In all studies, data were collected on nine ACEs occurring before the age of 18 years using the Centers for Disease Control and Prevention short ACE tool.[29] The nine ACEs were physical abuse, sexual abuse, verbal abuse, parental separation, exposure to domestic violence, household member alcohol abuse, drug abuse, mental illness and incarceration. In the five latter surveys, the three questions used to measure three types of sexual abuse were replaced with a single question measuring any sexual abuse. Positive responses to ACE questions were summed and categorised into an ACE count category: 0 ACEs, 1

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ACE, 2–3 ACEs and ≥4 ACEs. Questions used to measure ACEs and the health outcomes included in this study are shown in online supplemental table S2, along with variation in questions between studies.

All studies provided data on smoking (people who smoke); nine on violence (victimisation in the past year); seven on whether respondents had ever been diagnosed with cancer, type 2 diabetes or respiratory disease; six on drug use (ever used heroin or crack cocaine) and four on high alcohol use (see below), high body mass index (BMI, ≥25.0 kg/m^2) and whether participants had ever been diagnosed with heart disease (coronary heart disease/heart attack) or stroke (see online supplemental table S3). Our previous estimates included three mental illness outcomes of depression, anxiety and other mental illness based on data from a single study. None of the five newer studies had collected these outcomes separately, but four included a single question asking whether respondents had ever been diagnosed with depression, anxiety or other mental illness. Thus, here we use any mental illness as an outcome, including data from all studies that measured mental illness (n=5). While none of the newer studies contributed data on alcohol use, we amended our classification of high alcohol use consistent with methodological changes in the measurement of alcohol use as a risk factor in the GBD study. Thus, high alcohol use was determined based on estimated consumption above the theoretical minimum risk exposure level for Western Europe by age and gender[30] (see online supplemental table S2).

Calculating population attributable fraction

Statistical analysis was undertaken in IBM SPSS V.24, and data editing and calculations were performed in Excel. Risk ratios (RRs) and 95% CIs associated with each ACE count level for each outcome were calculated using log-binomial models,[31] controlling for study (ie, study ID), study method (face-to-face, telephone or online), sex, age group, deprivation quintile of residence and ethnicity (white or other than white). Population attributable fractions (PAFs) were generated separately for England and Wales using equivalent ACE prevalence levels (raw proportions based on individual participant analysis from the combined dataset; see Results). Consistent with previous estimates,[12] PAF values were calculated at each ACE count level (1 ACE vs 0 ACEs; 2–3 ACEs vs 0 ACEs; ≥4 ACEs vs 0 ACEs) according to:

$$PAF_{ACE\alpha} = \frac{P_{ACE\alpha} \times (RR_{ACE\alpha} - 1)}{(P_{ACE0}) + (P_{ACE1} \times RR_{ACE1}) + (P_{ACE2-3} \times RR_{ACE2-3}) + (P_{ACE\geq 4} \times RR_{ACE\geq 4})}$$

where α is the ACE count category for the PAF being calculated, RR_{ACE} is the pooled RR associated with each ACE count and P_{ACE} is the proportion of the sample exposed to each ACE count. Overall PAFs for ACEs were calculated by summing the three PAF values.[32]

Calculating ACE-attributable costs

Health outcomes were matched to risk factor and cause categories in the 2023 GBD study[33] (eg, mental illness was matched to the GBD category for mental disorders; see online supplemental table S4). Disability-adjusted life years (DALYs) estimates for 2023 for each matched category for Wales, England and each English region were extracted and summed for age categories 15–49 years, 50–69 years and ≥70 years. PAFs were applied to DALYs for each risk factor and cause to estimate the number of DALYs attributable to ACEs by ACE level. Costs were then calculated by valuing each DALY at £70 000, the latest government-published estimate of UK willingness to pay per quality-adjusted life year.[34] This value is based on research estimating how much people would be willing to pay to mitigate risks of injury and premature death and consequently represents an intangible cost. To provide a level of comparison with previous estimates,[12] ACE costs for England and Wales were also calculated using the previous human capital-based method of valuing DALYs, where each DALY was valued at each region's GVA (gross value added) per capita. To estimate total ACE-attributable costs across all included risk factors and causes of ill health, we excluded DALYs for risk factors related to included causes of ill health (eg, those for smoking related to cancer). Sensitivity analyses for Wales and England estimates were run using the upper and lower bounds (uncertainty intervals) for DALYs, generating PAFs using the upper and lower CIs for RRs and restricting all data to people aged 15–69 years.

Patient and public involvement

Patients and the public were not involved in the design or planning of the study.

RESULTS

Sample demographics and ACE count levels for individual and combined studies are provided in online supplemental table S5. Over half (55.8%) of all participants were female, and 89.5% were of white ethnicity. Five studies were restricted to adults aged 18–69 years, while five also included adults aged ≥70 years. Three studies were conducted in areas with higher levels of deprivation, leading to slightly higher representation of residents from the most deprived quintiles nationally (24.5%). ACE prevalence levels (used to generate PAFs) were 51.2% for 0 ACEs, 19.7% for 1 ACE, 16.4% for 2–3 ACEs and 12.6% for ≥4 ACEs in Welsh samples, and 52.6% for 0 ACEs, 20.4% for 1 ACE, 17.2% for 2–3 ACEs and 9.8% for ≥4 ACEs in English samples. ACE prevalence was highest in the study conducted entirely online, which included both English and Welsh residents.

Table 1 shows RRs for each ACE count level and health outcome, with unadjusted proportions presented in online supplemental table S6. For all outcomes except high alcohol use, RRs increased as ACE count increased. RRs for smoking, drug use, mental illness, violence, type

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Table 1 RRs for risk factors and causes of ill health at each ACE count level

	1 ACE			2–3 ACEs			≥4 ACEs		
	RR	95% CI	P value	RR	95% CI	P value	RR	95% CI	P value
Risk factors									
High alcohol use	1.118	1.045 to 1.196	0.001	1.067	0.989 to 1.152	0.096	1.174	1.076 to 1.282	<0.001
Smoking	1.269	1.194 to 1.349	<0.001	1.561	1.473 to 1.655	<0.001	2.211	2.097 to 2.332	<0.001
Drug use	1.749	1.259 to 2.429	<0.001	3.097	2.295 to 4.179	<0.001	9.147	7.062 to 11.847	<0.001
High BMI	1.030	0.985 to 1.077	0.194	1.061	1.010 to 1.113	0.017	1.063	1.000 to 1.129	0.048
Causes of ill health									
Mental illness	1.475	1.359 to 1.601	<0.001	1.965	1.824 to 2.117	<0.001	2.415	2.244 to 2.600	<0.001
Violence	1.439	1.192 to 1.738	<0.001	2.864	2.436 to 3.367	<0.001	5.564	4.804 to 6.445	<0.001
Cancer	1.004	0.864 to 1.166	0.961	1.144	0.968 to 1.352	0.115	1.625	1.349 to 1.958	<0.001
Type 2 diabetes	1.190	1.036 to 1.365	0.014	1.239	1.061 to 1.446	0.007	1.560	1.293 to 1.882	<0.001
Heart disease	1.094	0.830 to 1.441	0.525	1.418	1.076 to 1.869	0.013	1.921	1.364 to 2.706	<0.001
Stroke	1.253	0.810 to 1.939	0.311	1.458	0.926 to 2.294	0.104	2.693	1.657 to 4.379	<0.001
Respiratory disease	1.158	1.012 to 1.325	0.033	1.499	1.312 to 1.712	<0.001	1.811	1.561 to 2.101	<0.001

Analysis uses generalised linear modelling controlling for study, study administration method (where relevant), deprivation quintile, age, sex and ethnicity (ethnicity was excluded for smoking as the model would not converge with the inclusion of this variable). Reference category=0 ACEs.
ACE, adverse childhood experience; BMI, body mass index; RR, risk ratio.

2 diabetes and respiratory disease increased significantly at any level of ACEs. RRs for high BMI and heart disease were increased in individuals with ≥2 ACEs, and for cancer and stroke in those with ≥4 ACEs only. For high alcohol use, RRs increased significantly for individuals with 1 ACE or ≥4 ACEs, but not for those with 2–3 ACEs (p=0.096).

Total PAFs for ACEs for all outcomes were slightly higher in Wales than in England due to higher ACE levels (table 2; see footnote for population size aged ≥15 years). Across the four risk factors, the highest PAFs due to ACEs were for drug use (Wales 60.3% and England 56.7%), and the lowest were for high BMI (Wales 2.3% and England 2.2%). The highest ACE-attributable costs, however, were for smoking (Wales £1.8 billion and England £22.7 billion per year) due to this risk factor having the highest DALYs. Across causes of ill health, cancer had the lowest PAFs associated with ACEs (9.4% in Wales and 8.0% in England), yet due to high DALYs, it had the highest annual ACE-attributable costs of all individual causes of ill health measured, at £1.5 billion in Wales and £18.7 billion in England. Violence and mental illness had the highest PAFs due to ACEs. Almost half of recent violence victimisation was attributable to ACEs (Wales 49.2% and England 46.2%), with associated costs of £45.4 million in Wales and £743.1 million in England; 30.1% of mental illness in Wales and 28.7% in England were attributable to ACEs, with associated annual costs of £1.8 billion and £37.8 billion, respectively. Our previous estimates used individual RRs for depression, anxiety and other mental illnesses based on data from a single study, and with no further data available to contribute to these estimates, a broader variable measuring any mental illness was used here. However, estimated costs for depression, anxiety and other mental illnesses using the single study data are provided in online supplemental table S7.

Total ACE-attributable costs across the four risk factors and seven causes of ill health were calculated by excluding DALYs from risk factors that related to included causes (see Methods). Total annual ACE-attributable costs were £7.8 billion for Wales and £115.6 billion for England (table 3), equivalent to 8.4% of GDP in Wales and 5.0% in England. Across England and Wales, almost half (48.9%) of ACE-attributable costs were accrued in the ≥4 ACEs category, a third (35.1%) in the 2–3 ACEs category and 16.0% in the 1 ACE category. In the sensitivity analysis (see Methods), combined estimated ACE-attributable

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Table 2 PAFs, DALYs and costs attributable to ACEs

		PAF				Total DALYs (age ≥15 years)	DALYs attributable to ACEs				Total estimated cost (£ million)*	Attributable costs by ACE count (£ million)*			
		1 ACE	2–3 ACEs	≥4 ACEs	All ACEs		1 ACE	2–3 ACEs	≥4 ACEs	All ACEs		1 ACE	2–3 ACEs	≥4 ACEs	All ACEs
High alcohol use	Wales	0.022	0.010	0.021	0.053	42 291	932	440	879	2251	2960.4	65.2	30.8	61.5	157.6
	England	0.023	0.011	0.016	0.050	652 837	14 929	7147	10 575	32 652	45 698.6	1045.0	500.3	740.3	2285.6
Smoking	Wales	0.041	0.071	0.118	0.230	113 935	4657	8085	13 408	26 149	7975.4	326.0	565.9	938.6	1830.5
	England	0.043	0.076	0.093	0.213	1 524 714	65 880	115 840	142 475	324 195	106 729.9	4611.6	8108.8	9973.3	22 693.7
Drug use	Wales	0.059	0.137	0.408	0.603	28 957	1697	3956	11 810	17 464	2027.0	118.8	276.9	826.7	1222.4
	England	0.066	0.156	0.345	0.567	381 449	25 209	59 501	131 739	216 448	26 701.4	1764.6	4165.0	9221.7	15 151.4
High BMI	Wales	0.006	0.010	0.008	0.023	108 147	627	1050	838	2515	7570.3	43.9	73.5	58.6	176.1
	England	0.006	0.010	0.006	0.022	1 290 146	7749	13 140	7772	28 662	90 310.2	542.5	919.8	544.0	2006.3
Mental illness	Wales	0.065	0.111	0.125	0.301	87 620	5732	9706	10 933	26 371	6133.4	401.3	679.4	765.3	1846.0
	England	0.069	0.118	0.099	0.287	1 886 687	130 337	223 504	186 704	540 544	132 068.1	9123.6	15 645.3	13 069.3	37 838.1
Violence	Wales	0.044	0.155	0.292	0.492	1318	58	205	385	648	92.3	4.1	14.3	27.0	45.4
	England	0.048	0.173	0.241	0.462	22 995	1110	3968	5537	10 616	1609.7	77.7	277.8	387.6	743.1
Cancer	Wales	0.001	0.021	0.071	0.094	225 418	151	4825	16 107	21 082	15 779.3	10.6	337.7	1127.5	1475.8
	England	0.001	0.023	0.056	0.080	3 350 545	2356	76 273	188 828	267 457	234 538.2	164.9	5339.1	13 217.9	18 722.0
Type 2 diabetes	Wales	0.033	0.034	0.062	0.128	20 858	680	712	1284	2676	1460.1	47.6	49.9	89.9	187.3
	England	0.034	0.036	0.048	0.119	457 536	15 596	16 551	22 121	54 268	32 027.5	1091.7	1158.5	1548.5	3798.7
Heart disease	Wales	0.015	0.057	0.097	0.169	100 641	1544	5741	9715	17 000	7044.9	108.1	401.9	680.1	1190.0
	England	0.016	0.061	0.076	0.153	1 391 261	22 490	84 696	106 298	213 484	97 388.3	1574.3	5928.7	7440.8	14 943.9
Stroke	Wales	0.037	0.056	0.160	0.253	39 173	1461	2198	6250	9909	2742.1	102.2	153.9	437.5	693.6
	England	0.040	0.061	0.128	0.229	603 983	24 058	36 669	77 326	138 053	42 278.8	1684.0	2566.8	5412.8	9663.7
Respiratory disease	Wales	0.026	0.067	0.084	0.177	56 166	1439	3782	4727	9949	3931.6	100.7	264.8	330.9	696.4
	England	0.027	0.072	0.066	0.165	809 574	21 778	57 970	53 732	133 480	56 670.2	1524.4	4057.9	3761.3	9343.6

Total population aged ≥15 years in 2023: Wales, 2 653 783 and England, 47 747 979.
*Calculated as 1 DALY=£70 000 (see Methods).
ACE, adverse childhood experience; BMI, body mass index; DALY, disability-adjusted life year; PAF, population attributable fraction.

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Table 3 Total ACE-attributable DALYs and costs, and sensitivity analyses

	ACE-attributable DALYs (thousands)			ACE-attributable costs (£ billion)			Equivalent percentage of GDP (%)		
	England	Wales	England and Wales	England	Wales	England and Wales	England	Wales	England and Wales
Best estimate	1651.7	111.2	1763.0	115.6	7.8	123.4	5.0	8.4	5.1
Limited to DALYs for people aged 15–69 years*	1083.9	70.9	1154.8	75.9	5.0	80.8	3.3	5.3	3.3
PAFs generated using lower CIs for RRs	837.1	55.7	892.8	58.6	3.9	62.5	2.5	4.2	2.6
PAFs generated using upper CIs for RRs	2441.9	164.5	2606.4	170.9	11.5	182.5	7.3	12.4	7.5
Lower bound (UI) for DALYs	1372.8	91.8	1464.6	96.1	6.4	102.5	4.1	6.9	4.2
Upper bound (UI) for DALYs	1943.3	131.4	2074.8	136.0	9.2	145.2	5.8	9.9	6.0

*Using PAFs based on survey data for people aged 18–69 years only.
ACE, adverse childhood experience; DALY, disability-adjusted life year; GDP, gross domestic product; PAF, population attributable fraction; RR, risk ratio; UI, uncertainty interval.

costs for Wales and England ranged from £62.5 billion to £182.5 billion (table 3).

PAFs for England were also used to calculate ACE-attributable DALYs and associated costs for individual English regions. These are provided in online supplemental tables S9a–i, with total ACE-attributable DALYs and costs for English regions shown in table 4 (along with population data). Total ACE-attributable costs ranged from £6.3 billion in North East England to £18.0 billion in South East England. With wide variation in regional GDP across England, the proportion of regional GDP represented by ACE-attributable costs also varied widely, from 2.4% in Greater London (which has the highest regional GDP) to 8.1% in North East England (which has the lowest regional GDP).

When using our previous approach to valuing DALYs for comparison with previous estimates (see methods),[12] total ACE-attributable costs across all risk factors and causes were £2.9 billion in Wales and £60.5 billion in England (equivalent figures in 2017 were £2.2 billion in Wales and £40.6 billion in England) (see online supplemental table S8).

DISCUSSION

We used primary data from 28 449 adults in England and Wales to estimate the health and financial costs attributed to ACEs in England, Wales and English regions in 2023 across four health risks and seven causes of ill health. Around half of participants across the 10 contributing studies reported exposure to at least 1 ACE before the age of 18 years, with around 1 in 10 reporting 4 or more ACE types. Across all risk factors and causes of ill health, the highest PAFs due to ACEs were found for drug use (60.3% in Wales and 56.7% in England) and violence (49.2% in Wales and 46.2% in England). However, due to their greater DALY burden, the highest ACE-attributable costs were for mental illness (£1.8 billion in Wales and £37.8 billion in England) and smoking (£1.8 billion in Wales, £22.7 billion in England). The total costs attributable to ACEs were £7.8 billion for Wales and £115.6 billion for England per year (£123.4 billion combined; table 3), equivalent to 8.4% of GDP in Wales and 5.0% in England (5.1% across Wales and England). In sensitivity analyses, total estimated costs for Wales and England combined ranged from £62.5 billion (2.6% of GDP) to £182.5 billion (7.5% of GDP; table 3). Estimates for English regions ranged from £6.3 billion in North East England to £18.0 billion in South East England, with GDP equivalents ranging from 2.4% (Greater London) to 8.1% (North East England; table 4). These figures emphasise the urgent ongoing need for action to prevent ACEs and support those affected by them to reduce the health and economic burden of poor-quality childhoods.

Our study used an established methodology[10–12] to update previous cost estimates and applied an alternative statistical life methods approach in line with studies elsewhere.[15] Valuing health based on how much people

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Table 4 Total ACE-attributable DALYs and costs for English regions

English region	DALYs attributable to ACEs	Costs attributable to ACEs (£ billion)	Regional GDP (£ billion) (2023)	Equivalent percentage of GDP (2023)	Total population aged ≥15 years (2023)
East Midlands	146 333	10.2	157.0	6.5	4 150 969
East of England	179 640	12.6	229.3	5.5	5 332 028
Greater London	215 703	15.1	617.9	2.4	7 363 305
North East England	89 505	6.3	77.5	8.1	2 269 309
North West England	243 655	17.1	270.8	6.3	6 274 237
South East England	256 619	18.0	391.8	4.6	7 838 958
South West England	169 368	11.9	207.6	5.7	4 903 411
West Midlands	176 924	12.4	195.2	6.3	4 987 044
Yorkshire and The Humber	174 002	12.2	182.5	6.7	4 628 718

ACE, adverse childhood experience; DALY, disability-adjusted life year; GDP, gross domestic product.

would be willing to pay to reduce their risks of illness and premature death provides intangible costs that do not relate directly to government budgets, yet may better reflect the broader health effects of ACEs beyond those linked solely to economic productivity. To enable a level of comparison with our previous cost estimates, however, we also included results using the previous human capital (GVA-based) approach[12] (online supplemental table S8). Our new estimates were strengthened by the inclusion of data from five additional ACE surveys. While our previous estimates measured the costs of depression, anxiety and other mental illnesses separately, here we used a broader measure of any mental illness to enable inclusion of a larger sample. This resulted in a more conservative cost estimate for mental illness (online supplemental table S7). However, not all outcomes were measured in all studies, and new data were not available for some outcomes (alcohol use and high BMI), meaning data for these outcomes were restricted to samples of people aged 18–69 years. Further, while DALYs extracted for the study were age-specific and sex-specific, despite our relatively large sample size, it was not feasible to generate age-specific and sex-specific PAFs for each ACE exposure level.[15 35] Equally, estimates for English regions were based on PAFs generated at the country level (ie, England) and thus will not account for any regional variation in ACE prevalence. However, age group, sex, residential deprivation level, ethnicity and study ID were all included in our models to generate overall RRs that accounted for demographic differences, and sensitivity analyses were undertaken with all data restricted to those aged up to 69 years (ie, RRs calculated based on data for people aged 18–69 years only, DALYs for those aged 15–69 years; total ACE-attributable costs across Wales and England of £80.8 billion; table 3).

Our estimates relied on cross-sectional survey data, and as such, we cannot infer causality. While we controlled for basic demographic factors, a range of other non-measured socioeconomic and environmental factors in both childhood and adulthood can affect adult health. While substantial evidence elsewhere suggests causal relationships between ACEs and poorer life course health,[36] the health and financial burden estimated here should be considered associated with, but not conclusively or solely attributable to, ACEs. The 10 surveys contributing to estimates all relied on retrospective, self-reported ACE measurements and self-reported outcome measurements, making findings subject to recall issues and reluctance to report. The surveys were undertaken over a 12-year period, and while survey year was not included as a confounder in our models, study ID was, and this is strongly linked with survey year (see online supplemental table 1). Participant age was also included in all models to account for age-cohort differences in reported ACE exposure and health outcomes. However, some population groups are likely to have greater ACE exposure and greater health risks (eg, those institutionalised, incarcerated or homeless[37 38]) and will be under-represented, and we could not account for people who had died prematurely. These biases may have led to reduced relative risks. While ACEs showed significant associations with all outcomes, relative risks were not significant at all ACE levels (eg, cancer; ≥4 ACEs only). Further, while we focused on leading health risks and causes of ill health, ACEs have been associated with a wide range of other outcomes (eg, sexually transmitted infections,[39] suicide[40] and crime[41]) that were not accounted for. Estimates were also restricted to adults and thus do not account for the burden of ACEs in children. Consequently, while improved, our estimates of the costs of ACEs in England and Wales are likely to remain conservative.

Findings from this study suggest a substantially greater financial burden of ACEs than previously calculated, with total costs almost tripling from our previous estimates for England and more than tripling for Wales. A large part of this increase relates to the alternative valuation method used, which also explains the greater increase seen in Wales. Wales has a lower GVA (and GDP) per

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capita than England and thus a greater increase to the single willingness-to-pay value used here. However, large increases in estimated costs were seen even when replicating our original approach using GVA per capita (from £2.2 to £2.9 billion in Wales and from £40.6 to £60.5 billion in England). This reflects increases between study years in both GVA and DALY estimates for many outcomes. GVA per capita in 2017 was £19 899 for Wales and £28 096 for England, and £25 742 and £36 632, respectively, in 2023 (current basic prices). GVA per capita was used in our previous study due to GDP not being calculated separately for England and Wales at the time of the study. In particular, a substantial increase was seen in DALYs for mental disorders extracted from the GBD between study years. Conversely, reductions in DALYs were seen for smoking, violence and, in Wales, type 2 diabetes and stroke. While this may be partly accounted for by changes in GBD methodologies between 2017 and 2023, a study using GBD data found a significant increase in the global burden of mental disorders over three decades. Age-standardised DALY rates for 12 mental disorders were found to have increased by 15% between 1990 and 2021, with this increase particularly sharp during the COVID-19 pandemic.[42] In England and Wales, data show declines in mental health in both adults and children,[43 44] with, for example, surveys finding an increase in common mental health problems such as depression and anxiety.[45] Potential drivers include the COVID-19 pandemic, financial inequality exacerbated by the cost-of-living crisis and increasing pressures on young people.[43] Our study highlights the substantial role that ACEs play in driving poor mental health, with around 30% of mental illness attributable to ACEs. Importantly, ACEs have been linked to greater vulnerability to poor mental health during the COVID-19 pandemic[18 19 46] and to poorer coping during the cost-of-living crisis.[16] Addressing ACEs should be a priority to prevent further escalation of mental health burden and to help build resilience against national and global societal shocks.

The high costs attributable to ACEs calculated here have clear implications for policy and investment. A range of evidence-based strategies are available to prevent ACEs and support those affected by them. These include programmes to develop safe, stable, nurturing relationships and environments for children, families and communities; to build life skills and provide quality education and professional training; and to provide services that respond to ACEs and work to reduce their impacts.[47–49] Such programmes must be supported by policy and legislation that address the social determinants of childhood adversity, including poverty, inequality, low education, unemployment and poor access to services.[50] Programmes such as Flying Start in Wales[51] and Best Start Family Hubs in England[52] can provide targeted support using a range of evidence-based strategies, including parenting programmes, early childhood education and access to broader health and community services. However, the impacts of ACEs and the onus to prevent and respond to them span multiple sectors and society as a whole. Accordingly, alongside prevention and the provision of direct response services, there is a developing evidence base for trauma-informed approaches that strengthen understanding of ACEs and trauma and develop skills for prevention and response at broader service and organisational levels.[53 54]

Wales has devolved powers to legislate and enact policy across most areas of public service, including health, education, housing and local government. This has enabled strong government commitment to addressing ACEs and a broad range of actions across multiple agencies.[55] Building on this, the Trauma-informed Wales Framework, published in 2022, sets out a societal approach to understanding, preventing and supporting the impacts of trauma and adversity, ranging from societal awareness and enabling services to specialist clinical intervention.[56] In England, no similar national framework exists, and decisions on such services are increasingly being made at a regional level. Our regional estimates of the health burden and costs of ACEs for England can support this decision-making. With Wales and English regions all facing substantial burdens from ACEs, there would be benefit in greater cross-regional collaboration to share experience and practice and inform the development of effective action.

Our study focused on the health impacts of ACEs measured retrospectively in adult populations. Awareness of ACEs and their consequences has increased substantially in recent decades. In response, a policy focus on specific ACEs, such as physical abuse, may be contributing to reductions in their prevalence.[57 58] However, other types of ACEs, such as verbal abuse[59] and mental illness in the household, may have been less affected and may even be increasing. Consequently, the implementation of policy and prevention interventions (such as Flying Start and Family Hubs) that adopt a broader whole-family approach is welcomed and, if effective, should result in meaningful reductions in levels of multiple ACEs experienced at a population level. Identifying such changes requires timely data on recent exposure to ACEs, which remains limited both in the UK and internationally. Equally, measures to build resilience and develop trauma-informed and responsive systems should attenuate the poorer life course health outcomes associated with ACEs. Ultimately, success should be reflected in lower ACE-related PAFs for health conditions with reduced associated lifetime costs. Almost half of all ACE-attributable costs in this study were accounted for by the ≥4 ACEs category. Successfully addressing such combinations of ACEs requires multi-agency commitment and coordination of health, education, criminal justice and other services. In the UK and elsewhere, these sectors are facing significant financial constraints and service pressures. Our findings indicate that addressing ACEs could alleviate demand and generate substantial economic benefits, as entirely avoidable childhood trauma is prevented or its impacts moderated. While ensuring safe and nurturing childhoods for

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all should be a sufficient rationale for action, evidence of the substantial financial burden of ACEs may provide an additional and regrettably more compelling case for action.

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