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Research article

Associations between childhood deaths and adverse childhood experiences: An audit of data from a child death overview panel

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ABSTRACT

Background: Despite strong associations between adverse childhood experiences (ACEs) and poor health, few studies have examined the cumulative impact of ACEs on causes of childhood mortality.

Methods: This study explored if data routinely collected by child death overview panels (CDOPs) could be used to measure ACE exposure and examined associations between ACEs and child death categories. Data covering four years (2012–2016) of cases from a CDOP in North West England were examined.

Results: Of 489 cases, 20% were identified as having ≥4 ACEs. Deaths of children with ≥4 ACEs were 22.26 (5.72–86.59) times more likely (than those with 0 ACEs) to be classified as 'avoidable and non-natural' causes (e.g., injury, abuse, suicide; compared with 'genetic and medical conditions'). Such children were also 3.44 (1.75–6.73) times more likely to have their deaths classified as 'chronic and acute conditions'.

Conclusions: This study evidences that a history of ACEs can be compiled from CDOP records. Measurements of ACE prevalence in retrospective studies will miss individuals who died in childhood and may underestimate the impacts of ACEs on lifetime health. Strong associations between ACEs and deaths from 'chronic and acute conditions' suggest that ACEs may be important factors in child deaths in addition to those classified as 'avoidable and non-natural'. Results add to an already compelling case for ACE prevention in the general population and families affected by child health problems. Broader use of routinely collected child death records could play an important role in improving multi-agency awareness of ACEs and their negative health and mortality risks as well in the development of ACE informed responses.

1. Introduction

Globally, substantial progress has been made in reducing child mortality over the past several decades. Across Europe, there has been a 65% decline in under-five mortality between 1990 and 2016, yet globally 15,000 deaths of children aged five or under occur per day, mostly from preventable causes (UNICEF, 2017). Improving child survival remains a matter of urgent concern. Whilst infant mortality in England and Wales is a rare but tragic event, recent years have witnessed an increase in mortality rates from 3.6 deaths per 1000 live births in 2014, to 3.8 in 2016 (Office for National Statistics, 2018).

Child death reviews are used as a way of identifying patterns in child deaths and reflecting on what can be learned from the death

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of a child. In 1991, the United States (US) Public Health Service endorsed child death reviews. However, current systems vary on a state by state basis, with some states examining the deaths of all children under the age of 18 and others only where abuse or maltreatment were identified as a contributing factor (Fraser, Sidebotham, Frederick, Covington, & Mitchell, 2014; Webster, Schnitzer, Jenny, Ewigman, & Alario, 2003). Child death overview panels (CDOPs) were introduced across England in 2008, to review the deaths of all children under the age of 18 at a local level. CDOPs operate on behalf of the Local Safeguarding Children's Board (LSCB; a multi-agency body in every local authority that coordinates safeguarding, promotes the welfare of children and ensures that organisations act effectively), with the aim to identify modifiable factors and prevent future deaths. CDOPs collect information from a range of organisations to understand the circumstances of the child's life and death; information that otherwise may never be collated. The panels include multi-agency representation (e.g., health and social care, police, emergency services, safeguarding) who anonymously review all child deaths in their area, generating annual reports on trends and patterns and making recommendations for action when trends in deaths are identified, such as safer sleep campaigns (Officer, 2017).

The multi-agency nature of CDOPs mean that they are able to provide an extensive understanding of the factors surrounding each child's death (Sidebotham, Fox, Horwath, & Powell, 2011). However, the breadth of information collected at CDOPs is not fully utilised, nor is there an epidemiologically informed process for how information gathered is combined to identify the circumstances contributing to child mortality. There is a dearth of research that utilises CDOP data. To date, research on this topic has focussed on the implementation and practice of CDOP (Allen, Lenton, Fraser, & Sidebotham, 2014), how the processes within CDOP have evolved (Fraser et al., 2014), and specific causes of death (Firth, Petherick, & Oddie, 2018). Little research has explored the use of CDOP data in predictive and potentially preventative models for reducing childhood mortality.

Exposure to adversity in childhood is a major global public health concern (Anda, Butchart, Felitti, & Brown, 2010; Hillis et al., 2004). Adverse childhood experiences (ACEs) include harms that can affect children directly, through abuse or neglect, and indirectly through factors in the living environment, for example domestic violence being present in the household or parental incarceration (Anda et al., 2006; Bellis et al., 2015; Hughes et al., 2017). In some cases, ACEs can be fatal (Brown et al., 2009), however, those surviving ACE exposure can be at increased risk of developments in nervous, endocrine, and immune systems which impact adversely on cognitive, social and emotional functioning and increase allostatic load (Danese & McEwen, 2012; Pechtel & Pizzagalli, 2011). Consequently, exposure to ACEs has been associated with increased risk of physical and mental health problems in adulthood (Anda et al., 1999; Chapman et al., 2004, 2011; Dube, Anda, Felitti, Edwards, & Croft, 2002; Ford et al., 2011; Huang et al., 2015; Hughes, Ford, Davies, Homolovai, & Bellis, 2018). Equally, children with long-term health conditions and disabilities are at greater risk of suffering ACEs. A meta-analysis found that children with disabilities were 3.5 times more likely to experience violence than typically developing children (Jones et al., 2012), potentially compounding existing health problems and increasing risks of mortality.

Although prevalence varies, a review of retrospective studies identified that in England and Wales approximately half of adults report suffering at least one ACE, with around 10% experiencing ≥ 4. Internationally, figures for ≥ 4 ACEs range from 1% to 38% (Hughes et al., 2017). The elevated risk of poor health-related outcomes due to childhood adversity has led to international calls to both prevent ACEs and respond effectively to mitigate the associated life-long harms. The prevention of ACEs now features in Government strategy (Welsh Government, 2017) and in 2011, Washington became the first state to enact legislation to reduce the prevalence of ACEs and mitigate their effects (Kagi & Regala, 2012). However, with many ACE studies being retrospective those affected fatally are absent from study populations. Furthermore, assessing current adversity in children is uncommon and challenging, and ACEs are not routinely enquired about in child or youth populations (McGee et al., 2015; Sethi et al., 2013). Thus, it is important that alternative methods of collecting information on early adversity be explored so that the negative, potentially fatal, impacts associated with ACE exposure across different populations are fully understood.

In England, CDOPs provide a unique opportunity to understand how ACEs are associated with childhood mortality. In addition, applying an ACE framework to CDOP data could provide insight into the levels of adversity suffered by children whose death may not be typically attributed to abuse, neglect or other trauma. Such information would illuminate risk factors capable of being addressed by health, social, criminal justice and other agencies through prevention and response measures. Here data routinely collected through CDOP processes in the North West of England is used to measure ACEs in child death cases and their association to different categories of death (e.g., infections or abuse). To our knowledge, this is the first study to utilise routinely collected CDOP data to explore ACEs in children who have died.

2. Methods

2.1. Study design

This research examined data from a four-year period (March 2012 to March 2016). Cases prior to 2012 were collected by CDOP using a different system, thus, were unable to be included in analysis. Further, cases that were under review at the time of data collection were excluded. A final sample of 489 cases was included in the analysis.

CDOP records include information sourced from a range of services and agencies involved with the child and their family. This differs on a case basis but can include social services, safeguarding teams, police, health (i.e., ambulance services, general practitioners and paediatricians, midwifery, health visitors), education, and coroner reports. The information is requested and collated by the CDOP coordinator and is used to inform the discussions in CDOP meetings. All services provide the information in the same format. However, CDOP can request additional information to enable a more accurate dialogue to take place.

Information is stored by the CDOP in anonymised, electronic files. All information held for each included case was made available to the lead researcher for review at the LSCB office using password-protected systems. The lead researcher screened each case and

Table 1
Re-categorization of CDOP causes of death into three study categories.

Study category	Nine CDOP causes of death by study category
Genetic and medical conditions	Chromosomal, genetic and congenital deaths; perinatal and neonatal deaths; malignancy
Avoidable/non-natural deaths	Deliberately inflicted injury, abuse or neglect; suicide or deliberate self-inflicted harm; trauma and other external factors
Chronic and acute conditions	Acute medical or surgical conditions; chronic medical conditions; infection; sudden unexpected, unexplained deaths

securely extracted relevant data, entering it into a separate electronic database. Anonymous information was collected on the child's demographic characteristics (i.e., age, gender and ethnicity) and deprivation. Index of multiple deprivation (IMD) was used as a measure of deprivation. IMD is a small geography measure (calculated at the lower super output area level, LSOA; average population of 1500 individuals) which incorporates seven domains (income, health, employment, education, access to services, community safety and physical environment; Smith et al., 2015) to create a single standardised measure for comparing deprivation between areas. Individuals were assigned to the LSOA of their last known household post code, which was classified according to national quintiles of IMD. CDOP category of death was extracted by the nine causes of death that are routinely recorded by CDOPs in England (see Table 1).

Following previous research that has utilised case-files to identify ACE exposure (Pinto & Maia, 2013), all material pertaining to each case were examined by the researcher to ascertain exposure to 10 types of ACE (Table 2; definitions taken from Bellis et al., 2015 and Meinck et al., 2016). The Centers for Disease Control and Prevention (CDC) short ACE tool was used as a basis for identifying within each child's case notes whether an ACE had occurred at any point in their life. Whilst a number of tools are available to measure childhood maltreatment (see Meinck et al., 2016), the validated CDC short tool has been shown to be reliable in retrospective assessments of adverse childhood experiences (Bynum et al., 2010; Von Cheong, Sinnott, Dahly, & Kearney, 2017; Wade, Becker, Bevans, Ford, & Forrest, 2017). The researcher recorded exposure to any ACE when it had been identified in the case notes by professionals who had worked with either the child or their family. This included where ACEs were reported to have occurred or had been directly observed by any of the agencies involved in providing information to the CDOP. This information was used by the researcher to generate an individual's ACE score - the total number of different types of adversities experienced.

2.2. Statistical analyses

Data were entered into Microsoft Excel on a password-protected computer accessible only by the principal investigator. Consistent with ACE literature, ACE scores were categorised into an ACE count: 0 ACEs, 1 ACE, 2–3 ACEs, and ≥ 4 ACEs (Bellis et al., 2015, 2017; Felitti et al., 1998). Due to small sample sizes within groups, and to align with previous research conducted using CDOP data, CDOP cause of death was categorised into three categories for analyses (Table 1; Pearson, Ward-Platt, Harnden, & Kelly, 2011): genetic and medical conditions, avoidable/non-natural deaths, and chronic and acute conditions. Due to small numbers, ethnicity was grouped into 'White British' and 'Other ethnicities' and age was categorised into under one, one to four years, five to eleven years and twelve to seventeen years old.

Descriptive analyses examined the prevalence of ACEs and their variation across a number of socio-demographic characteristics (demographics, deprivation, number of siblings, and cause of death; Table 3). Bivariate analysis using chi-square and Fisher's exact tests explored the association between ACE score and (1) demographic characteristics (Table 3) and (2) category of death (Table 4). Further, binary logistic regressions (Table 5) identified the independent associations between these factors. Variables were considered significant at a p-value of < 0.05. All statistical analyses were performed on SPSS v.24.

2.3. Ethical considerations

The data was already collated for the purposes of CDOP business and consent for its confidential and anonymous use in this audit

Table 2
ACE definitions used in data collection.

ACE	Definition
Physical abuse	Intentional use of physical force against the child that results in, or has the potential to result in, physical injury
Sexual abuse	Any completed or attempted sexual act, sexual contact with, or exploitation of the child by a caregiver
Emotional abuse	Intentional caregiver behaviour that conveys to a child that they are worthless, flawed, unloved, unwanted, endangered, or valued only in meeting another's needs
Neglect	Failure by a parent or caregiver to meet a child's basic physical, emotional, health, or educational needs, or a combination of these
Domestic violence	Any form of verbal or physical violence between any two adults in the home
Parental separation	Parental or caregiver divorce or separation
Substance misuse	A parent or caregiver in the household who misuses substances, including illegal drugs and prescription medication
Alcohol misuse	A parent or caregiver in the household who misuses alcohol
Mental health issues	An adult in the household with a mental health condition, including depression or, attempted suicide
Incarceration	Having a household member sentenced to serve time in a prison or youth offending institution

Table 3
Relationships between ACE counts, sample demographics and CDOP cause of death.

			ACE count					
		All %	0 %	1 %	2-3 %	≥4 %	X^2	P
	N	489	182	97	112	98		
	All		37.2	19.8	22.9	20.0		
Gender	Male	56.9	36.3	18.3	25.9	19.4	3.505	
	Female	43.1	38.4	21.8	19.0	20.9		0.320
Ethnicity	White British	71.8	32.2	20.5	24.2	23.1	15.381	
	Other	28.2	50.0	18.1	19.6	12.3		0.002
Age group (years)	< 1	62.0	42.6	18.5	24.8	14.2	27.824	
	1–4	15.3	30.7	24.0	13.3	32.0		
	5–11	10.4	33.3	19.6	25.5	21.6		
	12–17	12.3	21.7	21.7	23.3	33.3		0.001
Deprivation quintile	1 (least deprived)	8.6	54.8	26.2	9.5	9.5	17.473	
	2	11.0	37.0	25.9	25.9	11.1		
	3	13.3	38.5	18.5	26.2	16.9		
	4	20.0	36.7	19.4	21.4	22.4		
	5 (most deprived)	47.0	33.9	17.8	24.3	23.9		0.133
Siblings	0	26.0	47.2	26.8	20.5	5.5	62.016	
	1–2	52.1	37.6	17.6	25.9	18.8		
	3–4	17.6	25.6	19.8	20.9	33.7		
	5+	4.3	19.0	4.8	9.5	66.7		< 0.001

Table 4
Relationship between category of death, ACE counts and individual ACEs.

			Cause of death				
		Total % (n = 489)	Genetic and medical conditions % (n = 317)	Avoidable/non-natural deaths % (n = 55)	Chronic and acute conditions % (n = 117)	X^2	P
ACE count	0	37.2	43.8	9.1	32.5	80.820	< 0.001
	1	19.8	24.9	9.1	11.1		
	2–3	22.9	21.1	30.9	23.9		
	≥4	20.0	10.1	50.9	32.5		
ACE category	Physical abuse	6.5	3.5	23.6	6.8	31.188	< 0.001
	Sexual abuse	5.9	1.9	27.3	6.8	54.343	< 0.001
	Emotional abuse	2.9	1.6	7.3	4.3	6.567	0.037
	Neglect	21.1	11.0	52.7	33.3	62.911	< 0.001
	Alcohol misuse	14.7	10.4	34.5	17.1	22.432	< 0.001
	Substance misuse	17.6	13.2	25.9	25.6	11.923	0.003
	Mental health issues	35.4	30.9	43.6	43.6	7.854	0.020
	Incarceration	4.3	1.9	12.7	6.8	15.806	< 0.001
	Domestic violence	36.2	28.1	65.5	44.4	32.885	< 0.001
	Parental separation	32.9	23.0	70.9	41.9	54.240	< 0.001

was given by the Lancashire Local Safeguarding Children's Board and Blackburn with Darwen Borough Council. Ethical approval for the use of the audit data for research purposes was obtained from Bangor University's Healthcare and Medical Sciences Ethics Committee.

3. Results

3.1. ACE prevalence and demographics

The demographic characteristics of the sample are shown in Table 3. Almost two-thirds (62.8%) had experienced one or more ACE, with one in five having experienced ≥4 ACEs (Table 3). The most commonly identified ACE (Table 4) was domestic violence, present in over a third of cases with a similar number having a parent/carer who experienced mental health issues (35.4%; Table 4). The least commonly identified ACE was emotional abuse (2.9%).

ACEs were significantly associated with ethnicity (White British children having a higher prevalence) across all ACE counts compared to other ethnicities ($p < 0.01$). Associations were also found with age, specifically, those aged 12–17 years were seen to have a significantly higher ACE count than other age groups ($p = 0.001$). Of those with five or more siblings, around two thirds (66.7%) had ≥4 ACEs, compared with 5.5% of those with no siblings ($p < 0.001$). No significant associations were found between

Table 5
Binary logistic regression analyses of ACEs and socio-demographic relationships with categories of death.

		Avoidable/non-natural deaths				Chronic and acute conditions			
		AOR	95% CIs		P	AOR	95% CIs		P
ACE count	0	Ref				Ref			
	1	1.32	0.30	5.85	0.713	0.46	0.22	0.97	0.04
	2–3	9.34	2.52	34.70	0.001	1.56	0.85	2.88	0.152
	≥4	22.26	5.72	86.59	< 0.001	3.44	1.75	6.73	< 0.001
Age group (years)	Under 1	Ref				Ref			
	1–4	6.56	2.17	19.80	0.001	3.05	1.59	5.87	0.001
	5–11	2.65	0.67	10.47	0.163	1.57	0.76	3.24	0.227
	12–17	43.89	14.10	136.68	< 0.001	3.17	1.37	7.33	0.007
Gender[a]	Male	1.75	0.75	4.09	0.198	1.16	0.72	1.87	0.537
Ethnicity[b]	White British	1.46	0.50	4.28	0.492	1.089	0.63	1.86	0.774
Deprivation[c]	1	Ref				Ref			
	2	1.56	0.26	9.16	0.625	1.52	0.54	4.28	0.43
	3	0.73	0.12	4.60	0.735	0.41	0.13	1.25	0.117
	4	1.23	0.22	6.84	0.811	0.78	0.29	2.08	0.616
	5	0.61	0.12	3.19	0.554	1.00	0.41	2.42	0.992
Siblings	0	Ref				Ref			
	1–2	1.18	0.34	4.15	0.797	2.03	1.03	4.00	0.040
	3–4	1.68	0.37	7.67	0.502	2.88	1.29	6.42	0.010
	5+	2.01	0.23	17.89	0.533	3.79	1.03	13.92	0.045

AOR: Adjusted Odds Ratio; 95% CIs: 95% confidence intervals; Ref: reference category; Genetic and medical conditions used as reference category.
[a] Female used as reference category.
[b] Other ethnicities used as reference category.
[c] 1: Least deprived; 5: most deprived.

ACE count and gender or deprivation.

3.2. Causes of childhood deaths and ACEs

Nearly two thirds of deaths were classified through CDOP as genetic and medical conditions, with just over one in ten attributable to avoidable and non-natural deaths and almost one quarter due to chronic and acute conditions. There was a strong association between exposure to ACEs and category of death, those who died of genetic and medical conditions predominantly had less ACEs than those who died of other causes of death (Table 4).

Within children who had died of genetic and medical conditions, the most prevalent ACE identified was having a parent/carer who had mental health issues (30.9%) and the least commonly identified was emotional abuse (1.6%). Parental separation was the most identified ACE in avoidable/non-natural deaths (70.9%) and the least commonly identified ACE within this category was emotional abuse (7.3%). Lastly, over two-fifths of children who had died of chronic and acute conditions had domestic violence present in their household (44.4%) and again, the least identified ACE within this group of children was emotional abuse (4.3%).

Almost all children who died as a result of avoidable and non-natural causes experienced at least one ACE, with half (50.9%) exposed to ≥4 ACEs. In comparison, four in ten (43.8%) of those who died of genetic and medical conditions had no ACEs, with only one in ten (10.1%) exposed to ≥4 ACEs; figures were 32.5% for 0 ACEs and 32.5% ≥4 ACEs respectively for those who died of chronic and acute conditions (Table 4).

3.3. Identification of possible predictor variables for cause of death

A binary logistic regression allowed for identifying possible predictors whilst controlling for demographic factors (Table 5). Genetic and medical conditions were used as a reference category as this relates to potentially unavoidable health conditions and the ACE count for this category most closely resembled the ACE prevalence in the general population (genetic and medical conditions: 0 ACEs 43.8%, ≥4 ACEs 10.1%; General population study: 0 ACEs 53.0%, ≥4 ACEs 12.3%; Bellis, Lowey, Leckenby, Hughes, & Harrison, 2014).

A strong association was observed between avoidable/non-natural deaths and exposure to multiple ACEs (Table 5). The likelihood of death classified as avoidable/non-natural cause (vs. genetic conditions) was 22.26 times higher in those with ≥4 ACEs. Equally, likelihood of death categorised as chronic and acute condition (vs. genetic conditions) was 3.44 times more likely in those with ≥4 ACEs.

Compared to individuals aged under 1 year, those aged one to four years and aged twelve to seventeen years were more likely to have died from an avoidable/non-natural cause or from a chronic/acute condition than from a genetic or medical condition (Table 5).

It was hypothesised that deprivation would have a significant association with cause of death independent of ACE count; however, after controlling for other variables, no significant independent association was found between deprivation and categories of death (Table 5).

4. Discussion

The UK experiences one of the worst child mortality rates in Western Europe (Viner, Hargreaves, & Cheung, 2017). Progress in reducing childhood mortality has slowed in comparison to other European nations, whilst child mortality in the US has been higher than in comparable nations since the 1980s (Thakrar, Forrest, Maltenfort, & Forrest, 2018). Advances in neuroscience have provided a framework to explain how childhood adversity may cause negative health outcomes (Danese & McEwen, 2012; Essex et al., 2011) and a substantial body of research has linked ACEs to a number of chronic diseases and early mortality. Studies examining the effects of ACE exposure within childhood are lacking, and it is important to understand the risk factors for potentially preventable deaths. The study evidences that CDOP records can be used to identify a number of ACEs, despite not being formally recorded in the data as such. Secondly, this study has shown that there are high levels of ACEs in deaths where they would be expected (e.g., avoidable and non-natural deaths), but also that ACEs were prevalent in children who had died from other causes where perhaps a higher ACE count would not be expected (e.g., chronic and acute conditions). The findings in this study highlight that this data can be used to explore the epidemiology of child deaths, which can inform future practice and prevention.

Although not directly comparable, a higher prevalence of ACEs amongst children who have died was found than reported in retrospective general population surveys; approximately two-thirds (62.8%) of the current sample experienced at least one ACE in their lives and one in five (20.0%) had experienced ≥ 4 ACEs. A retrospective study conducted across England and Wales found under half (43.7%) of adults have at least one ACE and one in ten reported ≥ 4 ACEs (Bellis et al., 2017). These findings suggest that the prevalence of ACEs in many retrospective studies are likely to be underestimated, as they do not account for individuals already deceased. Further research should explore the prevalence of ACEs in potentially vulnerable populations.

Children categorised as having died from genetic and medical conditions were found to have an ACE prevalence comparable with the general population (10.1%, ≥ 4 ACEs). Unsurprisingly, those categorised as dying from avoidable and non-natural deaths were exposed to substantially higher levels of ACEs than nationally reported levels. However, those categorised as dying from chronic and acute conditions had elevated levels of adversity in their lives too. The findings indicate that multiple ACEs are a predictor of deaths relating to chronic or acute conditions and highlight the importance of considering wider attributable factors such as problems in the household or exposure to adversity within reviews of these cases.

In the current study, deprivation was not shown to have a significant association with either cause of death or ACE count. However, wider environmental, historical and structural factors are associated with adversity. Environments which are characterised by poverty, unemployment, violence, housing instability, and a lack of opportunity or social capital contribute to a situation where adversity is more likely to occur (Ellis & Dietz, 2017). The experience of ACEs is associated with deprivation, with populations living in highly deprived areas more likely to report experiencing four or more ACEs (Bellis et al., 2014). Furthermore, where wider structural inequalities exist, there may be lower levels of social capital and support systems available for individuals at risk of ACEs to draw upon (Lin, 2000). Community resilience can therefore play an important role in creating supportive environments, preventing adversity, or mitigating its negative effects (Ungar, 2011).

ACEs are linked with chronic long-term health risks such as cardiovascular disease and diabetes in adults and have been associated with poor outcomes in childhood such as obesity and asthma (Bellis et al., 2018; Pretty, O'Leary, Cairney, & Wade, 2013; Wing, Gjelsvik, Nocera, & McQuaid, 2015). However, childhood adversity can predict poor health and somatic complaints even at an early age (Flaherty et al., 2013). Individuals exposed to four or more ACEs are five times more likely to have poor childhood health compared to those with no ACEs (Bellis et al., 2018). Suffering multiple ACEs almost triples the risk of illness requiring medical attention in children aged between four and six (Flaherty et al., 2006). Increased efforts to prevent and mitigate against adversity may help to improve the health of children and, results here suggest, reduce child mortality.

Studies have identified that children with illness or disability are at increased risk of abuse or neglect (Hughes et al., 2017; Miller & Brown, 2014). Equally ACEs such as domestic violence and mental health problems in the family can also affect the health of children. However, CDOPs may not necessarily consider children's health as a risk factor or certain social or health problems in parents and caregivers as related to a child's health conditions. Whilst additional research is needed to identify the extent of these links, the results here suggest levels of ACEs in those with chronic and acute conditions are considerably elevated and their potential impact requires further consideration.

The results identified that those who had high ACE counts also had a high number of siblings. Whilst the immediate issues of safeguarding siblings from similar harms and adversity may be typically considered by CDOP, the long-term impact of exposure to ACEs on their general health and well-being may not. In fact, adolescent exposure to adversity is often overlooked (Flaherty et al., 2013) but can be significant. Moreover, previous research has stated that child death review teams need to show an increased ability to move from case review to effective action, with research highlighting gaps between the information collected and its use to inform policies and practice (Fraser et al., 2014; Gijzen, Petter, L'Hoir, Boere-Boonekamp, & Need, 2017). Given that a number of children in this study who died from a medical condition also suffered adversity, there are likely to be siblings remaining in households where adversity has not been fully considered or addressed.

Although English data was used in this study, results on ACEs are likely to have relevance for other countries and systems that review child deaths. CDOPs and other similar systems may currently consider a wide range of factors that potentially play a part in the death of a child. A broader ACE-informed approach to the review of all child deaths may increase understanding of underlying contributing factors to deaths and critically help protect others at risk. England only records modifiable factors that may have played a direct part in the child's death (Garstang, Ellis, Griffiths, & Sidebotham, 2016), whilst internationally, differing approaches to child death reviews mean they may only explore cases that are assumed to be as a result of maltreatment. CDOPs may therefore not provide an accurate reflection of the prevalence of factors that might impact on a child's death and this could have implications on how

childhood deaths are classified.

This study has highlighted that child death reviews hold information that can be used to identify ACEs, and that widening the scope of child death reviews to explore exposure to cumulative adversity may be important in further understanding, preventing and learning from childhood deaths. As such, the organisations involved in CDOPs have the potential to identify risks in families that would otherwise be missed, but that may contribute to a child's death. The strong association between ACEs and childhood mortality identified in this study, highlights how, by interacting with the wider health system, CDOPs can use ACE data as an exemplar of the impact of adversity on children and the need for wider preventative activity. Improving ACE awareness across CDOPs could enable professionals (e.g., health services, police, and education) involved in CDOPs to understand the potential outcomes of ACE exposure and identify where preventative work should be directed. Successful examples exist of improved staff training and awareness and prospective enquiry of ACEs in children to address risk factors for maltreatment (e.g., Safe Environment for Every Kid [SEEK] program; Dubowitz et al., 2011). Systems can therefore incorporate a knowledge of ACEs into policy and practice, and become trauma-informed (Gillingham, 2006).

Research has identified that the stakeholders who regularly contribute to child death reviews, such as the police and the education sector, often lack understanding of ACEs and the short and long-term implications of suffering trauma (Ford et al., 2017; Kerker et al., 2016). A better knowledge of ACEs, their immediate and long-term effects in child death review panels and within the range of sectors who contribute to CDOPs could improve the identification of those at risk.

There are a number of limitations that should be considered when interpreting the findings of this study. The sample utilised secondary case-file data which is collated retrospectively after the death of a child. CDOPs and similar child protection organisations rely on the collation of documents from a variety of organisations, which can differ for each individual whose death is reviewed, depending on their service involvement. However, the use of case-file data offers the opportunity to study rare outcomes, allowing investigators to aggregate information from a range of agencies. Data collected by CDOP relies on accurate information that should be used to underpin national strategies for child health and wellbeing. However, inaccuracies can exist in the processes of death certifications. For example, deaths can be wrongly classified particularly when complex co-morbidities exist (Sidebotham, Hunter, Appleton, & Dunkley, 2015), and the need to identify a single cause of death can be restrictive (Fraser et al., 2014).

Here ACE identification was dependent on the professional reporting of childhood maltreatment; identification of abuse and other experiences may depend on individual and professional interpretations. The current CDOP practices and policies may not reflect a true account of the types of adversity a child experiences in their lives. Research has shown that databases recording child maltreatment can both under- and over-represent the presence of adversity (Bromfield & Higgins, 2004), and that the co-occurrence of multiple forms of adversity is particularly under-estimated (Kim, Mennen, & Trickett, 2017). Consequently, ACE counts may be a misrepresentation of actual exposure. Previous research has shown that ACE categories such as emotional abuse are often covert and can be hard to define and recognise routinely (Glaser, 2002; Trickett, Mennen, Kim, & Sang, 2009), and therefore are difficult to assess through case-file analysis (Pinto & Maia, 2013). This may account for the low prevalence of emotional abuse identified in this sample. Exposure to verbal abuse as an ACE was not included in this study due to a lack of reliable and valid information for its identification. Furthermore, the data was collected by one researcher. Whilst this ensured consistency between all cases it also resulted in identification of ACEs relying on one individuals' interpretation of case materials.

The ACE categories used in the current study are not an exhaustive list. Discussions around expanding the concepts of adversity to more accurately represent experiences across sociodemographic groups may add to the prediction of mental and physical health problems (Cronholm et al., 2015; Finklehor, Shattuck, Turner, & Hamby, 2015). Other limitations specific to the use of the ACE methodology also apply: for example, the summing of exposure to ACEs into a count does not account for variations in the timing and duration of ACE exposure (Hughes et al., 2017). However, the ACE questions and analytical methodology follows that established elsewhere in the literature to provide a cumulative measure of adversity (Anda et al., 2006) and employs a binary measure for whether any individual ACE was present or absent. Further work should examine outcomes by both frequency and the level of severity of exposure to ACEs. Due to the use of retrospective data, analyses presented here cannot establish causality.

Early childhood adversity has been shown to have long-lasting impacts on reproductive health, including associations between parental ACEs, low birth weights and preterm births, which can increase the risks of perinatal and neonatal deaths (Smith, Gotman, & Yonkers, 2016). This could have implications when discussing perinatal and neonatal cases at multi agency child death reviews. Future research that includes information on the parents own experiences of adversity may be helpful in understanding childhood deaths further, whilst allowing for an additional exploration of the intergenerational cycles of abuse and adversity.

Finally, the sample used in this study was relatively small, covering only three local authorities with higher than national average deprivation and ethnic diversity. Whilst IMD was included in the study as a measure of deprivation, further data was not available to explore the potential influence of other wider structural factors, for example, racism, victimisation and social isolation. Future research could utilise a larger sample across multiple CDOPs to allow for further exploration of the associations between causes of death and ACE counts.

5. Conclusions and future directions

This study is the first of its kind to explore ACE prevalence amongst children who have died, identifying that ACEs could be recognised within death case review records. The high ACE prevalence in children who have died suggests that retrospective studies have potentially underestimated the level of childhood trauma across society; with fatalities removing some individuals from studies who may be disproportionately affected by ACEs. In addition, it highlights a high ACE prevalence within children who have died from avoidable and non-natural causes as well as childhood deaths that were classified as chronic and acute conditions, often not

attributed to abuse or neglect. Multi-agency child reviews provide a framework for detailed investigations of deaths and this study reiterates the need to invest in the prevention of ACEs and improve multi-agency awareness of childhood adversity and its immediate and long-term negative impacts health and mortality risks.

Currently, ACEs are not comprehensively addressed within multi-agency reviews of children's deaths and incorporating adversity into these discussions should be explored as part of protecting living siblings and identifying actions to prevent future child mortality risks. This study has implications for how child death reviews record ACEs, as well as evaluating how an awareness of adversity may impact on the interventions and policies that such panels employ. By becoming ACE-informed, services that contribute to child death reviews have the opportunity to understand how children and their families can be better supported so that risks of child deaths or other non-fatal but often life-long harms to children are minimised.

Declarations of interest

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