

Comparison of person-centred and cumulative risk approaches in explaining the relationship between adverse childhood experiences and behavioural and emotional problems.

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*Accepted for publication in **Journal of Interpersonal Violence***

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Abstract

Adverse childhood experiences (ACEs) commonly co-occur, and researchers often estimate their impact using a cumulative risk approach. The person-centred approach offers another approach to operationalise the co-occurrence of ACEs. This study aims to estimate latent classes of ACEs in a sample of UK children, examine their relationship with emotional and behavioural problems, and compare the explanatory value of the latent classes to cumulative risk scores. Data were collected among a general population sample of British 10-year-old children extracted from the UK Household Longitudinal Study ($N = 601$). Seven items characterised ACEs, comprising parent-report physical discipline, emotional abuse, supervisory neglect, maternal psychological distress, and child-report parental educational disinterest, bullying victimisation, and adverse neighbourhood. Outcome measures were derived from the self-report Strengths and Difficulties Questionnaire including total difficulties, emotional symptoms, conduct problems, hyperactivity, peer problems, and prosocial behaviour. Latent class analysis resulted in a 3-class solution: *low ACEs*, *household challenges*, *community challenges*. Compared to the other classes, the *community challenges* class scored substantially worse on total difficulties, emotional symptoms, and peer subscales. The cumulative risk score was associated with all outcomes except prosocial behaviour. Cumulative risk models accounted for a larger proportion of variance compared with the latent class models, except for peer problems which the person-centred model explained better. This study confirms that ACEs are associated with impairment in child functioning, and that both person-centred and cumulative risk approaches can capture this relationship well. Specifically, the person-centred approach demonstrated how co-occurring risks factors in the *community challenges* class produced particularly poor internalising outcomes.

Keywords: Adverse Childhood Experiences; Latent class analysis; Person-centred approach; Cumulative risk approach

Introduction

Adverse childhood experiences (ACEs) have been linked to many negative outcomes, but underlying mechanisms remain elusive. Several studies examined the relationship between a summed score of seven adversities (e.g. physical abuse, parental substance use), and outcomes including alcoholism, drug abuse, depression, suicide attempts, and smoking (e.g. Chapman et al., 2004; Edwards et al., 2003; Felitti et al., 1998). These studies concurred in finding a dose-response relationship between the number of ACEs and outcome severity. More recently, Hughes et al.'s (2017) meta-analysis of 137 studies found exposure to four or more ACEs (compared to no ACEs) substantially worsened outcomes, with particularly strong risks associated with problematic drug or alcohol use, self-directed or interpersonal violence, sexual risk taking, and mental ill health.

The predominant approach to operationalising ACEs has been the cumulative risk approach, which treats each categorical ACE as equally additive to an overarching effect. Consequently, the cumulative risk approach does not distinguish specific types of adversity and provides limited insight into the risks of exposure to specific ACEs. The discovery of homogeneous patterns of risk co-occurrence might be beneficial for practitioners, who might see the presence of one risk factor as a marker of the likely presence of other risks. Knowledge about patterns of co-occurrence and associated outcomes might also help to identify people who are particularly vulnerable to adversity. Models which can provide these unique insights might prove to be a valuable alternative to the cumulative risk approach.

One such method is the person-centred approach, which uses latent class analysis (LCA) with categorical data or latent profile analysis (LPA) with continuous data to identify unobserved groups defined by patterns of co-occurring items (Lanza & Rhoades, 2013). A key assumption of this approach is that the distribution of ACEs can be explained by groups of individuals who have experienced similar patterns of ACEs. Each group has an estimated likelihood of the presence of each item. Classes can be distinguished quantitatively (i.e. high/low probability of all items) and qualitatively (i.e. high probability of some items, low probability of other items). Membership of computed latent classes can be used to estimate outcomes associated with that class, or to highlight groups at higher risk of class membership (e.g. Debowska et al., 2018). The effects of different combinations of ACEs and those who are at most risk of the worst outcomes can be ascertained through the person-centred approach, which might be informative for intervention and prevention strategies.

Qualitatively homogeneous groups can be difficult to summarise from study to study, perhaps due to differences in measuring ACEs. Alternatively, this might be due to the relatively recent adoption of LCA for ACE items. Further refinement of the person-centred approach to ACEs might elucidate general population-level trends, as has been done with child maltreatment. For instance, a systematic review of child maltreatment LCA studies found that a 3- or 4-class solution is fairly typical, quantitatively distinct classes (i.e. no/low abuse and poly-victimisation) were common, and while qualitative classes varied between studies a sexual abuse class was observed somewhat consistently (Debowska et al., 2017). Studies varied in using child, adolescent, and adult samples, and used a range of data collection methods such as self-report, parent-report, and child welfare records, all of which may have contributed to variation in class solutions.

Formal comparisons between cumulative risk and person-centred approaches

Studies utilising both cumulative risk and person-centred approaches agree that greater numbers of ACEs are associated with worse outcomes, although some LCA studies have demonstrated that qualitative classes are also informative. One study using a community sample of children identified a 7-class model, (Lanier et al., 2018) where the classes with the strongest association to health outcomes were a high ACEs class, and a parental mental illness and poverty class. However, the 7-class solution in this study included small classes (< 5% membership) which could be regarded as spurious without theoretical justification (Hipp & Bauer, 2006). Another study sampled American undergraduate students and found a 4-class model comprising high ACEs, moderate risk of non-violent household dysfunction, emotional and physical abuse, and low ACEs (Merians et al., 2019). While the high ACEs group was associated with the most severe outcomes, the emotional and physical abuse class only differed slightly from the high ACEs class, which implies that this qualitative class is particularly potent.

The cumulative risk approach and the person-centred approach are both viable approaches to operationalising ACE co-occurrences among different age groups (Lian et al., 2022). Formal comparisons of explanatory utility approaches have so far produced inconclusive results. For instance, Merians et al. (2019) compared approaches using nine ACE items among a sample of undergraduate students, with the outcomes concerning mental health, physical health, alcohol use, and academic performance. A 4-class solution was compared to nominal groupings of 0, 1, 2, 3, 4, and 5 or more ACEs; both models explained similar magnitudes of variance. However, this could be an inappropriate comparison because the number of categorical groups in each model was unbalanced. Another study compared LCA and cumulative risk approaches in relation to chronic inflammation outcomes (Lacey et al., 2020). This study found a 4-class solution (low ACEs, polyadversity, parental mental illness and substance misuse, maltreatment and conflict). While the cumulative risk approach

produced a dose-response relationship for three inflammation markers, the person-centred approach produced different outcomes for each class. The polyadversity and maltreatment and conflict classes were associated with the highest scores for different inflammation markers. This study presents subtle differences in outcomes by latent class typology, which suggests that the combination of maltreatment and familial conflict might pose a specific risk for chronic inflammation, which was not captured by the cumulative risk approach.

There are several limitations in the literature assessing the measurement of ACEs which could contribute to inconsistent findings. First, much research relies on retrospective data. A recent meta-analysis found poor agreement between prospective and retrospective measures of child maltreatment (Cohen's $k = 0.19$), so study design could impact results (Baldwin et al., 2019). The focus on adult retrospective data limits understanding of latent classes in children and how age of onset might modify the effect of ACE exposure (Debowska et al. 2017). Second, many studies using LCA/LPA utilise samples with a wide age range (e.g. Lanier et al., 2018). This can compromise validity because participants aged 11-18 have had more time to accumulate adversity than 10-year-olds, and developmental stages could modify the impact of ACEs based on sensitive periods of maturation. Third, many studies use American samples, which might limit the generalisability to other populations. Fourth, there is inconsistency in how ACEs are conceptualised. The original specification of ACEs included seven items (Felitti et al., 1998), but the number of adversities included in measurements varies. A recent study recommended the inclusion of variables such as bullying victimisation and social ostracism (Finkelhor et al., 2015).

The current study

The current study aims to a) explore latent classes of ACEs (physical discipline, emotional abuse, supervisory neglect, educational disinterest, maternal psychological distress,

bullying victimisation, adverse neighbourhood) in a UK household sample of 10-year-old British children; b) identify relationships between identified classes and child behaviour and emotional problems; c) compare latent class and cumulative risk approaches in explanatory validity of child behaviour and emotional problems. Given that prior research findings are inconsistent, no predictions are made regarding the content of emerging latent classifications. This current study will address several limitations in the exploration of cumulative risk and person-centred approaches to ACEs, and their relation to emotion and behaviour outcomes in children. First, ACEs were measured concurrently during childhood, so the present study does not rely on retrospective self-report data. Second, the sample was restricted to children aged 10 years old which eschews the confounding effects of age. Third, the population sampled is a non-American community sample, which supplements the evidence base currently reliant on American samples. Fourth, the ACEs included were chosen to reflect the broadening concept of ACEs, which resulted in the inclusion of ACEs such as bullying victimisation, adverse neighbourhood, and (parental) educational disinterest. This study will contribute to the growing knowledge of how ACEs co-occur, and the explanatory value of person-centred and cumulative risk approaches to operationalising ACEs.

Method

Sample and Data

We used data from the general population youth sample at wave 3 of the UK Household Longitudinal Study (UKHLS) to perform cross-sectional analysis. This was collected 2011-2013, from approximately 24,000 households (University of Essex, 2020). We only used data collected concerning children aged 10 years old. Data were collected through paper self-completed and parent-reported questionnaires. Oral consent was given by

participants at each wave. Adults were incentivised to participate with a £10 voucher, while children received £3 vouchers. The University of Essex Ethics Committee approved data collection. All data were accessed after End User License approval from the UK Data Service (<https://beta.ukdataservice.ac.uk/datacatalogue/studies/study?id=6614>).

Only observations with complete ACEs data were included in analysis, which resulted in $n = 119$ observations being dropped. The final sample (after participants with missing ACE data had been removed) used for analysis is $N = 601$, with a balanced sample of males (48.8%, $n = 293$) and females (51.2%, $n = 308$). Most of the sample were White British or Irish (82.5%) and the remaining 17.5% were from Asian, Black, or mixed ethnic backgrounds, which closely represents the UK population (ONS, 2012).

Measures

Confidential computer-assisted self-report data from child participants and parent-report data were retrieved to create variables representing ACEs. In total, seven binary adversity indicators were created, see Supplementary Table 1 for all contributing items.

Parent-report adversities

Three parent-reported adversities, *physical discipline* (five items, e.g. “I use physical punishment as a way of disciplining [child’s name]”), *emotional abuse* (two items, e.g. “I scold and criticise to make [child’s name] improve”), and *supervisory neglect* (one item, “I punish [child’s name] by putting him/her somewhere alone with little or no explanation”), were adapted from the parent-report parenting styles questionnaire (see Robinson et al., 1995). All item responses followed a five-point likert scale: “never”, “once in a while”, “about half the time”, “very often”, and “always”. Items were dichotomised for latent class analysis, defined as present for: “about half the time”, “very often”, or “always”, and absent for “never” or “once in a while”. “Once in a while” was treated as absent to follow the

approach taken elsewhere (see Felitti et al., 1998) where psychological and physical abuse were only recorded as present if parents “often or very often” engaged in a behaviour.

Maternal psychological distress was self-reported by mothers using the Short General Health Questionnaire (GHQ-12; Goldberg & Williams, 1988). The summed caseness scale gives values between 0 (least distressed) and 12 (most distressed), based on items such as “Have you recently felt you couldn’t overcome your difficulties?”. Researchers have previously found that using 3 as a cut-off provides a good balance of sensitivity and specificity for screening mental illness diagnoses (Goldberg et al., 1998). For analysis, maternal psychological distress was dichotomised so that values between 3-12 were coded as present, values between 0-2 were coded as absent, which identified 26.3% of mothers to be experiencing psychological distress.

Child self-report adversities

Items adapted from child self-report questionnaires were dichotomised from five-point likert scales although the response items differ slightly. We identified three ACEs: *educational disinterest* (two items, e.g. “My parents are interested in how I do at school”), *bullying victimisation* (two items, e.g. “How often do you get physically bullied at school?”), and *adverse neighbourhood* (two items, e.g. “How safe would you feel walking alone in this area after dark?”). For educational disinterest, responses of “hardly ever” or “never” were coded as present, and “always or nearly always”, “sometimes”, and “not sure” as absent; for bullying victimisation “a lot” or “quite a lot” were coded as present, and “not much or never” as absent; and for adverse neighbourhood “a bit unsafe” and “very unsafe” were coded as present, and “very safe” or “fairly safe” as absent for the question about safety, and “a bit of a worry” and “a big worry” coded as present, and “an occasional doubt” and “not a worry at all” as absent for the question about worrying about being a victim of crime.

Strengths and Difficulties Questionnaire

The self-report SDQ comprises five subscales each containing five items. The subscales measure “emotional symptoms” (e.g. “I am often unhappy, depressed or tearful”), “conduct problems” (e.g. “I get very angry and often lose my temper”), “hyperactivity” (e.g. “I am restless, I cannot stay still for long”), “peer problems” (e.g. “I would rather be alone than with people of my age”), and “prosocial behaviours” (e.g. “I try to be nice to other people. I care about their feelings”). Each item is scored from 0 to 2 as “not true”, “somewhat true”, or “certainly true”, making the total score for each subscale between 0 to 10. SDQ scores were derived in the UKHLS dataset prior to researchers gaining access, only the derived scales variables were retrieved from the dataset. Subscale scores were marked by the data controller as missing if more than two out of five items are missing, but if only one contributing item was missing a response the subscale score was retained. A total difficulties score range from (0 to 40) was a sum of the emotional symptoms, conduct problems, hyperactivity, and peer problems scales. The SDQ is useful in screening for psychiatric problems in children (Goodman et al., 2000). Elsewhere, in a sample of Dutch children, self-report SDQ subscales have demonstrated mixed internal consistency, total difficulties ($\alpha = .78$), emotional symptoms ($\alpha = .71$), conduct problems ($\alpha = .45$), hyperactivity ($\alpha = .72$), peer problems ($\alpha = .54$), prosocial behaviour ($\alpha = .62$) (Muris et al., 2003), and good predictive validity in relation to child mental health outcomes (Goodman & Goodman, 2009). We recommend caution in interpreting results regarding conduct problems and peer problems, as these subscales have been criticised elsewhere (see Sharratt et al., 2018).

Data analysis

Latent class analysis was utilised to explore the number and nature of qualitatively homogeneous patterns of ACE exposure (physical discipline, emotional abuse, supervisory

neglect, maternal psychological distress, parental educational disinterest, bullying victimisation, and adverse neighbourhood). As latent class analysis is an exploratory process, models of between 2 and 7 classes were specified. No single index distinguishes the best model. We tested relative model fit by comparing k class models to $k - 1$ class models, using conventional indices such as Akaike Information Criteria (AIC; Akaike, 1974), Bayesian Information Criteria (BIC; Schwarz, 1978), sample-size adjusted BIC (SSABIC; Sclove, 1987), the Lo-Mendell-Rubin adjusted likelihood test (LMR-LRT; Lo et al., 2001), parametric bootstrapped likelihood ratio test (BLRT; Arminger et al., 1999), and entropy values (Ramaswamy et al., 1993). The AIC, BIC, and SSABIC are used similarly; lower values for model with k number of classes compared to $k - 1$ indicate a model with better relative fit. LMR-LRT and BLRT test relative fitness through a significance test by comparing model k to $k - 1$. Larger entropy values indicate a larger proportion of correctly classified observations, where values approaching 1 indicate better classification of observations. Simulation studies found that the BLRT test performed best, followed by the BIC and SSABIC values (see Nylund et al., 2007), and that SSABIC improves on BIC when sample sizes are $N < 1000$ (Yang, 2006). For each model the AIC, BIC, SSABIC, LMR-LRT, BLRT, and entropy values are presented. As our sample size is relatively small, greater emphasis is placed on SSABIC than AIC and BIC, but the model with best fit should have high agreement between AIC, BIC, and SSABIC, and the LMR-LRT and BLRT significance tests. Entropy values will be used to judge whether the model solution categorises observations to an acceptable level ($> .80$; Ramaswamy et al., 1993).

To explore relationships between most likely class membership and child behaviour and emotional symptoms, ANOVAs were run with latent class membership as the predictor variable, and SDQ scales (total difficulties, emotional symptoms, conduct problems, hyperactivity, peer problems, prosocial behaviour) as the outcomes. Cohen's d values were

estimated to compare the effect of belonging to each class. To compare person-centred and cumulative risk approaches, ANOVAs were repeated using the cumulative risk score (summed dummy indicators of exposure to adversity) with the same number of groups as the latent class groupings. All ANOVAs were repeated with sex and ethnicity included as covariates. Direct comparisons between person-centred and cumulative risk models were made by computing Hay's omega-squared (ω^2) for both sets of models by each outcome. Additionally, a regression was computed which included dummy coded latent class and cumulative risk groupings in the model. Latent class analyses were conducted using Mplus version 8.6 (Muthén & Muthén, 1998-2017), while data management and other analyses were conducted using Stata MP 16 (StataCorp, 2019).

Results

Descriptive information

Table 1 shows the least frequent ACE was supervisory neglect (3.5%), and the most frequent was adverse neighbourhood (34.6%). The average number of ACEs reported was 1.29 ($SD = 1.11$) (range of 0-6). The majority reported at least one ACE (74.9%) but only 4.2% reported four or more ACEs.

[Table 1 here.]

Latent Class Model selection

Table 2 shows enumeration statistics for models specifying 2-7 latent classes. AIC and SSABIC values, as well as BLRT significance test favoured the 3-class model, whereas BIC values favoured the 2-class model. Entropy values for models of 3-7 classes indicated good classification of observations, but relative fit statistics for models of 4-7 were

unfavourable. The 3-class solution was conceptually meaningful and selected for further analysis. Item endorsement probabilities for each class are presented graphically in Figure 1.

[Enter table 2. here.]

[Figure 1 here.]

Class descriptions

Class 1 comprised the majority of the sample ($n = 540$, 89.9%) and was labelled “*low ACEs*” due to low endorsement probability of all items. Class 2 comprised a minority of the sample ($n = 36$, 6%) and was labelled “*household challenges*” due to the moderate to high probabilities of emotional abuse and physical discipline. The remaining items were of comparable probability to the *low ACEs* class. Class 3 also comprised a minority of the sample ($n = 25$, 4.2%) and was labelled “*community challenges*”. This class was characterised by high probabilities of bullying, adverse neighbourhood, and emotional abuse. Other items were of comparable probability to the *low ACEs* class.

Differences between classes regarding emotional and behavioural outcomes.

Six one-way ANOVAs were computed using latent class groupings as the independent variables and the SDQ scales as outcome variables (see Table 3). For total difficulties, emotional symptoms, and peer problems, significant F values were observed (after Bonferroni correction). Additionally, ANOVAs repeated with sex and ethnicity included as covariates remained significant for total difficulties, emotional symptoms, and peer problems (see Supplementary Table 2). Group comparisons were made through observation of the means and standardised effect sizes (Cohen’s d). Effects of .2, .5, and .8 were treated as small, medium, and large respectively (Cohen, 1992).

[Insert Table 3 here]

The *community challenges* class differed had the highest score for each SDQ scale (excluding prosocial behaviour) compared to the *low ACEs* classes. Compared to the *household challenges* class, the *community challenges* class had a higher total difficulties, emotional problems, and peer problems. When comparing the *community challenges* class to the *low ACEs* class, we observed large effect sizes for total difficulties and peer problems, and medium effect sizes for emotional symptoms and conduct problems, all with the *community challenges* class scoring higher. Comparisons between *community challenges* and *household challenges* classes indicate large differences in magnitude for the total difficulties and peer problems, and moderate differences in magnitude for emotional symptoms, again all with the *community challenges* class scoring higher. Differences between *household challenges* and *low ACEs* classes were all non-significant based on effect size confidence intervals.

Associations between cumulative risk of ACEs and SDQ outcomes

Table 3 presents the cumulative risk approach to assessing the relationship between adversities and SDQ scales. Groups were created to reflect the same number of groups as latent classes. Here, the groups have been formulated as 0-1 ACEs, 2-3 ACEs, and the widely adopted 4 or more ACEs group (e.g. Hughes et al., 2017). ANOVAs indicated the cumulative risk grouping of adversities was significantly (after Bonferroni correction) associated with all SDQ scales except prosocial behaviour. All ANOVAs were re-run with sex and ethnicity included in the model, which did not substantively alter the observed relationships (see Supplementary Table 3). As expected, comparisons between the 4 or more ACEs group and 0-1 ACEs produced the largest effect sizes, specifically large for emotional symptoms and total difficulties, and moderate for peer problems and conduct problems. Comparisons between 2-3 ACEs and 0-1 ACEs showed small differences for emotional problems, conduct problems, hyperactivity, peer problems, and a moderate difference for total difficulties. Only

one significant difference was observed between 4 or more ACEs and 2-3 ACEs, which was a small difference in emotional problems.

Comparison between latent class and cumulative risk models

Comparisons between person-centred and cumulative risk approaches were made using Hay's ω^2 , presented in both Table 3 and 4. Statisticians have identified values of .01, .06, and .14 as estimates of small, medium, and large magnitudes respectively (Kirk, 1996). For total difficulties, emotional symptoms, conduct problems, and hyperactivity, the cumulative risk models accounted for more variance. For peer problems, the latent class model accounted for more variance. Both latent class and cumulative risk models accounted for small or medium magnitudes of variance for total difficulties, emotional symptoms, conduct problems, hyperactivity, and peer problems.

Regressions were run with dummy coded latent class and cumulative risk variables concurrently for SDQ scales, minus prosocial behaviour (see Table 5). At the Bonferroni corrected alpha level, the *community challenges* class significantly contributed to the model for the peer problems outcome alone. The 2-3 ACEs cumulative risk group was a significant contributor for total difficulties, emotional symptoms, hyperactivity, and peer problems, while the 4 or more ACEs group was significant for emotional symptoms.

[Table 4 here.]

[Table 5 here.]

Discussion

This study addressed the co-occurrence of adversities in a UK household cohort, testing how latent adversity classes related to domains of behavioural and emotional problems in childhood, and compared person-centred and cumulative risk approaches to

operationalising ACEs. The findings add to the growing literature adopting LCA in the study of ACEs and offers insight into the explanatory value of the person-centred and cumulative risk approaches for behavioural and emotional outcomes in children.

Using latent class analysis, three homogeneous classes were extracted: *low ACEs*, *community challenges*, and *household challenges*. The *low ACEs* class had a low probability of all items, the *community challenges* class had a much larger probability of bullying, adverse neighbourhood, and emotional abuse, while the *household challenges* class had a high probability of emotional abuse and physical discipline. The class solution implies that ACEs either co-occurred mostly within the household, or in the wider community (with the overlap of emotional abuse). This is an interesting notion for intervention and prevention, because clinicians might be concerned that the presence of bullying, or an adverse neighbourhood could be a marker for other adversities. The presence of a class characterised by little or no exposure to ACEs is in line with findings elsewhere, but the absence of a high ACEs class was unexpected. This may be due to the low sample size unable to capture the high ACEs group, or the absence of some ACEs observed in the dataset.

Comparison of means between classes found that the *community challenges* class had faced more adverse outcomes compared to both other classes, with moderate or large differences observed for total difficulties, peer problems, and emotional symptoms. The co-occurrence of emotional abuse in addition to adversities in the community might contribute to the potency of this co-occurrence. There is already strong evidence to link bullying victimisation to mental health problems (Moore et al., 2017), and a recent meta-analysis found that perceived neighbourhood crime was strongly associated with mental health outcomes (Baranyi et al., 2021). The large effects associated with the combination of these adversities is consistent with the literature elsewhere. Our findings could be of clinical

interest to identifying children at high risk of emotional and behavioural problems in the community. Future studies might be well placed to test the impact of these co-occurrences.

It is perhaps counterintuitive that the *household challenges* class scored similarly to a class with low probabilities of all adversities, especially since the severe effects of child maltreatment have been widely documented (e.g. Gilbert et al., 2009). One potential explanation is that the emotional abuse and physical discipline items were adapted from a parent-report questionnaire about parenting styles (see Robinson et al., 1995) and therefore might not reflect abusive parenting practices as well as other measures. Alternatively, the questionnaire being parent-reported might have led to underreporting as parents have been found to underreport ACEs compared to their offspring (Fisher et al., 2011).

Comparison of means between cumulative risk groups (0-1 ACEs, 2-3 ACEs, 4 or more ACEs) found that the 2-3 ACEs and 4 or more ACEs groups had worse difficulties scores compared to the 0-1 ACEs group. Although notably there was only one significant difference between the 2-3 ACEs and 4 or more ACEs groups, which does not imply a linear effect. Observed differences were larger for internalising outcomes (emotional symptoms, peer problems) than externalising problems (hyperactivity, conduct problems), which was also observed in the latent class models. This could indicate that the adversities included in this study are more closely related to internalising problems than externalising problems. It has been found elsewhere that certain ACEs (e.g. physical abuse, sexual abuse, and physical neglect) predict externalising problems better than internalising problems (Petrenko et al., 2012), which supports the use of person-centred approaches to understand the relationship between co-occurrence profiles of ACEs and specific outcomes.

Formal comparisons between latent class and cumulative risk models were made by comparing Hay's ω^2 values, and by including both latent class and cumulative risk groupings

in regression models. The latent class model explained more variance in the peer problems subscale. However, the cumulative risk model explained more variance for the remaining outcomes, excluding prosocial behaviour which neither model captured well. In regression models where dummy variables of both latent class and cumulative risk groupings were included, the *community challenges* group was a significant contributor to the peer problems outcome. The 2-3 ACEs group was a significant contributor to the total difficulties, emotional symptoms, hyperactivity, and peer problems, and the 4 or more ACEs group was a significant contributor to emotional symptoms. This suggests that even when accounting for the number of ACEs, the *community challenges* group provides unique insight to explaining peer problems. This further suggests that while the cumulative risk approach is very useful, the person-centred approach may be particularly beneficial for targeting intervention and prevention strategies to specific subgroups at risk of or exposed to ACEs in the community context.

These findings should be interpreted in the context of other published comparisons made between person-centred and cumulative risk approaches. Other studies (e.g. Merians et al., 2019) tend to examine ACEs using retrospective self-report in adulthood, which has been found to produce only modest overlap with concurrent self-report in identifying occurrence of abuse (Baldwin et al., 2019). Young adults retrospectively reporting on ACEs have reported experiencing more ACEs (Radford et al., 2013), so differences in results between our study and previous studies could be due to the disparate age of participants, or the confounds of memory. Indeed, Lacey et al. (2020) found different results based on prospectively and retrospectively reported ACEs in relation to inflammation. Additionally, our study measured outcomes in childhood, whereas both Merians et al. (2019) and Lacey et al. (2020) measured adult outcomes. It is reasonable to expect different causal pathways or different magnitudes of effect between ACEs and outcomes in childhood compared to adulthood, even if outcomes

are similar in valence. However, we cannot imply the development or persistence of these problems as our analyses are cross-sectional. Future research designs would be well placed to compare person-centred and cumulative risk models over multiple timepoints. This would enable researchers to better estimate the effect of developmental sensitivities (as recommended by Debowska et al., 2017), as well as examine reverse causation which cannot be examined in cross-sectional studies.

Limitations and future studies

The conclusions drawn in this study must be considered in the context of several limitations. First, class enumeration statistics did not unanimously support one solution in the latent class analysis. This might be explained by difficult modelling conditions such as low number of items and relatively small sample size which compromises the performance of AIC and BIC (Yang, 2006). However, our class solution was theoretically meaningful and demonstrated external validity through associations with relevant outcomes. Second, the ACE items were drawn from a mixture of self-report and parent-report, meaning that our results are vulnerable to underreporting from parents, or common-method variance bias from self-report. It is unclear to what extent these biases impact estimations, but the combination of two types of data collection likely reduces the effect of common method variance. Third, data regarding important ACEs such as sexual abuse, and information such as age at onset, chronicity, and severity of ACEs were not observed. However, several ACEs that are usually measured were included, as well as items not normally included such as bullying victimisation. It would be informative to consider age of onset, length of exposure, severity, confounding factors such as socioeconomic status, genetic variation, and birth risks in future research (Debowska et al., 2017; Hughes et al., 2017). Future studies would also benefit from adopting a validated measure of ACEs which includes additional adversities such as the revised inventory of ACEs (Finkelhor et al., 2015) to better estimate co-occurring risks.

Conclusions

This research study contributes to the ACEs literature by formulating latent classes in a UK sample of children and comparing person-centred and cumulative risk approaches to operationalising ACEs. Results suggest that the cumulative risk approach accounts for more variance in most regards, but that the person-centred approach generates unique insights. Both cumulative risk and person-centred approaches characterised ACEs well characterised, and specific latent classes conferred risk for specific problems in childhood. Future studies should explore the usefulness of cumulative risk (dichotomised or ordinal) and person-centred approaches, include a broad array of ACEs, and utilise longitudinal data to compare these competing approaches at different stages in childhood and their relevance to adulthood.

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Table 1.

Observed proportions of adverse childhood experiences in whole sample and by sex and ethnicity.

Adversity	Whole sample	Male	Female	White	Ethnic minority
Physical discipline	6.5%	8.2%	4.9%	5%	13.3%
Emotional abuse	30.6%	35.8%	25.7%	28.4%	41%
Supervisory neglect	3.5%	4.4%	2.6%	2.4%	8.6%
Maternal psychological distress	26.3%	28.7%	24%	24.6%	34.3%
Educational disinterest	12.8%	14.7%	11%	12.1%	16.2%
Bullying victimisation	15.1%	19.8%	10.7%	15.9%	11.4%
Adverse neighbourhood	34.6%	30%	39%	33.3%	41%
ACEs score mean (SD)	1.29 (1.11)	1.42 (1.13)	1.18 (1.08)	1.22 (1.04)	1.66 (1.32)

Note. Whole sample, $n = 601$; Male, $n = 293$, Female, $n = 308$, White, $n = 496$, Ethnic minority, $n =$

Table 2.*Class enumeration statistics for latent class models of two to six classes of adverse childhood*

No of classes	Log-likelihood	AIC	BIC	SSABIC	Entropy
2	-1797.12	3524.24	3690.219	3642.598	.736
3	-1780.624	3607.249	3708.416	3635.397	.876
4	-1773.031	3608.062	3744.418	3646.002	.903
5	-1767.245	3612.49	3784.035	3660.221	.84
6	-1762.265	3618.531	3825.265	3676.052	.855
7	-1758.517	3627.035	3868.958	3694.347	.863

experiences.

Boldface indicates acceptable values for each criterion (entropy is evaluated by a cut-off of .8; LRT adjusted and BLRT by an alpha value of .05, while AIC, BIC, and SSABIC are evaluated by comparison with $k - 1$ models).

Figure 1

Model-estimated class specific item-probability profile plot of 3-class model.

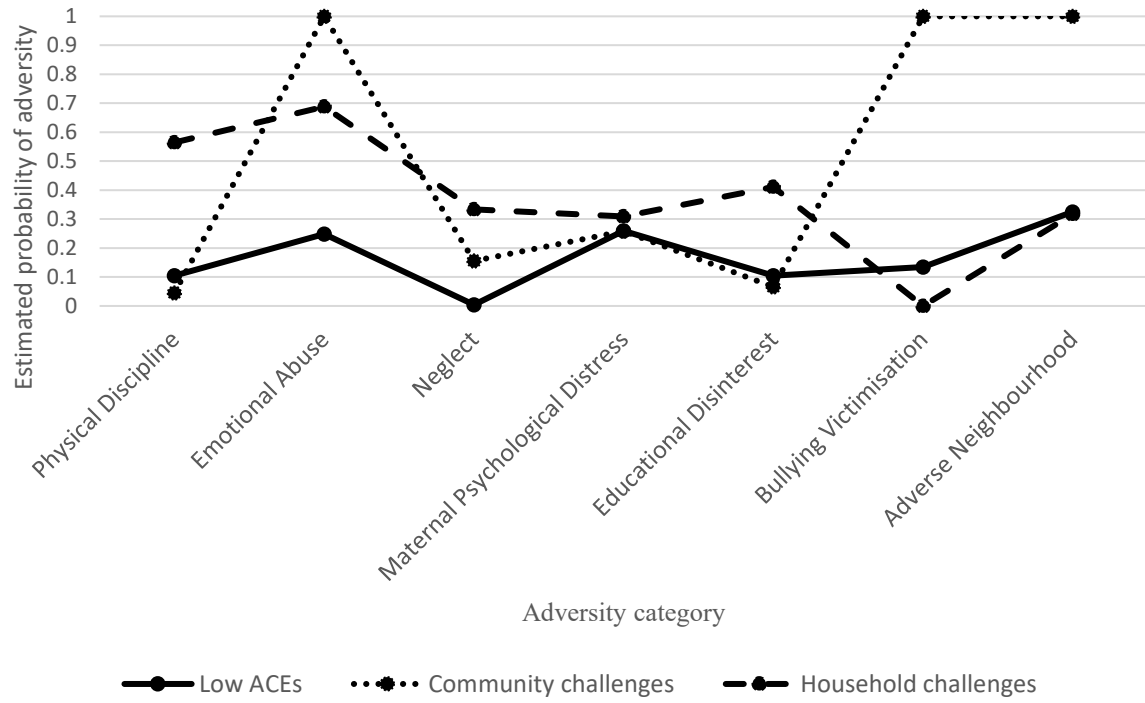


Table 3

Person-centred models and comparison of Strengths and Difficulties subscale outcomes between identified latent classes.

Outcome	Outcome means per class (<i>SD</i>)			Cohen's <i>d</i> [95% Confidence Interval]			<i>F</i>	<i>p</i>	ω^2
	Low ACEs	Household challenges	Community challenges	Community Low ACEs	Household Low ACEs	Community Household challenges			
Total difficulties	9.91 (5.33)	10.29 (5)	15.28 (5.71)	1.00 [.60, 1.41]	.07 [-.27, .41]	.94 [.40, 1.48]	12.16	<.001	.036
Emotional problems	2.54 (2.04)	2.75 (1.95)	4.12 (2.11)	.77 [.37]	.1 [-.24, .44]	.68 [.15, 1.2]	7.22	<.001	.02
Conduct problems	1.98 (1.57)	2.44 (1.80)	2.76 (1.61)	.50 [.10, .90]	.30 [-.04, .63]	.18 [-.33, .69]	4.18	.016	.011
Hyperactivity	3.65 (2.15)	3.81 (2)	4.56 (1.80)	.43 [.02, .83]	.07 [-.27, .41]	.39 [-.12, .91]	2.22	.109	.004
Peer relationship	1.72 (1.64)	1.46 (1.56)	3.84 (1.77)	1.29 [.88, 1.70]	-.16 [-.51, .18]	1.44 [.86, 2.01]	20.71	<.001	.062
Prosocial behaviour	8.35 (1.61)	8.14 (1.76)	7.92 (1.80)	-.27 [-.67, .13]	-.13 [-.47, .21]	-.12 [-.63, .39]	1.09	.337	.0003

Note. Low ACEs class n = 540, Household challenges class n = 36, Community challenges and emotional abuse class n = 25. Sample size for each model

varies between 595-598 dependent on occasional missing data. Extreme values were winsorised to the lower/upper extreme values. Boldface indicates

significant group differences where confidence interval does not cross 0. Bonferroni corrected alpha, $\alpha = .003$.

Table 4*Comparison of Strengths and Difficulties subscale outcomes between cumulative risk groupings.*

Outcome	Outcome means per class (<i>SD</i>)			Cohen's <i>d</i> [95% Confidence Interval]			<i>F</i>	<i>p</i>	ω^2
	0-1 ACEs	2-3 ACEs	4 or more ACEs	4 or more vs 0-1	2-3 vs 0-1	4 or more vs 2-3			
Total difficulties	9.15 (5)	11.96 (5.72)	13.08 (5.46)	.78 [.37, 1.20]	.54 [.36, .72]	.20 [-.23, .62]	21.62	<.001	.065
Emotional problems	2.32 (1.96)	3.08 (2.12)	4.08 (2)	.90 [.49, 1.31]	.38 [.20, .55]	.48 [.05, .90]	15.66	<.001	.047
Conduct problems	1.86 (1.53)	2.35 (1.62)	2.52 (1.83)	.42 [.02, .83]	.31 [.14, .49]	.10 [-.32, .52]	7.26	<.001	.021
Hyperactivity	3.44 (2.07)	4.21 (2.23)	4.08 (1.73)	.31 [-.09, .72]	.36 [.19, .54]	-.06 [-.48, .36]	8.75	<.001	.025
Peer relationship problems	1.53 (1.49)	2.27 (1.90)	2.71 (2.05)	.77 [.36, 1.19]	.45 [.28, .63]	.23 [-.20, .66]	16.24	<.001	.049
Prosocial behaviour	8.38 (1.56)	8.24 (1.73)	7.96 (1.97)	-.27 [-.67, .14]	-.09 [-.26, .09]	-.16 [-.58, .26]	1.12	.328	.0004

Note. 0-1 ACEs group *n* = 393, 2-3 ACEs group *n* = 183, 4 or more ACEs group *n* = 25. Sample size for each model varies between 595-598 dependent on occasional missing data. Extreme values were winsorised to the lower/upper extreme values. Boldface indicates significant group differences where confidence interval does not cross 0. Bonferroni corrected alpha, $\alpha = .003$.

Table 5.

Associations between latent class and cumulative risk groupings and outcomes.

Outcome	Community Challenges		Household Challenges		2-3 ACEs		4 + ACEs	
	β	p	β	p	β	p	β	p
Total difficulties	.115	.01	-.078	.077	.239	<.001	.12	.011
Emotional problems	.060	.189	-.074	.102	.178	<.001	.172	<.001
Conduct problems	.061	.191	.024	.599	.124	.005	.051	.303
Hyperactivity	.036	.428	-.043	.349	.172	<.001	.060	.219
Peer relationship problems	.181	<.001	-.116	.008	.199	<.001	.010	.034

Note. Regressions were not run for the prosocial behaviour outcome because neither latent class or cumulative risk models were significant in the first instance. Boldface indicates significant β value at the Bonferroni corrected $\alpha = .003$

Adversities and their contributing items.

Adversities	Items
Physical discipline ^a	“I use physical punishment as a way of disciplining [child]” “I spank [child] when [he/she] is disobedient” “I explode in anger towards [child]” “I grab [child] when [he/she] is being disobedient” “I slap [child] when [he/she] misbehaves”
Emotional abuse ^a	“I scold and criticise to make [child] improve” “I scold or criticise when [child]'s behaviour doesn't meet my expectations”
Supervisory Neglect ^a	“I punish [child] by putting [him/her] somewhere alone with little or no explanation”
Maternal Psychological Distress ^a	Reported using the Short General Health Questionnaire (GHQ-12; Goldberg & Williams, 1988)
Educational disinterest ^b	“My parents are interested in how I do at school” “My parents come to school parents’ evenings”

Bullying Victimization^b

“How often do you get physically bullied at school, for example getting

hit, pushed around or threatened, or having belongings stolen?”

“How often do you get bullied in other ways at school such as getting

called names, getting left out of games, or having nasty stories spread

about you on purpose?”

Adverse Neighbourhood^b

“How much do you worry that you might be a victim of a crime?”

“How safe would you feel walking alone in this area after dark?”

Note. ^a = parent-reported items, ^b = child-reported items.

Supplementary Table 2.

Latent class and SDQ subscale ANOVAs re-run with sex and ethnicity in the model.

Outcome	Model		Latent Class		Sex		Ethnicity	
	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>
Total difficulties	10.51	<.001	11.36	<.001	15.62	<.001	1.01	.316
Emotional problems	4.72	.001	7.63	.001	4.22	.04	.09	.76
Conduct problems	7.15	<.001	3.49	.031	18.55	<.001	.95	.331
Hyperactivity	11.84	<.001	1.77	.171	37.16	<.001	4.05	.045
Peer relationship problems	13.73	<.001	19.76	<.001	12.75	<.001	0	.975
Prosocial behaviour	7.37	<.001	.52	.595	27.17	<.001	.02	.901

Supplementary Table 3.

Cumulative risk and SDQ subscale ANOVAs re-run with sex and ethnicity in the model.

Outcome	Model		Cumulative risk		Sex		Ethnicity	
	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>
Total difficulties	15.76	<.001	21.54	<.001	15.75	<.001	2.24	.135
Emotional problems	9.04	<.001	16.21	<.001	4.67	.031	.04	.837
Conduct problems	8.88	<.001	6.82	.001	18.95	<.001	1.12	.29
Hyperactivity	15.56	<.001	8.71	<.001	36.78	<.001	5.37	.021
Peer relationship problems	11.52	<.001	15.43	<.001	12.54	<.001	.25	.621
Prosocial behaviour	7.47	<.001	.73	.484	27.53	<.001	0	.956