

# BMJ Open

## Adverse Childhood Experiences (ACEs) and Later-life Depression: Perceived Social Support as a Potential Protective Factor

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2016-013228
Article Type:	Research
Date Submitted by the Author:	28-Jun-2016
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<b>Primary Subject Heading</b>:	Public health
Secondary Subject Heading:	Mental health, Epidemiology, Evidence based practice, General practice / Family practice, Public health
Keywords:	MENTAL HEALTH, Adverse Childhood Experience(s), Depression & mood disorders < PSYCHIATRY

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**TITLE PAGE****Title: Adverse Childhood Experiences (ACEs) and Later-life Depression: Perceived Social Support as a Potential Protective Factor**

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- 1) Medicine and the Humanities and Social Sciences Conference, Sam Houston State University, Huntsville, Texas, USA; March 4 – 5 2015
- 2) The Atlantic Medical Corridor Conference, University College Cork, Western Road, Cork, Ireland; November 10 2014
- 3) The 18<sup>th</sup> International Conference on Public Health, The World Academy of Science, Engineering and Technology, London; May 23 – 24 2016

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3 **Keywords:** Childhood experience, Community Mental Health, Depressive Disorders,  
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5 Epidemiology  
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8 **Word Count:** 3766  
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14 **What is already known on this subject?**  
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16 Adverse childhood experiences (ACEs) are common and have been linked to poorer health  
17 and wellbeing across the life course. While the prevention of ACEs is a worthwhile goal, it is  
18 important that we also try to lessen the impact of ACEs for those who do experience them.  
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24 **What this study adds?**  
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26 In a population-based study of Irish older adults, we found that ACEs were strongly  
27 associated with depressive symptoms in people who perceived themselves as having poor  
28 social support. Conversely, amongst study participants who perceive themselves as having  
29 better social support, there was no statistical relationship between ACEs and subsequent  
30 depression. These results have important implications for clinicians seeking to prevent mental  
31 illness among survivors of childhood adversity. Interventions that aim to prevent poor mental  
32 health outcomes among survivors of childhood adversity should focus on strengthening  
33 *perceptions* of available support in addition to increasing actual availability of social support.  
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## ABSTRACT

**Objective:** To investigate associations between adverse childhood experiences (ACEs) and later-life depressive symptoms; and to explore whether perceived social support (PSS) moderates these.

**Method:** We analysed baseline data from the Mitchelstown (Ireland) 2010-11 cohort of 2047 men and women aged 50–69 years. Self-reported measures included ACEs (Centre for Disease Control ACE questionnaire), PSS (Oslo Social Support Scale), and depressive symptoms (CES-D). The primary exposure was self-report of at least one ACE. We also investigated the effects of ACE exposure by ACE scores and ACE subtypes *abuse*, *neglect*, and *household dysfunction*. Associations between each of these exposures and depressive symptoms were estimated using logistic regression, adjusted for socio-demographic factors. We tested whether the estimated associations varied across levels of PSS (poor, moderate, and good).

**Results:** 23.7% of participants reported at least one ACE (95% CI: 21.9% to 25.6%). ACE exposures (overall, subtype or ACE scores) were associated with a higher odds of depressive symptoms, but only among individuals with poor PSS. Exposure to any ACE (vs. none) was associated with almost 3 times the odds of depressive symptoms (Adjusted OR 2.85; 95% CI 1.64 to 4.95) among individuals reporting poor PSS, while among those reporting moderate and strong PSS, the adjusted ORs were 2.21 (95% CI 1.52 to 3.22) and 1.39 (95% CI 0.85 to 2.29) respectively. This pattern of results was similar when exposures were based on ACE subtype and ACE scores.

**Conclusions:** ACEs are common among older adults in Ireland and are associated with higher odds of later-life depressive symptoms among those with poor PSS. Interventions that

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3 enhance perception of social support may help reduce the burden of depression in older  
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5 populations with ACE exposure.  
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## 8 **ARTICLE SUMMARY**

### 9 10 **Strengths & Limitations of this Study**

- 14 • Wide range of demographic and health information collected using validated,  
15 standardized instruments and questionnaires
- 17 • Large sample size (n = 2047)
- 18 • Study population is representative of the source population reported in national census  
19 data
- 20 • Assessment of 10 types of ACEs under three ACE subtypes i.e. abuse, neglect,  
21 household dysfunction
- 22 • Informs future interventions seeking to prevent or manage mental ill-health among  
23 those with ACE exposure
- 24 • ACE questionnaire previously shown to have good test-retest reliability
- 25 • Risk of recall bias from retrospective self-report

## 26 **INTRODUCTION**

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42 A life-course approach to mental health views mental illness as a product of  
43 biological and social factors that operate across the lifespan(1). The stress sensitisation  
44 theory(2) suggests that childhood adversity reduces an individual's threshold for developing  
45 depressive reactions towards stressful events, causing one to have depressive reactions  
46 towards current mild stressors or greater reactivity towards severe stressful events. For  
47 example, young women who were exposed to childhood adversities such as domestic  
48 violence, parent psychopathology and alcoholism, are at a higher risk for depression  
49 following exposure to mild stress than women without a history of adversity(3). Women with  
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3 a history of childhood abuse have higher ACTH, cortisol and heart rate responses to  
4 psychosocial stress such as public speaking, compared to those without a history of childhood  
5 abuse(4). These psychosocial and neurobiological findings converge on the idea that early  
6 life adversities have an enduring effect on how one responds to stressful life events, hence,  
7 setting the life-course trajectory for one's mental health.  
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14 Adverse childhood experiences (ACEs) encompass any acts of commission or  
15 omission by a parent or other caregiver that result in harm, potential for harm, or threat of  
16 harm to a child in the first 18 years of life, even if harm is not the intended result(5). While  
17 the association between ACEs and poor mental health has been reported previously(6-9),  
18 there remains a lack of research on factors that may modify this relationship. Identifying  
19 factors that alter the processing of stressful events following exposure to ACEs may be a  
20 valuable tool in developing interventions aimed at preventing or mitigating the long-term  
21 mental health consequences of ACEs(10).  
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33 Social support may have a protective or buffering effect against the consequences of a  
34 stressful event by enhancing cognitive and emotional processing of the experience(11, 12).  
35 This facilitates reappraisal of the stressful event in a manner that is psychologically  
36 adaptive(11, 12). Findings from meta-analyses have found a lack of social support to be the  
37 single strongest predictor of post-traumatic stress symptoms in both military and civilian  
38 populations with a history of psychological trauma(11, 13). Importantly, perception of  
39 available social support was found to be a better buffer of psychological distress than actual  
40 availability of social support(11, 14). This suggests that enhancing perception of available  
41 support may be just as important, if not more, than increasing actual social support in  
42 interventions aimed at moderating psychological effects of stress. Although a number of  
43 studies have generated findings supportive of the role of perceived social support, most of  
44 these studies were focussed on female victims of childhood sexual abuse(15, 16).  
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3 This present study aims to build on prior research by examining whether three ACE  
4 subtypes (abuse, neglect, and household dysfunction) are related to later-life depressive  
5 symptoms, and if so, whether these associations vary across levels of perceived social support  
6 (PSS). In line with recent work that suggests that multiple ACEs have an increasingly greater  
7 effect on mental health, this study also aims to examine the association between ACE scores  
8 and depressive symptoms, and if perceived social support differentially impacts depressive  
9 symptoms across an accumulation of ACEs.  
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## 19 **METHOD**

### 20 **Study Design and Population**

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22 Our analysis uses baseline data from the Mitchelstown cohort(17), a study of 50- to 69-year-  
23 old adults randomly selected from patients attending the Livinghealth Clinic in Mitchelstown,  
24 Ireland in 2010-11. The study population is representative of the profile of the source  
25 population reported in national census data(17). A complete description of the study was sent  
26 out to all selected participants with a reply slip indicating acceptance or refusal. After written,  
27 informed consent was obtained, the participants completed a detailed health and lifestyle  
28 questionnaire and attended a physical examination conducted by research nurses using  
29 standardised and validated instruments. Participants were offered separate sealed envelopes  
30 to submit their responses to the ACE questionnaire during data collection. Ethical approval  
31 for the original study was granted by the Clinical Research Ethics Committee of the Cork  
32 Teaching Hospitals.  
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### 49 **Predictors**

#### 50 *Adverse Childhood Experiences*

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52 Exposure to ACE was assessed using the ACE questionnaire(18, 19) which addresses 10  
53 individual ACEs under three categories:  
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3 Abuse: emotional, physical and sexual abuse  
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6 Neglect: emotional and physical neglect  
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9 Household dysfunction: parental separation/divorce, violence against mother, household  
10 substance abuse, household mental illness, and incarceration of household member.  
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13 The ACE questionnaire is a reliable and valid measure of childhood adversity that has been  
14 used extensively in large-scale ACE studies(18, 19).  
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18 All questions about ACEs pertained to the respondents' first 18 years of life and were binary  
19 (yes vs. no). From these, a dichotomous variable was created to reflect exposure to any ACE,  
20 and similar variables were created to reflect any exposure to each ACE subtype (abuse,  
21 neglect, household dysfunction). We also calculated a total ACE score for each participant  
22 (+1 for each of the 10 types of ACE reported). ACE scores of 3 and above were combined  
23 into one category due to small sample sizes in some strata, and the score was treated as a  
24 categorical variable (0, 1, 2, or  $\geq 3$ ) to capture any potential non-linearities in the relationship  
25 with depressive symptoms. This method of ACE score categorisation has been used in  
26 previously (20, 21).  
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#### 42 *Perceived Social Support*

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45 PSS was assessed using the self-administered Oslo Social Support Scale with three  
46 questions(22):  
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50 Oslo 1: How many people are you so close to that you can count on them if you have great  
51 personal problems? (none (1), 1–2 (2), 3–5 (3), 5+ (4))  
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55 Oslo 2: How much interest and concern do people show in what you do? (a lot (5), some (4),  
56 uncertain (3), little (2), none (1))  
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3 Oslo 3: How easy is it to get practical help from neighbours if you should need it? (very easy  
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5 (5), easy (4), possible (3), difficult (2), very difficult (1))  
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8 The response categories were assessed independently for each of the three questions, and a  
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10 sum score was created by summarizing the three scores. The Oslo Social Support Scale has  
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12 been used in several studies, thus confirming its feasibility and predictive validity with  
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14 respect to psychological distress(23, 24). A sum score ranging between 3 and 8 was  
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16 categorised as *poor*, a score between 9 to 11 as *moderate*, and a score of 12 to 14 as *strong*  
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18 PSS (22). This categorisation was used previously in a study assessing PSS in a population of  
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20 older adults(25).  
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## 23 24 **Outcomes**

### 25 26 27 *Depressive Symptoms*

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29 The CES-D questionnaire(26) was used to assess for depressive symptoms. The items of the  
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31 scale are symptoms associated with depression which have been used in longer, previously  
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33 validated instruments, and have been tested in both household and clinical settings(26). It has  
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35 very high internal consistency and adequate test-retest repeatability(26).  
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39 The score is a sum of 20 questions. The possible range of scores is 0 to 60, with higher scores  
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41 indicating the presence of greater symptomatology. A score between 16 and 21 on the CES-D  
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43 scale indicates the presence of *mild to moderate* depressive symptoms while a score of 22 or  
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45 above indicates the possibility of *major* depression(26). Participants with a score of  $\geq 16$  were  
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47 defined as having depressive symptoms(26). This cut-off point has been used extensively in  
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49 other studies in identifying individuals at risk of clinical depression(27, 28).  
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## 52 53 **Covariates**

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3 Educational attainment was ascertained by the question ‘What is the highest level of  
4 education you have completed?’ and responses were categorized into primary, secondary or  
5 tertiary level.  
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10 Current marital status was ascertained by the question ‘What is your current marital status?’  
11 and the options were single (never married), separated, cohabiting, divorced, married, or  
12 widowed.  
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17 Participants were asked whether they were covered by the General Medical Services (GMS)  
18 scheme, which entitles those covered to free medical care at the point of access. Responses  
19 were categorized as GMS patient (yes/no). GMS eligibility is based on low-income  
20 thresholds.  
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25 Smoking status was categorized as never smoked, current smoker or former smoker in  
26 response to the questions ‘have you smoked at least 100 cigarettes in your entire life?’ and  
27 ‘are you a current smoker?’  
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32 Alcohol consumption was derived from the question ‘During the past 7 days how many  
33 standard drinks of any alcoholic beverage did you have each day?’ and was categorized as  
34 non-drinker (< 1 unit/week), moderate drinker (1 – 14 units/week), and heavy drinker (> 14  
35 units/week)(29).  
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40 Physical activity was measured as metabolic equivalents (METs) minutes per week using the  
41 short-form International Physical Activity Questionnaire(30) and was categorized into 3  
42 groups (low, moderate or high) based on MET minutes per week in all activity types.  
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47 Height and weight were measured using standardized methods by study personnel and used  
48 to calculate body mass index (BMI, kg/m<sup>2</sup>). Participants were classified as underweight if  
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3 their BMI was  $< 18.5 \text{ kg/m}^2$ , normal if  $18.5$  to  $< 25 \text{ kg/m}^2$ , overweight if  $25$  to  $< 30 \text{ kg/m}^2$  and  
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5 obese if  $\geq 30 \text{ kg/m}^2$ .  
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## 8 **Statistical Methods**

### 9 *Descriptive Data*

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14 Continuous variables were described by means and standard deviations. Categorical variables  
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16 were described by counts and percentages. Student's T-test, one-way ANOVA, or Pearson's  
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18 Chi square test were used as appropriate to test for differences in the distributions of  
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20 demographic, health and lifestyle measures between the groups with and without ACE.  
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### 24 *Logistic regression*

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28 Associations between each ACE exposure (any ACE, each ACE subtype, and ACE score)  
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30 and depressive symptoms were estimated using logistic regression in two models, A and B.  
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32 Model A included the main effects of the ACE exposure, PSS, and a product interaction term  
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34 between the two. Model B included additional predictors which were selected using directed  
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36 acyclic graphs (DAGs) (Supplementary Figure 1) to adjust for potential confounding and  
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38 selection biases. These were age, gender, and educational attainment, current marital status  
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40 and GMS cover (Supplementary Figure 1). Results were reported as odds ratios with 95%  
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42 confidence intervals.  
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### 47 *Missing Data*

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51 Missing data were handled using multiple imputation. Thirty imputed datasets were created,  
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53 after a burn-in of 30 replications, using predicted mean matching(31). The imputation model  
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55 included all variables included in this analysis, and allowed for non-linear relationships using  
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3 restricted cubic splines with 3 knots. Parameter estimates were combined using Rubin's  
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5 rules(32). A complete case sensitivity analysis was also performed for comparison.  
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9 All analyses were conducted using the R Project for Statistical Computing (V 3.3.1)(33).  
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## 11 12 13 14 15 16 **Research reporting**

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18 The STROBE guidelines were used to inform the study report.  
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## 21 22 23 24 **RESULTS**

### 25 26 27 **Baseline Characteristics**

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29 Of the 3051 people invited to participate in this study, 2047 (67%) completed the baseline  
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31 assessment. The mean age at baseline was 55.8 years and 51% of the participants were  
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33 female.  
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37 Of these, 1926 (94%) completed the ACE questionnaire. 23.7% (n = 457; 95% CI 21.9 to  
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39 25.6) of the respondents reported at least one form of adverse childhood experience. 16.1% (n  
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41 = 302, 95% CI 14.4 to 17.7) of the participants reported depressive symptoms.  
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45 The characteristics of respondents with and without self-reported ACEs are summarised in  
46  
47 Table 1. Prevalence of participants with a CES-D score indicative of major depression was  
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49 significantly higher among participants who reported ACE compared to participants who did  
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51 not, (14.1% vs. 6.0%,  $p \leq 0.001$ ). Prevalence of poor PSS was also higher among participants  
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53 who reported ACEs (19.6% vs. 10.7%,  $p \leq 0.001$ ). Participants who reported ACEs tended to  
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3 be younger, separated/divorced, have GMS cover, reported long-term illness/disability and  
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5 had attained tertiary education.  
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For peer review only

**Table 1: Baseline characteristics of participants in the Mitchelstown cohort study, 2010–11 stratified by self-reported Adverse Childhood Experience (n = 1926)**

Characteristics	With ACE (N = 457; 23.7%)	Without ACE (N = 1469; 76.3%)	Group Difference			Missing Data N (%)
			Estimate*	Test statistic**	Df	
<b>Age (years)</b>	53.6 (16.9)	56.6 (15.2)	3.54	1924	≤ 0.001	0
<b>Sex</b>						
Male	234 (51.2)	707 (48.1)	1.32	1	0.25	0
Female	223 (48.8)	762 (51.9)				
<b>Marital Status</b>						
Single (never married)	45 (10.0)	116 (8.0)	28.85	3	≤ 0.001	18 (0.9)
Co-habiting/Married	334 (74.2)	1175 (80.6)				
Separated/divorced	52 (11.6)	73 (5.0)				
Widowed	19 (4.2)	94 (6.4)				
<b>Socio-economic</b>						
Perceived Social Support						
Poor	86 (19.8)	148 (10.6)	27.10	2	≤ 0.001	101 (5.2)
Moderate	193 (44.5)	632 (45.4)				
Strong	155 (35.7)	611 (43.9)				
Education						
Primary	116 (26.9)	382 (27.7)	10.57	2	0.01	117 (6.1)
Secondary	192 (44.4)	701 (50.9)				
Tertiary	124 (28.7)	294 (21.4)				
General Medical Services Cover						
Yes	158 (34.6)	432 (29.4)	4.31	1	0.04	0
No	299 (65.4)	1037 (70.6)				
<b>Personal health behaviours</b>						
Smoking						
Never smoked	200 (45.0)	750 (52.9)	8.93	2	0.01	64 (3.3)
Former smoker	175 (39.4)	462 (32.6)				
Current smoker	69 (15.5)	206 (14.5)				
Alcohol						
Non-drinker	56 (17.7)	202 (21.4)	3.07	2	0.22	667 (34.6)
Moderate drinker	208 (65.6)	610 (64.8)				
Heavy drinker	53 (16.7)	130 (13.8)				
Physical activity						
Low	211 (49.8)	667 (47.7)	0.70	2	0.70	104 (5.4)
Moderate	120 (28.3)	423 (30.3)				
High	93 (21.9)	308 (22.0)				
<b>Personal health history</b>						
Self-rated health status						
Very good	123 (27.2)	435 (30.1)	12.06	4	0.02	30 (1.5)

Good	235 (52.0)	804 (55.7)				
Fair	81 (17.9)	178 (12.3)				
Poor	11 (2.4)	20 (1.4)				
Very Poor	2 (0.4)	7 (0.5)				
Long-term illness/Disability						
Yes	74 (19.6)	144 (11.8)	14.66	1	≤ 0.001	331 (17.2)
No	304 (80.4)	1073 (88.2)				
Hypertension						
Hypertensive	198 (43.3)	699 (52.4)	2.62	1	0.11	2 (0.1)
Non-hypertensive	259 (56.7)	768 (47.6)				
Diabetes						
Diabetic	39 (8.8)	121 (8.4)	0.05	1	0.90	44 (2.3)
Non-diabetic	406 (91.2)	1316 (19.6)				
Body Mass Index						
Normal	97 (21.2)	329 (22.5)				
Overweight	196 (42.9)	669 (45.7)	2.82	3	0.28	4 (0.2)
Obese	164 (35.9)	467 (31.9)				
Mental health						
Depression						
No symptoms	309 (71.2)	1153 (84.8)				
Mild to moderate Possibility of major depression	64 (14.7)	125 (9.2)	44.34	2	≤ 0.001	133 (6.9)
	61 (14.1)	81 (6.0)				

\* Estimates are reported as Mean (SD) for continuous variables; and N (%) for categorical variables

\*\* Differences in means were tested using Student's t-test; dependence between categorical variables was tested using Pearson's chi-squared test

### Logistic regression

Table 2 gives ORs and 95% CIs for Models A and B where *any ACE* is the exposure variable. Exposure to any ACE was associated with almost 3 times the odds for depressive symptoms among participants reporting low PSS (Adjusted OR = 2.85, 95% CI 1.64 to 4.95). The association between any ACE and depressive symptoms was substantially attenuated with moderate PSS (OR 2.21, 95% CI 1.52 to 3.22), and strong PSS (OR 1.39, 95% CI 0.85 to 2.29). The estimates were similar in the unadjusted and adjusted models (Figure 1), as were results from the complete case analysis (Supplemental Table 1).

Similarly, each ACE subtype was also associated with increased odds of depressive symptoms among individuals reporting low PSS, and this association was reduced among individuals reporting moderate and high PSS (Figure 1, and Supplemental Tables 2-4). The odds of depressive symptoms among those reporting abuse (vs not) were more than five times greater in individuals reporting low PSS (OR 5.20, 95% CI 2.71 to 9.99), three times greater in those reporting moderate PSS (OR 3.22, 95% CI 2.11 to 4.92), but only slightly increased in those reporting high PSS (OR 1.29, 95% CI 0.68 to 2.45). Among those reporting neglect, those figures were OR 3.31 (95% CI 1.76 to 6.20); OR 3.31 (95% CI 1.63 to 5.73); and 1.81 (95% CI 0.83 to 3.95), respectively; and among those reporting household dysfunction, the estimates were OR 2.24 (95% CI 1.24 to 4.06); OR 1.87 (95% CI 1.20 to 2.90); and OR 1.24 (95% CI 0.68 to 2.28).

The odds of depressive symptoms were progressively higher among individuals who experienced a greater ACE score (Figure 2 and Supplemental Table 5). These associations were again strongest in those reporting poor PSS, for whom an ACE score of 1 (vs. 0) was associated with 1.44 times the odds of depressive symptoms (95% CI 0.61 to 3.37); the OR



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3 for an ACE score of 2 was 3.08 (95% CI 1.24 to 7.65); and the OR for an ACE score of 3+  
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5 was 5.33 (95% CI 2.56 to 11.10).  
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**Table 2. Logistic Regression Analyses for ACE & Later-life Depression (n = 2047\*)**

	Model A (Unadjusted)		Model B (Fully Adjusted)	
	ORs	95% CI	ORs	95% CI
ACE				
No		1		1
Yes	2.82	1.64 – 4.85	2.85	1.64 – 4.95
Perceived Social Support				
Poor		1		1
Moderate	0.51	0.34 – 0.78	0.52	0.34 – 0.80
Strong	0.34	0.223 – 0.53	0.35	0.22 – 0.54
ACE x Perceived Social Support				
No ACE x Poor Social Support		1		1
ACE x Moderate Social Support	0.76	0.40 – 1.48	0.77	0.40 – 1.51
ACE x Strong Social Support	0.52	0.25 – 1.09	0.49	0.23 – 1.02
<i>Covariates</i>				
Older Age		-	0.98	0.96 – 1.00
Gender				
Male				1
Female			1.36	1.05 – 1.75
Education				
Primary				1
Secondary			0.91	0.68 – 1.21
Tertiary			0.67	0.46 – 0.96
Current Marital Status				
Cohabiting/Married				1
Separation/Divorce			0.73	0. – 1.21
Single (never married)			1.24	0.71 – 2.20
Widowed			1.53	0.84 – 2.80
General Medical Services (GMS Status)				
Not Covered				1
Covered			1.11	0.85 – 1.45

\* Parameter estimates based on the complete sample with missing data accounted for with multiple imputation with predictive mean matching.

## DISCUSSION

In this population-based study, exposure to ACE was significantly related to a higher odds of depressive symptoms later in life, even after controlling for demographic and socio-economic factors. While other studies have reported an association between ACE and later-life depression(34-36), few have explored the role of perceived social support as a potential moderator. Importantly, we found that the deleterious impact of ACEs was typically limited to those individuals who also reported poor and moderate PSS. These findings have implications for the development of interventions for childhood adversity survivors that aim to improve mental health outcomes by enhancing PSS.

23.7% of the sample reported having experienced at least one form of ACE. This is low compared to international and national estimates. The prevalence of self-reported ACE was ~66% in the ACE study(19), a collaboration between the CDC and Kaiser Permanente, while in the Irish Longitudinal Study of Ageing (TILDA), the prevalence was 33.6%(37). The higher prevalence of ACE in TILDA may be explained by the broader nature of the ACE measure. In contrast to the 10-item ACE questionnaire used in the current study, a four-item measure was used in TILDA to capture socio-economic disadvantage, parental substance abuse, physical abuse, and sexual abuse(37).

Prevalence of depressive symptoms and poor perceived social support were substantially higher among participants who reported ACE compared to those who did not. Perception of social support level did not significantly differ between men and women in our study, contrary to literature suggesting that women tend to perceive their social support is stronger than men do (38). Prevalence of separation/divorce, GMS cover, and long-term illness/disability were found to be markedly higher among participants who reported ACEs. These findings suggest that exposure to childhood adversity affects a multitude of factors

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2  
3 across the lifespan. Animal studies have shown that early stressors result in long-term  
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5 changes in oxytocin, a peptide that regulates pair bonding and social attachment(39, 40). This  
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7 may extend to individuals with ACEs, accounting for their impaired ability in forming long-  
8  
9 term social attachments.  
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11  
12 Exposure to all ACE subtypes among those who perceived poor social support were  
13  
14 significantly related to higher odds for late-life depression. Though the estimated impact on  
15  
16 depressive symptoms was strongest for abuse, the less severe forms of childhood adversity  
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18 such as neglect and household dysfunction may also have long-term effects on mental health.  
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20 Further, the experience of any number of childhood adversity, from having experienced 1  
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22 type of ACE to 3 or more types of ACE, is associated with a higher odds for late-life  
23  
24 depression, in the presence of poor perceived social support.  
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27  
28 The relationship between ACE (overall, subtype or ACE score) and depression later in life  
29  
30 were found to vary according to level of perceived social support. Consistent with the stress  
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32 buffering model(14), moderate social support were found to attenuate the ACE-depression  
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34 association while strong social support protected against late-life depression across all ACE  
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36 subtypes and ACE scores.. These findings suggest that the strength of perceived social  
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38 support is correlated with the magnitude of decrease in odds for mental health outcomes  
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40 among childhood adversity survivors. Importantly, these findings highlight that the  
41  
42 strengthening of perceived social support among childhood adversity survivors has a  
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44 protective role on mental health, regardless of the number or type of adversity experienced.  
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49 Social support may enhance cognitive and emotional processing of the experience, hence,  
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51 facilitating reappraisal of the stressful event in a manner that is psychologically adaptive(11,  
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53 12). Findings from experience sampling method studies highlight the role of positive  
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55 emotional content in buffering negative reactivity of stress(41, 42) and in improving  
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3 responsiveness towards antidepressant medications(42). These findings suggest that in  
4  
5 addition to preventing depression, improving perception of social support may serve as an  
6  
7 important adjunct in the medical management of depression.  
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10 The role of social support may be especially important for older persons as this is a phase of  
11  
12 major social transitions such as retirement and bereavement(43).  
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15 There is also evidence for the role of perceived social support among those with chronic  
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17 medical conditions. Higher levels of perceived social support have been associated with  
18  
19 longer survival following heart attacks(44) and improved well-being i.e. mental health,  
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21 perceived burden of illness, and quality of life among end-stage renal disease patients(45).  
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### 24 25 **Strengths & Limitations**

26  
27 Demographic information and personal histories in this study were obtained using validated,  
28  
29 standardized instruments and questionnaires of health and well-being(17). Although the  
30  
31 sample is a relatively homogenous Caucasian population taken from a single large primary  
32  
33 care centre, it is representative of the profile of the source population reported in national  
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35 census data(17).  
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38  
39 ACE was measured by retrospective self-report of events that happened ~30 years previously.  
40  
41 There may be a risk of recall bias due to the time lapse between the events in question and the  
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43 survey. Questions that concerned less objective events such as whether the participant felt  
44  
45 unloved may also be subject to greater recall bias and individual interpretation. Despite the  
46  
47 risk of recall bias, the ACE questionnaire has been previously shown to have good test-retest  
48  
49 reliability(46). The sensitive nature of the questions and the participant's perception of the  
50  
51 'social taboos' of responding to such questions may also be an important limitation. This was  
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53 acknowledged during data collection by offering patients a separate sealed envelope in which  
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55 to submit their responses.  
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## Implications of Findings and Further Research

There is evidence that shows the efficacy of social support intervention in improving perceived social support and psychological distress symptoms, specifically among women who had experienced intimate partner violence(47). This intervention was led by trained nurses and founded on the four modalities of social support i.e. belonging, evaluation, self-esteem, and tangible support(47). Belonging was done through listening and responding to others who had experienced intimate partner violence(47). Evaluation involved helping women see themselves as others see them(47). Self-esteem was promoted by focusing on their strengths and achievements in surviving domestic violence(47). Tangible support involved discussions of resources in the community for help they need such as financial assistance and healthcare(47).

Results of our study have important implications for clinicians seeking to prevent mental illness among survivors of childhood adversity. Interventions that aim to protect mental health among survivors of childhood adversity should focus on strengthening perceptions of available support in addition to increasing actual availability of social support.

Individuals with a history of childhood adversity may experience deficits in support-seeking behaviour and social attachments. Hence, interventions may include social skills training where participants are equipped with skills to identify, invite, and maintain healthy social connections with others(11, 48).

Further research on the implementation and efficacy of such interventions is indicated.

In addition, our findings show that the contribution of ACEs to mental health impairment persists across the life course. Despite such findings, ACE screening is not routinely undertaken in clinical practice. 25% of primary care physicians in the Massachusetts Academy of Family Physicians reported that they never or rarely screened for childhood

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3 trauma in adult patients(49). Further work on how this can be implemented effectively in  
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5 primary care and medical training is urgently needed.  
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## 10 **DECLARATION/STATEMENTS**

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12  
13 Funding: Health Research Board, Ireland (HRB/2014 to EVC). The Mitchelstown cohort  
14 study is supported by a research grant from the Irish Health Research Board (reference  
15 HRC/2007/13)  
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21 Ethical approval: Clinical Research Ethics Committee of the Cork Teaching Hospitals  
22  
23

24 Contributorship: Professor Patricia Kearney conceived of the study. Professor Patricia  
25 Kearney, Dr Darren Dahly and Dr Carol Sinnott provided statistical expertise and contributed  
26 to interpretation of results. Dr Cheong E Von conducted the secondary data analysis,  
27 contributed to the interpretation of results, and drafted the manuscript. All authors contributed  
28 to critical revision of the article and approved the final manuscript.  
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36 Competing interest: None  
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39 Data sharing: No additional data available  
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## 41 **ACKNOWLEDGEMENTS**

42  
43  
44 The authors would like to thank the participants, study nurses, administrators and clinical  
45 staff at the Livinghealth Clinic, Mitchelstown, Cork, Ireland.  
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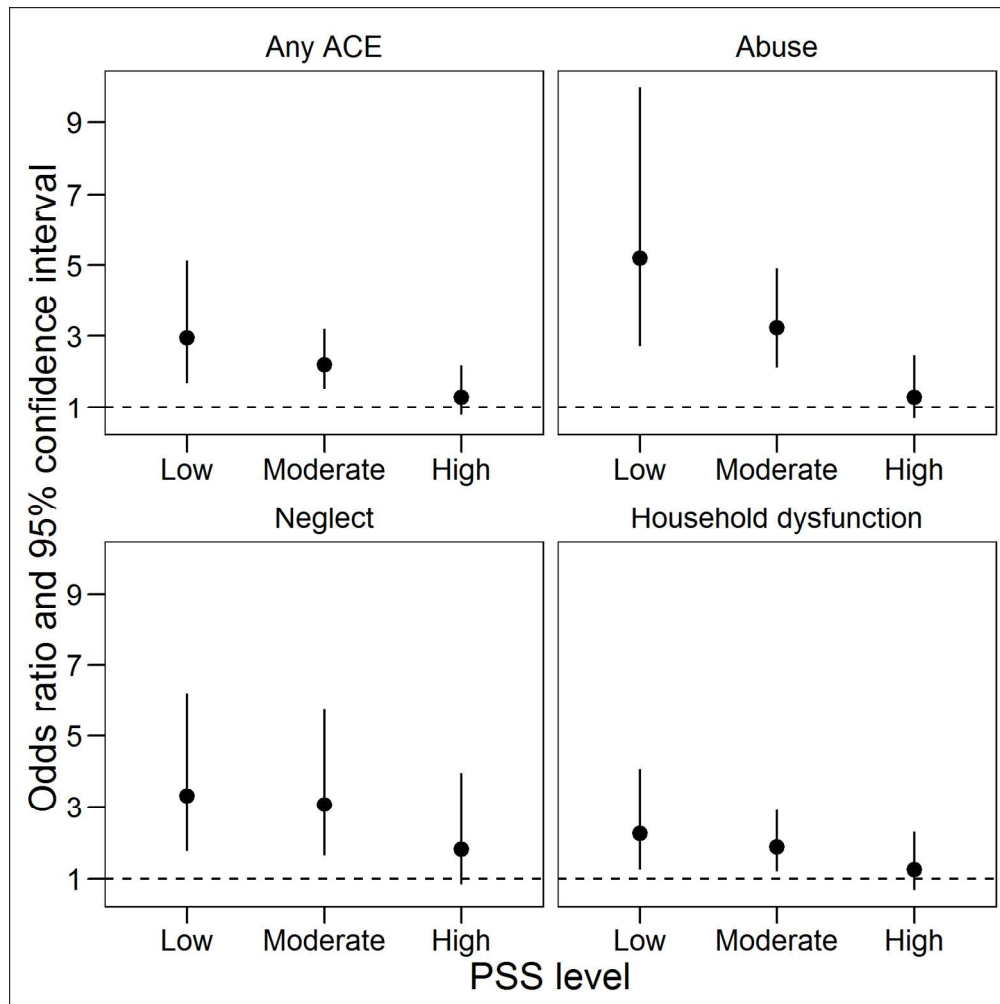


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26 **Figure 1. ORs and 95% CIs from a logistic regression model of later life depressive**  
27 **symptoms and any ACE or ACE subtypes, illustrating the interaction with perceived**  
28 **social support (n = 2047)**  
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36 **Figure 2. ORs and 95% CIs from a logistic regression model of later life depressive**  
37 **symptoms and ACE score, illustrating the interaction with perceived social support (n =**  
38 **2047)**  
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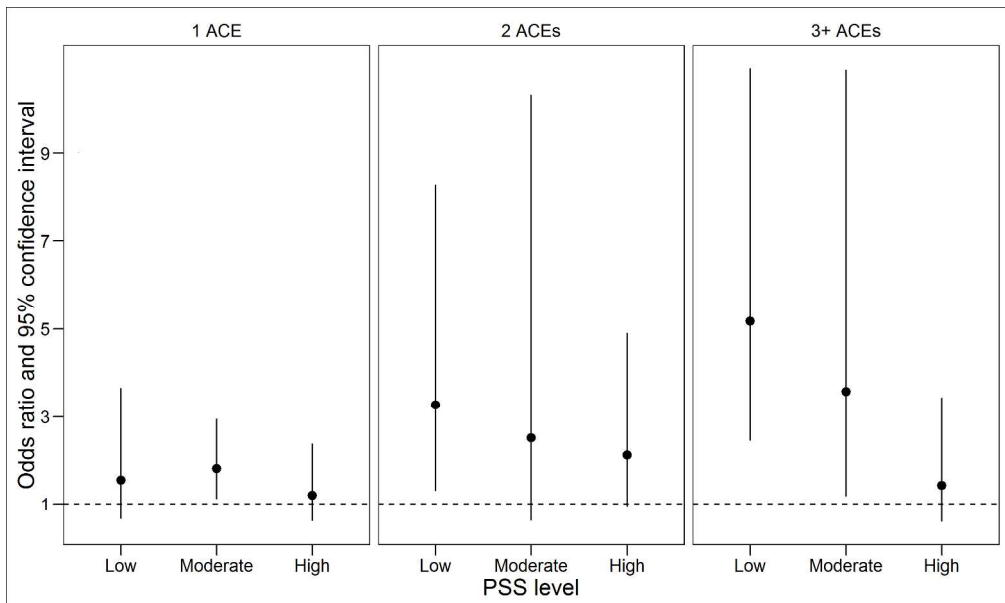
Adjusted Odds Ratio and 95% CI for Later-life Depression by Individual Adverse Childhood Experience (ACE) x Perceived Social Support (PSS)

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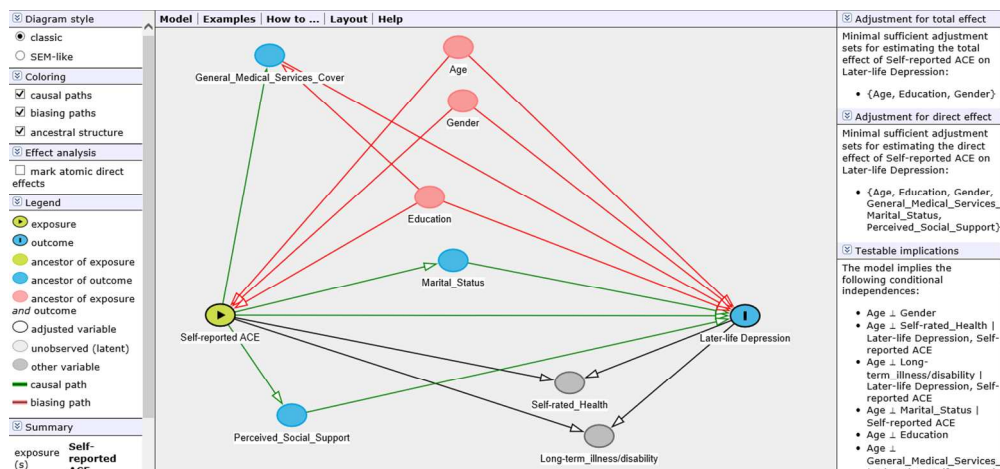
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Directed Acyclic Graph (DAG) was used to visually express a priori assumptions about relationships between the exposure (Adverse Childhood Experience), outcome (Later-life Depressive Symptoms), and covariates. Pink: Age, gender, and educational attainment were identified as potential confounders; Blue: Marital status and GMS cover were identified as potential mediators.

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**Supplementary Table 1: ORs and 95% CIs from a logistic regression model of later life depressive symptoms and any ACE using the complete case sample**

	Model A (n = 1741)		Model B (n = 1648)	
	OR	95% CI	OR	95% CI
ACE (and poor PSS)				
No		1		1
Yes	2.99	1.67 – 5.37	3.00	1.63 - 5.54
Perceived Social Support (and no ACE)				
Poor		1		1
Moderate	0.55	0.35 – 0.87	0.57	0.36 - 0.92
Strong	0.36	0.22 – 0.58	0.35	0.21 - 0.58
ACE x Perceived Social Support				
No ACE x Poor Social Support		1		1
ACE x Moderate Social Support	0.73	0.36 – 1.48	0.66	0.31 - 1.38
ACE x Strong Social Support	0.45	0.20 – 1.02	0.42	0.18 - 0.97
<i>Covariates</i>				
Age		-	0.99	0.96 - 1.02
Gender		-		
Male				1
Female			1.25	0.94 - 1.65
Education		-		
Primary				1
Secondary			0.89	0.64 - 1.25
Tertiary			0.69	0.46 - 1.03
Current Marital Status		-		
Cohabiting/Married				1
Separation/Divorce			1.82	1.12 - 2.96
Single (never married)			1.32	0.81 - 2.15
Widowed			2.21	1.32 - 3.68
General Medical Services (GMS Status)		-		
Not Covered				1
Covered			1.16	0.86 – 1.55

**Supplementary Table 2: ORs and 95% CIs from a logistic regression model of later life depressive symptoms and abuse (n = 2047\*)**

	Model A		Model B	
	OR	95% CI	OR	95% CI
Abuse (and poor PSS)				
No		1		1
Yes	5.21	2.80 – 9.73	5.20	2.70 – 9.99
Perceived Social Support (and no ACE)				
Poor		1		1
Moderate	0.53	0.37 – 0.77	0.53	0.36 – 0.77
Strong	0.36	0.24 – 0.54	0.35	0.24 – 0.53
Abuse x Perceived Social Support				
No Abuse x Poor Social Support		1		1
Abuse x Moderate Social Support	0.59	0.28 – 1.25	0.62	0.29 – 1.34
Abuse x Strong Social Support	0.26	0.11 – 0.64	0.25	0.10 – 0.62
<i>Covariates</i>				
Age		-	0.99	0.97 – 1.01
Gender		-		
Male				1
Female			1.31	1.02 – 1.69
Education		-		
Primary				1
Secondary			0.92	0.69 – 1.24
Tertiary			0.70	0.49 – 1.02
Current Marital Status		-		
Cohabiting/Married				1
Separation/Divorce			0.76	0.51 – 1.66
Single (never married)			1.26	0.71 – 2.24
Widowed			1.11	0.85 – 1.45
General Medical Services (GMS Status)		-		
Not Covered				1
Covered			1.11	0.85 – 1.45

\* Parameter estimates based on the complete sample with missing data accounted for with multiple imputation with predictive mean matching.

**Supplementary Table 3: ORs and 95% CIs from a logistic regression model of later life depressive symptoms and neglect (n = 2047\*)**

	Model A		Model B	
	OR	95% CI	OR	95% CI
Neglect (and poor PSS)				
No		1		1
Yes	3.42	1.81 – 6.45	3.30	1.76 – 5.12
Perceived Social Support (and no ACE)				
Poor		1		1
Moderate	0.50	0.35 – 0.72	0.50	0.34 – 0.77
Strong	0.31	0.21 – 0.45	0.30	0.21 – 0.48
Neglect x Perceived Social Support				
No Neglect x Poor Social Support		1		1
Neglect x Moderate Social Support	0.99	0.42 – 2.37	0.93	0.38 – 2.14
Neglect x Strong Social Support	0.70	0.21 – 1.62	0.55	0.20 – 1.83
<i>Covariates</i>				
Age		-	0.98	0.96 – 1.00
Gender		-		
Male				1
Female			1.26	0.98 – 1.67
Education		-		
Primary				1
Secondary			0.96	0.50 – 1.44
Tertiary			0.70	0.48 – 1.02
Current Marital Status		-		
Cohabiting/Married				1
Separation/Divorce			0.76	0.50 – 1.17
Single (never married)			1.33	0.75 – 2.37
Widowed			1.60	0.88 – 2.91
General Medical Services (GMS Status)		-		
Not Covered				1
Covered			1.09	0.84 – 1.42

\* Parameter estimates based on the complete sample with missing data accounted for with multiple imputation with predictive mean matching.



**Supplementary Table 4: ORs and 95% CIs from a logistic regression model of later life depressive symptoms and household dysfunction (n = 2047\*)**

	Model A		Model B	
	ORs	95% CI	ORs	95% CI
Household dysfunction (and poor PSS)				
No		1		1
Yes	2.50	1.39 – 4.45	2.24	1.24 – 4.06
Perceived Social Support (and no ACE)				
Poor		1		1
Moderate	0.48	0.33 – 0.69	0.47	0.32 – 0.68
Strong	0.30	0.20 – 0.44	0.29	0.20 – 0.43
Household dysfunction x Perceived Social Support				
No Household dysfunction x Poor Social Support		1		1
Household dysfunction x Moderate Social Support	0.74	0.36 – 1.52	0.83	0.40 – 1.73
Household dysfunction x Strong Social Support	0.55	0.24 – 1.25	0.56	0.24 – 1.29
<i>Covariates</i>				
Age		-	0.98	0.96 – 1.00
Gender		-		
Male				1
Female			1.34	1.05 – 1.74
Education		-		
Primary				1
Secondary			0.89	0.66 – 1.19
Tertiary			0.70	0.49 – 1.01
Current Marital Status		-		
Cohabiting/Married				1
Separation/Divorce			0.72	0.48 – 1.09
Single (never married)			1.29	0.74 – 2.25
Widowed			1.51	0.84 – 2.71
General Medical Services (GMS Status)		-		
Not Covered				1
Covered			1.11	0.85 – 1.44

\* Parameter estimates based on the complete sample with missing data accounted for with multiple imputation with predictive mean matching.

**Supplementary Table 5. ORs and 95% CIs from a logistic regression model of later life depressive symptoms and ACE score (n = 2047\*)**

	Model A (Unadjusted)		Model B (Fully Adjusted)	
	OR	95% CI	OR	95% CI
ACE Score (and Poor PSS)				
0		1		1
1	1.44	0.62 – 3.37	1.55	0.65 – 3.66
2	3.08	1.23 – 7.65	3.27	1.29 – 8.28
3+	5.33	2.56 – 11.10	5.18	2.45 – 10.94
Perceived Social Support (and ACE score = 0)				
Poor		1		1
Moderate	0.53	0.35 – 0.80	0.54	0.35 – 0.81
Strong	0.35	0.23 – 0.54	0.36	0.23 – 0.55
ACE Score x Perceived Social Support				
ACE Score 1 x Moderate Social Support	1.19	0.44 – 3.15	1.17	0.43 – 3.14
ACE Score 1 x Strong Social Support	0.84	0.28 – 2.49	0.78	0.25 – 2.33
ACE Score 2 x Moderate Social Support	0.78	0.24 – 2.49	0.77	0.24 – 2.50
ACE Score 2 x Strong Social Support	0.75	0.22 – 2.57	0.65	0.19 – 2.26
ACE Score 3+ x Moderate Social Support	0.69	0.27 – 1.79	0.69	0.26 – 1.81
ACE Score 3+ x Strong Social Support	0.29	0.09 – 0.91	0.27	0.09 – 0.87
<i>Covariates</i>				
Older Age			0.99	0.96 – 1.01
Gender				
Male				1
Female			1.35	1.04 – 1.73
Education				
Primary				1
Secondary			0.93	0.69 – 1.24
Tertiary			0.68	0.48 – 0.99
Current Marital Status				
Cohabiting/Married				1
Separation/Divorce			0.75	0.49 – 1.14
Single (never married)			1.21	0.69 – 2.11
Widowed			1.59	0.88 – 2.88
General Medical Services (GMS Status)				
Not Covered				1
Covered			1.10	0.85 – 1.43

\* Parameter estimates based on the complete sample with missing data accounted for with multiple imputation with predictive mean matching.

# BMJ Open

## Adverse Childhood Experiences (ACEs) and Later-life Depression: Perceived Social Support as a Potential Protective Factor

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2016-013228.R1
Article Type:	Research
Date Submitted by the Author:	26-Mar-2017
Complete List of Authors:	Cheong, E Von; University College Cork, School of Medicine; University College Cork, Department of Epidemiology and Public Health Sinnott, Carol; University College Cork, Department of General Practice Dahly, Darren; University College Cork, Department of Epidemiology and Public Health Kearney, Patricia; University College Cork, Department of Epidemiology and Public Health
<b>Primary Subject Heading</b>:	Public health
Secondary Subject Heading:	Mental health, Epidemiology, Evidence based practice, General practice / Family practice, Public health
Keywords:	MENTAL HEALTH, Adverse Childhood Experience(s), Depression & mood disorders < PSYCHIATRY

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**TITLE PAGE****Title: Adverse Childhood Experiences (ACEs) and Later-life Depression: Perceived Social Support as a Potential Protective Factor**

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**Previous Presentations:**

- 1) Medicine and the Humanities and Social Sciences Conference, Sam Houston State University, Huntsville, Texas, USA; March 4 – 5 2015
- 2) The Atlantic Medical Corridor Conference, University College Cork, Western Road, Cork, Ireland; November 10 2014

1  
2  
3 3) The 18<sup>th</sup> International Conference on Public Health, The World Academy of Science,  
4  
5 Engineering and Technology, London; May 23 – 24 2016  
6  
7

8 **Keywords:** Childhood experience, Community Mental Health, Depressive Disorders,  
9  
10 Epidemiology  
11

12  
13 **Word Count:** 3766  
14

#### 15 16 17 18 19 **What is already known on this subject?** 20

21 Adverse childhood experiences (ACEs) are common and have been linked to poorer health  
22 and wellbeing across the life course. While the prevention of ACEs is a worthwhile goal, it is  
23 important that we also try to lessen the impact of ACEs for those who do experience them.  
24  
25  
26  
27

#### 28 29 **What this study adds?** 30

31  
32 In a population-based study of Irish older adults, we found that ACEs were strongly  
33 associated with depressive symptoms in people who perceived themselves as having poor  
34 social support. However, amongst study participants who perceive themselves as having  
35 better social support, there was no statistical relationship between ACEs and subsequent  
36 depression. This interaction was primarily driven by individuals reporting ACEs reflecting  
37 abuse, and was much less pronounced, and perhaps non-existent, in those reporting neglect or  
38 household dysfunction. Lastly, greater perceived social support was protective against  
39 depressive symptoms, independent of ACE exposure or other covariates. These results  
40 suggest that interventions that aim to prevent poor mental health outcomes among survivors  
41 of childhood adversity, particularly abuse, might benefit from focusing on strengthening  
42 social support, or perceptions of social support.  
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## ABSTRACT

**Objective:** To investigate associations between adverse childhood experiences (ACEs) and later-life depressive symptoms; and to explore whether perceived social support (PSS) moderates these.

**Method:** We analysed baseline data from the Mitchelstown (Ireland) 2010-11 cohort of 2047 men and women aged 50–69 years. Self-reported measures included ACEs (Centre for Disease Control ACE questionnaire), PSS (Oslo Social Support Scale), and depressive symptoms (CES-D). The primary exposure was self-report of at least one ACE. We also investigated the effects of ACE exposure by ACE scores and ACE subtypes *abuse*, *neglect*, and *household dysfunction*. Associations between each of these exposures and depressive symptoms were estimated using logistic regression, adjusted for socio-demographic factors. We tested whether the estimated associations varied across levels of PSS (poor, moderate, and strong).

**Results:** 23.7% of participants reported at least one ACE (95% CI: 21.9% to 25.6%). ACE exposures (overall, subtype or ACE scores) were associated with a higher odds of depressive symptoms, but only among individuals with poor PSS. Exposure to any ACE (vs. none) was associated with almost 3 times the odds of depressive symptoms (Adjusted OR 2.85; 95% CI 1.64 to 4.95) among individuals reporting poor PSS, while among those reporting moderate and strong PSS, the adjusted ORs were 2.21 (95% CI 1.52 to 3.22) and 1.39 (95% CI 0.85 to 2.29) respectively. This pattern of results was similar when exposures were based on ACE subtype and ACE scores, though the interaction was clearly strongest among those reporting abuse.

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2  
3 **Conclusions:** ACEs are common among older adults in Ireland and are associated with  
4 higher odds of later-life depressive symptoms, particularly among those with poor PSS.  
5  
6 Interventions that enhance social support, or possibly perceptions of social support, may help  
7  
8 reduce the burden of depression in older populations with ACE exposure, particularly in  
9  
10 those reporting abuse.  
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## 13 14 **ARTICLE SUMMARY**

### 15 16 17 **Strengths & Limitations of this Study**

- 18  
19  
20 • Wide range of demographic and health information collected using validated,  
21  
22 standardized instruments and questionnaires  
23  
24
- 25 • Large sample size (n = 2047)  
26
- 27 • Study population is representative of the source population reported in national census  
28  
29 data  
30
- 31 • Assessment of 10 types of ACEs under three ACE subtypes i.e. abuse, neglect,  
32  
33 household dysfunction  
34
- 35 • Informs future interventions seeking to prevent or manage mental ill-health among  
36  
37 those with ACE exposure  
38
- 39 • ACE questionnaire previously shown to have good test-retest reliability  
40
- 41 • Risk of recall bias from retrospective self-report  
42  
43  
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## 45 46 **INTRODUCTION**

47  
48  
49 A life-course approach to mental health views mental illness as a product of  
50  
51 biological and social factors that operate across the lifespan(1). The stress sensitisation  
52  
53 theory(2) suggests that childhood adversity reduces an individual's threshold for developing  
54  
55 depressive reactions towards stressful events, causing one to have depressive reactions  
56  
57 towards current mild stressors or greater reactivity towards severe stressful events. For  
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2  
3 example, young women who were exposed to childhood adversities such as domestic  
4  
5 violence, parent psychopathology and alcoholism, are at a higher risk for depression  
6  
7 following exposure to mild stress than women without a history of adversity(3). Women with  
8  
9 a history of childhood abuse have higher ACTH, cortisol and heart rate responses to  
10  
11 psychosocial stress such as public speaking, compared to those without a history of childhood  
12  
13 abuse(4). The relationship persists into older adulthood; data from the Health and Retirement  
14  
15 Study, a U.S. population-based study of adults age 50+, showed that in accordance with the  
16  
17 stress sensitization theory, childhood trauma (especially physical abuse) amplifies the effect  
18  
19 of stresses in adulthood on depressive symptoms(5).  
20  
21  
22  
23

24 These psychosocial and neurobiological findings converge on the idea that early life  
25  
26 adversities have an enduring effect on how one responds to stressful life events, hence,  
27  
28 setting the life-course trajectory for one's mental health.  
29  
30

31 Adverse childhood experiences (ACEs) encompass any acts of commission or  
32  
33 omission by a parent or other caregiver that result in harm, potential for harm, or threat of  
34  
35 harm to a child in the first 18 years of life, even if harm is not the intended result(6). While  
36  
37 the association between ACEs and poor mental health has been reported previously(7-10),  
38  
39 there remains a lack of research on factors that may modify this relationship. Identifying  
40  
41 factors that alter the processing of stressful events following exposure to ACEs may be a  
42  
43 valuable tool in developing interventions aimed at preventing or mitigating the long-term  
44  
45 mental health consequences of ACEs(11).  
46  
47  
48

49 Social support may have a protective or buffering effect against the consequences of a  
50  
51 stressful event by enhancing cognitive and emotional processing of the experience(12, 13).  
52  
53 This facilitates reappraisal of the stressful event in a manner that is psychologically  
54  
55 adaptive(12, 13). Findings from meta-analyses have found a lack of social support to be the  
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1  
2  
3 single strongest predictor of post-traumatic stress symptoms in both military and civilian  
4  
5 populations with a history of psychological trauma(12, 14). The term social support  
6  
7 encompasses perceived and received support. It is suggested that perceived support is best  
8  
9 understood as an individual difference variable, with evidence that those who report that  
10  
11 others will provide them with aid when they are in need (perceived social support) are  
12  
13 protected from the pathogenic effects of life stress(15). Studies on perceived social support  
14  
15 have consistently shown it to be associated with reduced stress and improved physical and  
16  
17 mental health(16), and that perception of available social support was found to be a better  
18  
19 buffer of psychological distress than actual availability of social support in some studies(12,  
20  
21 17). This suggests that enhancing perception of available support may be just as important, if  
22  
23 not more, than increasing actual social support in interventions aimed at moderating  
24  
25 psychological effects of stress. Although a number of studies have generated findings  
26  
27 supportive of the role of perceived social support, most of these studies were focussed on  
28  
29 female victims of childhood sexual abuse(18, 19). Therefore, perceived social support is a  
30  
31 potentially modifiable risk factor, with evidence to show that social support interventions are  
32  
33 associated with improvements in measures of quality of life and burden of illness(20).  
34  
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39 This present study aims to build on prior research by examining whether three ACE  
40  
41 subtypes (abuse, neglect, and household dysfunction) are related to later-life depressive  
42  
43 symptoms, and if so, whether these associations vary across levels of perceived social support  
44  
45 (PSS). In line with recent work that suggests that multiple ACEs have an increasingly greater  
46  
47 effect on mental health, this study also aims to examine the association between ACE scores  
48  
49 and depressive symptoms, and if perceived social support differentially impacts depressive  
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51 symptoms across an accumulation of ACEs.  
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## 55 **METHOD**

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## Study Design and Population

Our analysis uses baseline data from the Mitchelstown cohort(21), a study of 50- to 69-year-old adults randomly selected from patients attending the Livinghealth Clinic in Mitchelstown, Ireland in 2010-11. The study population is representative of the profile of the source population reported in national census data(21). A complete description of the study was sent out to all selected participants with a reply slip indicating acceptance or refusal. After written, informed consent was obtained, the participants completed a detailed health and lifestyle questionnaire and attended a physical examination conducted by research nurses using standardised and validated instruments. Participants were offered separate sealed envelopes to submit their responses to the ACE questionnaire during data collection. Ethical approval for the original study was granted by the Clinical Research Ethics Committee of the Cork Teaching Hospitals.

## Predictors

### *Adverse Childhood Experiences*

Exposure to ACE was assessed using the ACE questionnaire(22, 23) which addresses 10 individual ACEs under three categories:

Abuse: emotional, physical and sexual abuse

Neglect: emotional and physical neglect

Household dysfunction: parental separation/divorce, violence against mother, household substance abuse, household mental illness, and incarceration of household member.

The ACE questionnaire is a reliable and valid measure of childhood adversity that has been used extensively in large-scale ACE studies(22, 23).

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2  
3 All questions about ACEs pertained to the respondents' first 18 years of life and were binary  
4 (yes vs. no). From these, a dichotomous variable was created to reflect exposure to any ACE,  
5 and similar variables were created to reflect any exposure to each ACE subtype (abuse,  
6 neglect, household dysfunction). We also calculated a total ACE score for each participant  
7 (+1 for each of the 10 types of ACE reported). ACE scores of 3 and above were combined  
8 into one category due to small sample sizes in some strata, and the score was treated as a  
9 categorical variable (0, 1, 2, or  $\geq 3$ ) to capture any potential non-linearities in the relationship  
10 with depressive symptoms. This method of ACE score categorisation has been used in  
11 previously (24, 25).  
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### 26 *Perceived Social Support*

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29 PSS was assessed using the self-administered Oslo Social Support Scale with three  
30 questions(26):  
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32

33  
34 Oslo 1: How many people are you so close to that you can count on them if you have great  
35 personal problems? (none (1), 1–2 (2), 3–5 (3), 5+ (4))  
36  
37

38  
39 Oslo 2: How much interest and concern do people show in what you do? (a lot (5), some (4),  
40 uncertain (3), little (2), none (1))  
41  
42

43  
44 Oslo 3: How easy is it to get practical help from neighbours if you should need it? (very easy  
45 (5), easy (4), possible (3), difficult (2), very difficult (1))  
46  
47

48  
49 The response categories were assessed independently for each of the three questions, and a  
50 sum score was created by summarizing the three scores. The Oslo Social Support Scale has  
51 been used in several studies, thus supporting its feasibility and predictive validity with respect  
52 to psychological distress(27, 28). A sum score ranging between 3 and 8 was categorised as  
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3 *poor*, a score between 9 to 11 as *moderate*, and a score of 12 to 14 as *strong* PSS (26). This  
4  
5 categorisation was used previously in a study assessing PSS in a population of older  
6  
7 adults(29).  
8  
9

## 10 **Outcomes**

### 11 *Depressive Symptoms*

12  
13 The CES-D questionnaire(30) was used to assess for depressive symptoms. The items of the  
14  
15 scale are symptoms associated with depression which have been used in longer, previously  
16  
17 validated instruments, and have been tested in both household and clinical settings(30). It has  
18  
19 very high internal consistency and adequate test-retest repeatability(30).  
20  
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24  
25 The score is a sum of 20 questions. The possible range of scores is 0 to 60, with higher scores  
26  
27 indicating the presence of greater symptomatology. A score between 16 and 21 on the CES-D  
28  
29 scale indicates the presence of *mild to moderate* depressive symptoms while a score of 22 or  
30  
31 above indicates the possibility of *major* depression(30). Participants with a score of  $\geq 16$  were  
32  
33 defined as having depressive symptoms(30). This cut-off point has been used extensively in  
34  
35 other studies in identifying individuals at risk of clinical depression(31, 32).  
36  
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38

### 39 **Covariates**

40  
41 Educational attainment was ascertained by the question ‘What is the highest level of  
42  
43 education you have completed?’ and responses were categorized into primary, secondary or  
44  
45 tertiary level.  
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47

48  
49 Current marital status was ascertained by the question ‘What is your current marital status?’  
50  
51 and the options were single (never married), separated, cohabiting, divorced, married, or  
52  
53 widowed.  
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3 Participants were asked whether they were covered by the General Medical Services (GMS)  
4  
5 scheme, which entitles those covered to free medical care at the point of access. Responses  
6  
7 were categorized as GMS patient (yes/no). GMS eligibility is based on low-income  
8  
9 thresholds.

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11  
12 Smoking status was categorized as never smoked, current smoker or former smoker in  
13  
14 response to the questions ‘have you smoked at least 100 cigarettes in your entire life?’ and  
15  
16 ‘are you a current smoker?’

17  
18  
19 Alcohol consumption was derived from the question ‘During the past 7 days how many  
20  
21 standard drinks of any alcoholic beverage did you have each day?’ and was categorized as  
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23 non-drinker (< 1 unit/week), moderate drinker (1 – 14 units/week), and heavy drinker (> 14  
24  
25 units/week)(33).  
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30 Physical activity was measured as metabolic equivalents (METs) minutes per week using the  
31  
32 short-form International Physical Activity Questionnaire(34) and was categorized into 3  
33  
34 groups (low, moderate or high) based on MET minutes per week in all activity types.  
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37  
38 Height and weight were measured using standardized methods by study personnel and used  
39  
40 to calculate body mass index (BMI, kg/m<sup>2</sup>). Participants were classified as underweight if  
41  
42 their BMI was < 18.5 kg/m<sup>2</sup>, normal if 18.5 to < 25 kg/m<sup>2</sup>, overweight if 25 to <30 kg/m<sup>2</sup> and  
43  
44 obese if ≥ 30kg/m<sup>2</sup>.  
45  
46

## 47 **Statistical Methods**

### 48 *Descriptive data and crude tests of association*

49  
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51 Continuous variables were described by means and standard deviations. Categorical variables  
52  
53 were described by counts and percentages. Student’s T-test, one-way ANOVA, or Pearson’s  
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3 Chi square test were used as appropriate to test for differences in the distributions of  
4 demographic, health and lifestyle measures between the groups with and without ACE.  
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### 10 *Logistic regression*

11  
12 Associations between each ACE exposure (any ACE, each ACE subtype, and ACE score;  
13 and in a set of supplemental models, each of the 10 individual ACEs) and depressive  
14 symptoms were estimated using logistic regression in two models, A and B. Model A  
15 included the main effects of the ACE exposure, PSS, and a product interaction term between  
16 the two. Model B included additional to adjust for potential confounding and selection biases.  
17 These were age, gender, and educational attainment, current marital status and GMS cover.  
18 Results were reported as odds ratios with 95% confidence intervals. Interaction terms were  
19 tested using type II sums of squares likelihood ratio  $\chi^2$  test (LRT), and exact p-values were  
20 reported.  
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### 37 *Quantile regression*

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39 Our main analyses use categorizations of the CES-D and the Oslo Social Support Scale to  
40 define depressive symptoms (yes/no) and PSS (low/medium/strong). While these  
41 categorizations are not uncommon, there will be some loss of power associated with their use.  
42 We thus used quantile regression(35) in a supplemental analysis to model the association  
43 between CES-D scores and ACE (any ACE, any abuse, any neglect, or any household  
44 dysfunction), conditional on the selected covariates. Quantile regression is analogous to  
45 multiple linear regression, except that it models a given centile of the outcome's distribution,  
46 the median in our case, rather than the outcome's mean. It is thus robust to departures from  
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3 the normally distributed errors assumption of linear regression, which is relevant given the  
4  
5 skewed distribution of CES-D scores in our sample.  
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### 22 *Missing Data*

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26 Missing data were handled using multiple imputation, so that all participants who completed  
27  
28 the baseline questionnaire were included in the analytical sample, even if they were missing  
29  
30 values for one or more variables. For each estimated statistical model, thirty imputed datasets  
31  
32 were created, after a burn-in of 30 replications using predicted mean matching (36). Each  
33  
34 imputation model included all variables used in a given statistical model, allowed for non-  
35  
36 linear relationships using restricted cubic splines with 3 knots, and included the key  
37  
38 interaction of interest (ACE X PSS). The statistical model of interest was then estimated in  
39  
40 each imputed dataset, and parameter estimates were combined using Rubin's rules (37). A  
41  
42 complete case sensitivity analysis was also performed for comparison.  
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45

### 46 *Inference*

47  
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49  
50 All parameter estimates are reported with 95% confidence intervals and/or exact p-values.  
51  
52 While we have estimated a fairly large number of parameters, we have not selectively  
53  
54 reported any of these, nor made any other decisions based on statistical significance testing.  
55  
56 This is consistent with current practice in major epidemiological journals, particularly with  
57  
58  
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2  
3 observational study designs, and recent guidance from the American Statistical  
4  
5 Association(38).

6  
7  
8 All analyses were conducted using the R Project for Statistical Computing (V 3.3.1) (39).  
9

## 10 11 12 13 **Research reporting**

14  
15  
16 The STROBE guidelines were used to inform the study report.  
17  
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19

## 20 21 22 **RESULTS**

### 23 24 25 **Baseline Characteristics**

26  
27 Of the 3051 people invited to participate in this study, 2047 (67%) completed the baseline  
28  
29 assessment. The mean age at baseline was 55.8 years and 51% of the participants were  
30  
31 female.

32  
33  
34 Of these, 1926 (94%) completed the ACE questionnaire. 23.7% (n = 457; 95% CI 21.9 to  
35  
36 25.6) of the respondents reported at least one form of adverse childhood experience. 16.1% (n  
37  
38 = 302, 95% CI 14.4 to 17.7) of the participants reported depressive symptoms.

39  
40  
41  
42 The characteristics of respondents with and without self-reported ACEs are summarised in  
43  
44 Table 1. Prevalence of participants with a CES-D score indicative of major depression was  
45  
46 significantly higher among participants who reported ACE compared to participants who did  
47  
48 not, (14.1% vs. 6.0%,  $p \leq 0.001$ ). Prevalence of poor PSS was also higher among participants  
49  
50 who reported ACEs (19.6% vs. 10.7%,  $p \leq 0.001$ ). Participants who reported ACEs tended to  
51  
52 be younger, separated/divorced, have GMS cover, reported long-term illness/disability and  
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54 had attained tertiary education.  
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For peer review only

**Table 1: Baseline characteristics of participants in the Mitchelstown cohort study, 2010–11 stratified by self-reported Adverse Childhood Experience (n = 1926)**

Characteristics	With ACE (N = 457; 23.7%)	Without ACE (N = 1469; 76.3%)	Group Difference			Missing Data N (%)
			Estimate*	Test statistic**	Df	
<b>Age (years)</b>	53.6 (16.9)	56.6 (15.2)	3.54	1924	≤ 0.001	0
<b>Sex</b>						
Male	234 (51.2)	707 (48.1)	1.32	1	0.25	0
Female	223 (48.8)	762 (51.9)				
<b>Marital Status</b>						
Single (never married)	45 (10.0)	116 (8.0)	28.85	3	≤ 0.001	18 (0.9)
Co-habiting/Married	334 (74.2)	1175 (80.6)				
Separated/divorced	52 (11.6)	73 (5.0)				
Widowed	19 (4.2)	94 (6.4)				
<b>Perceived Social Support</b>						
Poor	86 (19.8)	148 (10.6)	27.10	2	≤ 0.001	101 (5.2)
Moderate	193 (44.5)	632 (45.4)				
Strong	155 (35.7)	611 (43.9)				
<b>Socio-economic</b>						
Education						
Primary	116 (26.9)	382 (27.7)	10.57	2	0.01	117 (6.1)
Secondary	192 (44.4)	701 (50.9)				
Tertiary	124 (28.7)	294 (21.4)				
General Medical Services Cover						
Yes	158 (34.6)	432 (29.4)	4.31	1	0.04	0
No	299 (65.4)	1037 (70.6)				
<b>Personal health behaviours</b>						
Smoking						
Never smoked	200 (45.0)	750 (52.9)	8.93	2	0.01	64 (3.3)
Former smoker	175 (39.4)	462 (32.6)				
Current smoker	69 (15.5)	206 (14.5)				
Alcohol						
Non-drinker	56 (17.7)	202 (21.4)	3.07	2	0.22	667 (34.6)
Moderate drinker	208 (65.6)	610 (64.8)				
Heavy drinker	53 (16.7)	130 (13.8)				
Physical activity						
Low	211 (49.8)	667 (47.7)	0.70	2	0.70	104 (5.4)
Moderate	120 (28.3)	423 (30.3)				
High	93 (21.9)	308 (22.0)				
<b>Personal health history</b>						
Self-rated health status						
Very good	123 (27.2)	435 (30.1)	12.06	4	0.02	30 (1.5)

Good	235 (52.0)	804 (55.7)				
Fair	81 (17.9)	178 (12.3)				
Poor	11 (2.4)	20 (1.4)				
Very Poor	2 (0.4)	7 (0.5)				
Long-term illness/Disability						
Yes	74 (19.6)	144 (11.8)	14.66	1	≤ 0.001	331 (17.2)
No	304 (80.4)	1073 (88.2)				
Hypertension						
Hypertensive	198 (43.3)	699 (52.4)	2.62	1	0.11	2 (0.1)
Non-hypertensive	259 (56.7)	768 (47.6)				
Diabetes						
Diabetic	39 (8.8)	121 (8.4)	0.05	1	0.90	44 (2.3)
Non-diabetic	406 (91.2)	1316 (19.6)				
Body Mass Index						
Normal	97 (21.2)	329 (22.5)				
Overweight	196 (42.9)	669 (45.7)	2.82	3	0.28	4 (0.2)
Obese	164 (35.9)	467 (31.9)				
Mental health						
Depression						
No symptoms	309 (71.2)	1153 (84.8)				
Mild to moderate Possibility of major depression	64 (14.7)	125 (9.2)	44.34	2	≤ 0.001	133 (6.9)
	61 (14.1)	81 (6.0)				

\* Estimates are reported as Mean (SD) for continuous variables; and N (%) for categorical variables

\*\* Differences in means were tested using Student's t-test; dependence between categorical variables was tested using Pearson's chi-squared test

### Logistic regression

Table 2 gives ORs and 95% CIs for Models A and B where *any ACE* was the exposure variable. Exposure to any ACE was associated with almost 3 times the odds for depressive symptoms among participants reporting low PSS (Adjusted OR = 2.85, 95% CI 1.64 to 4.95). The association between any ACE and depressive symptoms was substantially attenuated with moderate PSS (OR 2.21, 95% CI 1.52 to 3.22), and strong PSS (OR 1.39, 95% CI 0.85 to 2.29) (Figure 1). The LRT p-value for the interaction term was 0.19 in the full adjusted model. The estimates were similar in the unadjusted and adjusted models (Table 2), as were results from the complete case analysis (Supplemental Table 1).

Similarly, each ACE subtype was also associated with increased odds of depressive symptoms among individuals reporting low PSS, and this association was reduced among individuals reporting moderate and high PSS (Figure 1, and Supplemental Tables 2-4). The odds of depressive symptoms among those reporting abuse (vs not) were more than five times greater in individuals reporting low PSS (OR 5.20, 95% CI 2.71 to 9.99), three times greater in those reporting moderate PSS (OR 3.22, 95% CI 2.11 to 4.92), but only slightly increased in those reporting high PSS (OR 1.29, 95% CI 0.68 to 2.45). Among those reporting neglect, those figures were OR 3.31 (95% CI 1.76 to 6.20); OR 3.31 (95% CI 1.63 to 5.73); and 1.81 (95% CI 0.83 to 3.95), respectively; and among those reporting household dysfunction, the estimates were OR 2.24 (95% CI 1.24 to 4.06); OR 1.87 (95% CI 1.20 to 2.90); and OR 1.24 (95% CI 0.68 to 2.28).

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3 The odds of depressive symptoms were progressively higher among individuals who  
4 experienced a greater ACE score (Figure 2 and Supplemental Table 5). These associations  
5 were again strongest in those reporting poor PSS, for whom an ACE score of 1 (vs. 0) was  
6 associated with 1.44 times the odds of depressive symptoms (95% CI 0.61 to 3.37); the OR  
7 for an ACE score of 2 was 3.08 (95% CI 1.24 to 7.65); and the OR for an ACE score of 3+  
8 was 5.33 (95% CI 2.56 to 11.10). Overall, evidence for effect modification of ACE exposures  
9 by PSS was strongest for abuse, with a LRT p-value of 0.011 (Supplemental Table 2), while  
10 is was 0.16 and 0.23 for neglect and household dysfunction, respectively (Supplemental  
11 Tables 3 and 4).  
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26 Regarding individual ACEs, those reflecting abuse (Supplemental Table 6) and neglect  
27 (Supplemental Table 7) tended to be more strongly associated with depressive symptoms than  
28 those reflecting the various forms of household dysfunction (Supplemental Table 8). Further,  
29 the effect modification by PSS was most clearly demonstrated for the estimated effects of  
30 abuse.  
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41 The quantile regression model for continuously measured CES-D scores gave qualitatively  
42 similar estimated to the logistic regression models (Supplemental Table 9): Any ACE, any  
43 abuse, any neglect, and any household dysfunction were each associated with higher median  
44 CES-D scores, as was lower PSS score. Further, the association between ACE and CES-D  
45 score was highest in those with lower PSS scores.  
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**Table 2. Logistic Regression Analyses for ACE & Later-life Depression (n = 2047\*)**

	Model A (Unadjusted)		Model B (Fully Adjusted)	
	ORs	95% CI	ORs	95% CI
ACE (and Poor Perceived Social Support)				
No	1	-	1	-
Yes	2.82	1.64 – 4.85	2.85	1.64 – 4.95
Perceived Social Support (and no ACE)				
Poor	1	-	1	-
Moderate	0.51	0.34 – 0.78	0.52	0.34 – 0.80
Strong	0.34	0.223 – 0.53	0.35	0.22 – 0.54
ACE x Perceived Social Support †				
	p = 0.31		p = 0.19	
No ACE x Poor Social Support	1	-	1	-
ACE x Moderate Social Support	0.76	0.40 – 1.48	0.77	0.40 – 1.51
ACE x Strong Social Support	0.52	0.25 – 1.09	0.49	0.23 – 1.02
<i>Covariates</i>				
Age (year)		-	0.98	0.96 – 1.00
Gender		-		
Male			1	-
Female			1.36	1.05 – 1.75
Education		-		
Primary			1	-
Secondary			0.91	0.68 – 1.21
Tertiary			0.67	0.46 – 0.96
Current Marital Status		-		
Cohabiting/Married			1	-
Separation/Divorce			0.73	0. – 1.21
Single (never married)			1.24	0.71 – 2.20
Widowed			1.53	0.84 – 2.80
General Medical Services (GMS Status)		-		
Not Covered			1	-
Covered			1.11	0.85 – 1.45

\* Parameter estimates based on the complete sample with missing data accounted for with multiple imputation with predictive mean matching.

† p-values are from the Type II Sum of Squares Likelihood ratio Chi<sup>2</sup> test for the interaction term.

## DISCUSSION

In this population-based study, exposure to ACEs and reporting poor social support were both related to a higher odds of depressive symptoms later in life, even after controlling for demographic and socio-economic factors. While other studies have reported an association between ACE and later-life depression(40-42), few have explored the role of perceived social support as a potential effect modifier. Importantly, we found that the deleterious impact of ACEs was typically limited to those individuals who also reported poor and moderate PSS. However, the statistical evidence for this interaction was only strong among those reporting abuse.

In this sample, 23.7% reported having experienced at least one form of ACE. This is low compared to international and national estimates. The prevalence of self-reported ACE was ~66% in the ACE study(23), a collaboration between the CDC and Kaiser Permanente, while in the Irish Longitudinal Study of Ageing (TILDA), the prevalence was 33.6%(43). The higher prevalence of ACE in TILDA may be explained by the broader nature of the ACE measure. In contrast to the 10-item ACE questionnaire used in the current study, a four-item measure was used in TILDA to capture socio-economic disadvantage, parental substance abuse, physical abuse, and sexual abuse(43).

Prevalence of depressive symptoms and poor perceived social support were substantially higher among participants who reported ACE compared to those who did not. Perception of social support level did not significantly differ between men and women in our study, contrary to literature suggesting that women tend to perceive their social support as stronger than men do (44). Prevalence of separation/divorce, GMS cover, and long-term illness/disability were found to be markedly higher among participants who reported ACEs. These findings suggest that exposure to childhood adversity could affect a multitude of factors across the lifespan. Animal studies have shown that early stressors result in long-term

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3 changes in oxytocin, a peptide that regulates pair bonding and social attachment(45, 46). It's  
4 possible that this may extend to individuals with ACEs, accounting for their impaired ability  
5 in forming long-term social attachments, but it is important to note that our study does not  
6 speak directly to this speculation.  
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12 Exposure to all ACE subtypes among those who perceived poor social support were  
13 significantly related to higher odds for late-life depression. Though the estimated impact on  
14 depressive symptoms was strongest for abuse, the less severe forms of childhood adversity  
15 such as neglect and household dysfunction may also have long-term effects on mental health.  
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17 Further, the experience of any number of childhood adversity, from having experienced 1  
18 type of ACE to 3 or more types of ACE, is associated with increased odds for late-life  
19 depression, in the presence of poor perceived social support.  
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29 Consistent with the stress buffering model(17), the relationship between ACE (overall,  
30 subtype or ACE score) and depression later in life were found to vary according to level of  
31 perceived social support, though this interaction was clearly strongest amongst those  
32 reporting abuse. These findings highlight that the strengthening of social support among  
33 childhood adversity survivors may benefit mental health.  
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41 Social support may enhance cognitive and emotional processing of the experience, hence,  
42 facilitating reappraisal of the stressful event in a manner that is psychologically adaptive(12,  
43 13). Findings from experience sampling method studies highlight the role of positive  
44 emotional content in buffering negative reactivity of stress(47, 48) and in improving  
45 responsiveness towards antidepressant medications(48). These findings suggest that in  
46 addition to preventing depression, improving social support may serve as an important  
47 adjunct in the medical management of depression. The role of social support may be  
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3 especially important for older persons as this is a phase of major social transitions such as  
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5 retirement and bereavement(49).  
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8 There is also evidence for the role of perceived social support among those with chronic  
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10 medical conditions. Higher levels of perceived social support have been associated with  
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12 longer survival following heart attacks(50) and improved well-being i.e. mental health,  
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14 perceived burden of illness, and quality of life among end-stage renal disease patients(20).  
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### 17 **Strengths & Limitations**

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20 Demographic information and personal histories in this study were obtained using validated,  
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22 standardized instruments and questionnaires of health and well-being(21). Although the  
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24 sample is a relatively homogenous, Caucasian population taken from a single, large primary  
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26 care centre, it is representative of the profile of the source population reported in national  
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28 census data(21).  
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32 ACE was measured by retrospective self-report of events that happened ~30 years previously.  
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34 There may be a risk of recall bias due to the time lapse between the events in question and the  
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36 survey. Questions that concerned less objective events such as whether the participant felt  
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38 unloved may also be subject to greater recall bias and individual interpretation. Despite the  
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40 risk of recall bias, the ACE questionnaire has been previously shown to have good test-retest  
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42 reliability(40). The sensitive nature of the questions and the participant's perception of the  
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44 'social taboos' of responding to such questions may also be an important limitation. This was  
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46 acknowledged during data collection by offering patients a separate sealed envelope in which  
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48 to submit their responses.  
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53 We have reported models for each of ten individual ACEs. However, given the relatively  
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55 small number of participants experiencing any one specific ACE, the respective parameter  
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57 estimates will be volatile. While those results qualitatively conformed with the models for  
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3 any ACE and ACE subtypes, a larger study would be needed to further examine the impact of  
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5 the individual ACEs.  
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8 There was a non-negligible amount of missing data, which is not uncommon for such studies.  
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10 We have used multiple imputation, rather than case-wise deletion, to both improve the  
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12 efficiency of analyses (by retaining more observations in the analysis) and to reduce chances  
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14 of bias. Multiple imputation, assuming the model was correctly specified, is unbiased given  
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16 an assumption that data were missing at random, conditional on other variables accounted for  
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18 in the model (i.e. the MAR assumption). This is a more defensible position than the  
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20 assumption that data were missing completely at random (MCAR) required for valid  
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22 estimates using case-wise deletion. However, we cannot rule out the possibility that missing  
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24 data, particularly for ACEs and the CESD were missing not-at-random (MNAR).  
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28 Lastly, and most importantly, this is an observational study where both the exposure and  
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30 outcomes will certainly share causes. We have tried to adjust for this through the careful  
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32 selection and adjustment for confounders, but these in turn will be measured with some error  
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34 and will certainly not represent an optimal set of covariates to adjust for, so it is important  
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36 that these results are viewed as part of a larger and still developing body of research.  
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### 43 **Implications of Findings and Further Research**

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46 There is evidence that shows the efficacy of social support intervention in improving  
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48 perceived social support and psychological distress symptoms, specifically among women  
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50 who had experienced intimate partner violence(51). This intervention was led by trained  
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52 nurses and founded on the four modalities of social support i.e. belonging, evaluation, self-  
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54 esteem, and tangible support(51). Belonging was done through listening and responding to  
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56 others who had experienced intimate partner violence(51). Evaluation involved helping  
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3 women see themselves as others see them(51). Self-esteem was promoted by focusing on  
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5 their strengths and achievements in surviving domestic violence(51). Tangible support  
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7 involved discussions of resources in the community for help they need such as financial  
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9 assistance and healthcare(51).  
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12 Results of our study have potential implications for clinicians seeking to prevent mental  
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14 illness among survivors of childhood adversity. Interventions that aim to protect mental  
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16 health among survivors of childhood adversity might benefit from strengthening social  
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18 support, or perhaps even just perception of social support. There is an increasing literature  
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20 showing the positive effect of interventions that increase perceptions of social support in  
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22 patients with terminal disease or end stage kidney disease(20). By showing the buffering  
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24 effect of PSS on the ACE- mental health relationship, our findings highlight the potential for  
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26 interventions targeting PSS to reduce the likelihood of depression in patients who  
27  
28 experienced childhood adversity. Individuals with a history of childhood adversity may  
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30 experience deficits in support-seeking behaviour and social attachments. Hence, interventions  
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32 may include social skills training where participants are equipped with skills to identify,  
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34 invite, and maintain healthy social connections with others(12, 52). Further research on the  
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36 implementation and efficacy of such interventions is indicated.  
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42 In addition, our findings show that the contribution of ACEs to mental health impairment  
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44 persists across the life course. Despite such findings, ACE screening is not routinely  
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46 undertaken in clinical practice. 25% of primary care physicians in the Massachusetts  
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48 Academy of Family Physicians reported that they never or rarely screened for childhood  
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50 trauma in adult patients(53). Further work on how this can be implemented effectively in  
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52 primary care and medical training is urgently needed.  
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## DECLARATION/STATEMENTS

Funding: Health Research Board, Ireland (SSS-2014-781 to Dr Cheong E Von). The Mitchelstown cohort study is supported by a research grant from the Irish Health Research Board (reference HRC/2007/13). Dr Darren Dahly was further supported by a HRB Interdisciplinary Capacity Award (ICE/2012/12). Dr Carol Sinnott was supported by the HRB National SpR Academic Fellowship Award (NSAFP/2011/3).

Ethical approval: Clinical Research Ethics Committee of the Cork Teaching Hospitals

Contributorship: Professor Patricia Kearney conceived of the study. Professor Patricia Kearney, Dr Darren Dahly and Dr Carol Sinnott provided statistical expertise and contributed to interpretation of results. Dr Cheong E Von conducted the secondary data analysis, contributed to the interpretation of results, and drafted the manuscript. All authors contributed to critical revision of the article and approved the final manuscript.

Competing interest: None

Data sharing: No additional data available

## ACKNOWLEDGEMENTS

The authors would like to thank the participants, study nurses, administrators and clinical staff at the Livinghealth Clinic, Mitchelstown, Cork, Ireland.

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35 **Figure 1. ORs and 95% CIs from a logistic regression model of later life depressive**  
36 **symptoms and any ACE or ACE subtypes, illustrating the interaction with perceived**  
37 **social support (n = 2047)**  
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45 **Figure 2. ORs and 95% CIs from a logistic regression model of later life depressive**  
46 **symptoms and ACE score, illustrating the interaction with perceived social support (n =**  
47 **2047)**  
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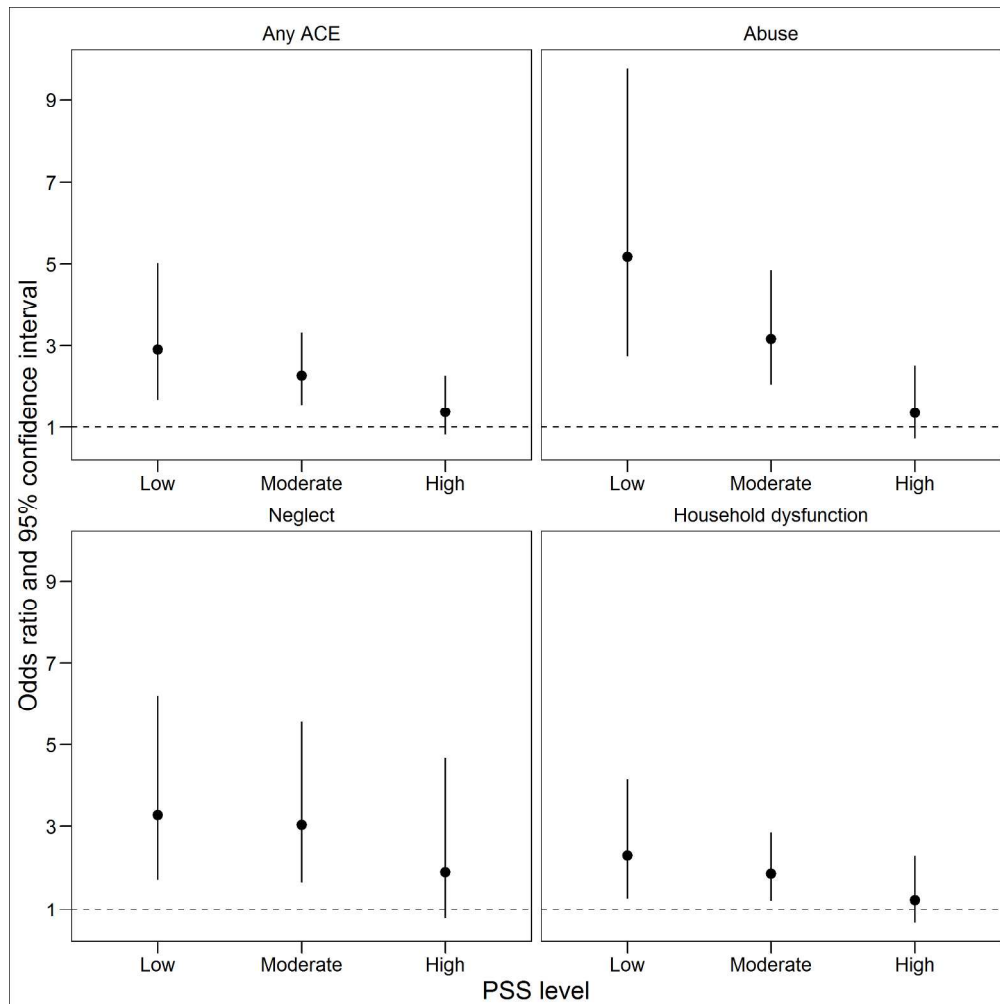


Figure 1. ORs and 95% CIs from a logistic regression model of later life depressive symptoms and any ACE or ACE subtypes, illustrating the interaction with perceived social support (n = 2047)

228x228mm (300 x 300 DPI)





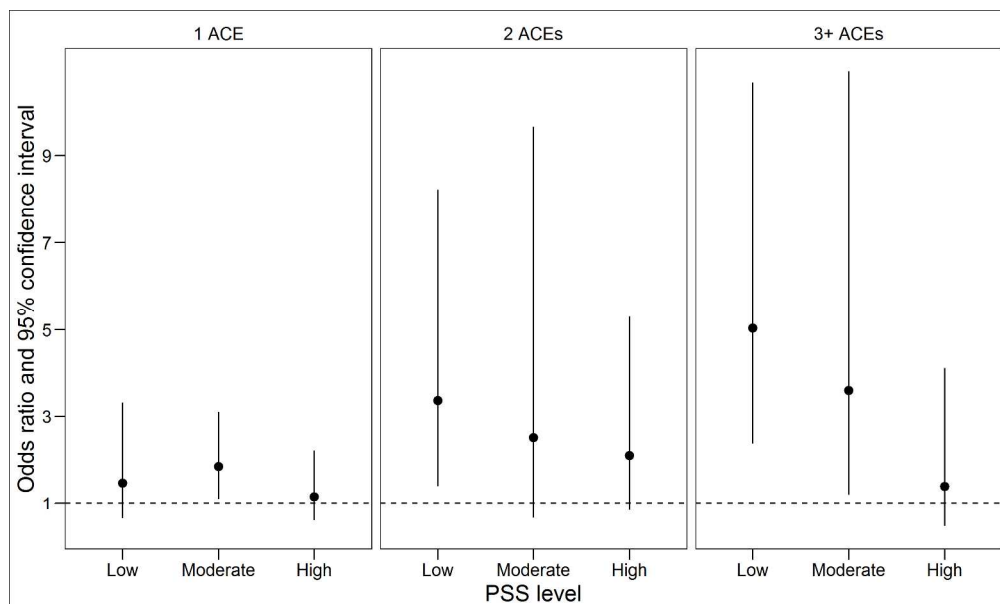


Figure 2. ORs and 95% CIs from a logistic regression model of later life depressive symptoms and ACE score, illustrating the interaction with perceived social support (n = 2047)

254x152mm (300 x 300 DPI)

Review only

## Supplementary Table 1: ORs and 95% CIs from a logistic regression model of later life depressive symptoms and any

## ACE using the complete case sample

	Model A (n = 1741)		Model B (n = 1648)	
	OR	95% CI	OR	95% CI
ACE (and Poor Perceived Social Support)				
No	1	-	1	-
Yes	2.99	1.67 – 5.37	3.00	1.63 - 5.54
Perceived Social Support (and no ACE) †				
	p = 0.14		p = 0.12	
Poor	1	-	1	-
Moderate	0.55	0.35 – 0.87	0.57	0.36 - 0.92
Strong	0.36	0.22 – 0.58	0.35	0.21 - 0.58
ACE x Perceived Social Support †				
No ACE x Poor Social Support	1	-	1	-
ACE x Moderate Social Support	0.73	0.36 – 1.48	0.66	0.31 - 1.38
ACE x Strong Social Support	0.45	0.20 – 1.02	0.42	0.18 - 0.97
<i>Covariates</i>				
Age (year)		-	0.99	0.96 - 1.02
Gender		-		
Male			1	-
Female			1.25	0.94 - 1.65
Education		-		
Primary			1	-
Secondary			0.89	0.64 - 1.25
Tertiary			0.69	0.46 - 1.03
Current Marital Status		-		
Cohabiting/Married			1	-
Separation/Divorce			1.82	1.12 - 2.96
Single (never married)			1.32	0.81 - 2.15
Widowed			2.21	1.32 - 3.68
General Medical Services (GMS Status)		-		
Not Covered			1	-
Covered			1.16	0.86 – 1.55

† p-values are from the Type II Sum of Squares Likelihood ratio Chi<sup>2</sup> test for the interaction term.

Supplementary Table 2: ORs and 95% CIs from a logistic regression model of later life depressive symptoms and abuse (n = 2047\*)

	Model A		Model B	
	OR	95% CI	OR	95% CI
Abuse (and Poor Perceived Social Support)				
No	1	-	1	-
Yes	5.21	2.80 – 9.73	5.20	2.70 – 9.99
Perceived Social Support (and no ACE)				
Poor	1	-	1	-
Moderate	0.53	0.37 – 0.77	0.53	0.36 – 0.77
Strong	0.36	0.24 – 0.54	0.35	0.24 – 0.53
Abuse x Perceived Social Support †		p = 0.0098		p = 0.011
No Abuse x Poor Social Support	1	-	1	-
Abuse x Moderate Social Support	0.59	0.28 – 1.25	0.62	0.29 – 1.34
Abuse x Strong Social Support	0.26	0.11 – 0.64	0.25	0.10 – 0.62
<i>Covariates</i>				
Age (year)		-	0.99	0.97 – 1.01
Gender				
Male			1	-
Female			1.31	1.02 – 1.69
Education				
Primary			1	-
Secondary			0.92	0.69 – 1.24
Tertiary			0.70	0.49 – 1.02
Current Marital Status				
Cohabiting/Married			1	-
Separation/Divorce			0.76	0.51 – 1.66
Single (never married)			1.26	0.71 – 2.24
Widowed			1.11	0.85 – 1.45
General Medical Services (GMS Status)				
Not Covered			1	-
Covered			1.11	0.85 – 1.45

\* Parameter estimates based on the complete sample with missing data accounted for with multiple imputation with predictive mean matching.

† p-values are from the Type II Sum of Squares Likelihood ratio Chi<sup>2</sup> test for the interaction term.

Supplementary Table 3: ORs and 95% CIs from a logistic regression model of later life depressive symptoms and neglect

(n = 2047\*)

	Model A		Model B	
	OR	95% CI	OR	95% CI
Neglect (and Poor Perceived Social Support)				
No	1	-	1	-
Yes	3.42	1.81 – 6.45	3.30	1.76 – 5.12
Perceived Social Support (and no ACE)				
Poor	1	-	1	-
Moderate	0.50	0.35 – 0.72	0.50	0.34 – 0.77
Strong	0.31	0.21 – 0.45	0.30	0.21 – 0.48
Neglect x Perceived Social Support †		p = 0.17		p = 0.16
No Neglect x Poor Social Support	1	-	1	-
Neglect x Moderate Social Support	0.99	0.42 – 2.37	0.93	0.38 – 2.14
Neglect x Strong Social Support	0.70	0.21 – 1.62	0.55	0.20 – 1.83
<i>Covariates</i>				
Age (year)		-	0.98	0.96 – 1.00
Gender		-		
Male			1	-
Female			1.26	0.98 – 1.67
Education		-		
Primary			1	-
Secondary			0.96	0.50 – 1.44
Tertiary			0.70	0.48 – 1.02
Current Marital Status		-		
Cohabiting/Married			1	-
Separation/Divorce			0.76	0.50 – 1.17
Single (never married)			1.33	0.75 – 2.37
Widowed			1.60	0.88 – 2.91
General Medical Services (GMS Status)		-		
Not Covered			1	-
Covered			1.09	0.84 – 1.42

\* Parameter estimates based on the complete sample with missing data accounted for with multiple imputation with predictive mean matching.

† p-values are from the Type II Sum of Squares Likelihood ratio Chi<sup>2</sup> test for the interaction term.

**Supplementary Table 4: ORs and 95% CIs from a logistic regression model of later life depressive symptoms and household dysfunction (n = 2047\*)**

	Model A		Model B	
	ORs	95% CI	ORs	95% CI
Household dysfunction (and Poor Perceived Social Support)				
No	1	-	1	-
Yes	2.50	1.39 – 4.45	2.24	1.24 – 4.06
Perceived Social Support (and no ACE)				
Poor	1	-	1	-
Moderate	0.48	0.33 – 0.69	0.47	0.32 – 0.68
Strong	0.30	0.20 – 0.44	0.29	0.20 – 0.43
Household dysfunction x Perceived Social Support †		p = 0.32		p = 0.23
No Household dysfunction x Poor Social Support	1	-	1	-
Household dysfunction x Moderate Social Support	0.74	0.36 – 1.52	0.83	0.40 – 1.73
Household dysfunction x Strong Social Support	0.55	0.24 – 1.25	0.56	0.24 – 1.29
<i>Covariates</i>				
Age (year)		-	0.98	0.96 – 1.00
Gender		-		
Male			1	-
Female			1.34	1.05 – 1.74
Education		-		
Primary			1	-
Secondary			0.89	0.66 – 1.19
Tertiary			0.70	0.49 – 1.01
Current Marital Status		-		
Cohabiting/Married			1	-
Separation/Divorce			0.72	0.48 – 1.09
Single (never married)			1.29	0.74 – 2.25
Widowed			1.51	0.84 – 2.71
General Medical Services (GMS Status)		-		
Not Covered			1	-
Covered			1.11	0.85 – 1.44

\* Parameter estimates based on the complete sample with missing data accounted for with multiple imputation with predictive mean matching.

† p-values are from the Type II Sum of Squares Likelihood ratio Chi<sup>2</sup> test for the interaction term.

**Supplementary Table 5. ORs and 95% CIs from a logistic regression model of later life depressive symptoms and ACE score (n = 2047\*)**

	Model A (Unadjusted)		Model B (Fully Adjusted)	
	OR	95% CI	OR	95% CI
ACE Score (and Poor Perceived Social Support)				
0	1	-	1	---
1	1.44	0.62 – 3.37	1.55	0.65 – 3.66
2	3.08	1.23 – 7.65	3.27	1.29 – 8.28
3+	5.33	2.56 – 11.10	5.18	2.45 – 10.94
Perceived Social Support (and ACE score = 0)				
Poor	1	-	1	-
Moderate	0.53	0.35 – 0.80	0.54	0.35 – 0.81
Strong	0.35	0.23 – 0.54	0.36	0.23 – 0.55
ACE Score x Perceived Social Support †		p = 0.36		p = 0.26
ACE Score 1 x Moderate Social Support	1.19	0.44 – 3.15	1.17	0.43 – 3.14
ACE Score 1 x Strong Social Support	0.84	0.28 – 2.49	0.78	0.25 – 2.33
ACE Score 2 x Moderate Social Support	0.78	0.24 – 2.49	0.77	0.24 – 2.50
ACE Score 2 x Strong Social Support	0.75	0.22 – 2.57	0.65	0.19 – 2.26
ACE Score 3+ x Moderate Social Support	0.69	0.27 – 1.79	0.69	0.26 – 1.81
ACE Score 3+ x Strong Social Support	0.29	0.09 – 0.91	0.27	0.09 – 0.87
<i>Covariates</i>				
Age (year)			0.99	0.96 – 1.01
Gender				
Male			1	-
Female			1.35	1.04 – 1.73
Education				
Primary			1	-
Secondary			0.93	0.69 – 1.24
Tertiary			0.68	0.48 – 0.99
Current Marital Status				
Cohabiting/Married			1	-
Separation/Divorce			0.75	0.49 – 1.14
Single (never married)			1.21	0.69 – 2.11
Widowed			1.59	0.88 – 2.88
General Medical Services (GMS Status)				
Not Covered			1	-
Covered			1.10	0.85 – 1.43

\* Parameter estimates based on the complete sample with missing data accounted for with multiple imputation with predictive mean matching.

† p-values are from the Type II Sum of Squares Likelihood ratio Chi<sup>2</sup> test for the interaction term.

Supplementary Table 6. ORs and 95% CIs from a logistic regression model of later life depressive symptoms and individual ACEs reflecting different forms of abuse (n = 2047\*)

ACE =	Emotional Abuse		Physical Abuse		Sexual Abuse	
	OR	95% CI	OR	95% CI	OR	95% CI
ACE (and Poor Perceived Social Support)	4.85	(2.49 to 9.42)	3.92	(1.86 to 8.25)	2.58	(0.96 to 6.92)
Perceived Social Support (and no ACE)						
Poor	1	-	1	-	1	-
Moderate	0.55	(0.38 to 0.8)	0.48	(0.34 to 0.68)	0.42	(0.3 to 0.59)
Strong	0.34	(0.23 to 0.51)	0.29	(0.2 to 0.42)	0.27	(0.19 to 0.38)
ACE X Perceived Social Support †	p = 0.012		p = 0.09		p = 0.24	
ACE + Moderate Social Support	0.61	(0.27 to 1.42)	0.56	(0.22 to 1.43)	1.48	(0.45 to 4.82)
ACE + Strong Social Support	0.36	(0.13 to 0.97)	0.37	(0.12 to 1.12)	0.57	(0.14 to 2.32)
<i>Covariates</i>						
Age (year)	0.98	(0.96 to 1.01)	0.98	(0.96 to 1)	0.98	(0.96 to 1)
Sex						
Male	1	-	1	-	1	-
Female	1.32	(1.02 to 1.71)	1.34	(1.04 to 1.72)	1.30	(1.01 to 1.67)
Education						
Primary	1	-	1	-	1	-
Secondary	0.93	(0.69 to 1.25)	0.96	(0.71 to 1.28)	0.92	(0.69 to 1.23)
Tertiary	0.73	(0.51 to 1.06)	0.76	(0.53 to 1.08)	0.70	(0.48 to 1)
Current Marital Status						
Married	1	-	1	-	1	-
Divorced/Separated	0.74	(0.49 to 1.13)	0.75	(0.49 to 1.15)	0.75	(0.49 to 1.13)
Single (Never Married)	1.24	(0.7 to 2.21)	1.35	(0.76 to 2.39)	1.32	(0.75 to 2.33)
Widowed	1.55	(0.86 to 2.78)	1.55	(0.85 to 2.83)	1.54	(0.85 to 2.79)
General Medical Services (GMS Status)						
Not Covered	1	-	1	-	1	-
Covered	1.12	(0.86 to 1.46)	1.11	(0.85 to 1.44)	1.09	(0.84 to 1.41)
Intercept	1.01	(0.21 to 4.84)	1.31	(0.29 to 5.99)	1.81	(0.41 to 8.12)

\* Parameter estimates based on the complete sample with missing data accounted for with multiple imputation with predictive mean matching.

† p-values are from the Type II Sum of Squares Likelihood ratio Chi<sup>2</sup> test for the interaction term.

**Supplementary Table 7. ORs and 95% CIs from a logistic regression model of later life depressive symptoms and individual ACEs reflecting different forms of neglect (n = 2047\*)**

	ACE =	<u>Emotional neglect</u>		<u>Physical Neglect</u>	
		OR	95% CI	OR	95% CI
ACE (and Poor Perceived Social Support)		3.35	(1.74 to 6.43)	3.43	(0.96 to 12.26)
Perceived Social Support (and no ACE)					
Poor		1	-	1	-
Moderate		0.50	(0.35 to 0.71)	0.44	(0.32 to 0.62)
Strong		0.30	(0.2 to 0.44)	0.27	(0.19 to 0.38)
ACE X Perceived Social Support †		p = 0.15		P = 0.07	
ACE + Moderate Social Support		1.07	(0.43 to 2.65)	0.91	(0.16 to 5.09)
ACE + Strong Social Support		0.66	(0.22 to 1.94)	**	**
<i>Covariates</i>					
Age (year)		0.98	(0.96 to 1)	0.98	(0.96 to 1)
Sex					
Male		1	-	1	-
Female		1.27	(0.98 to 1.64)	1.32	(1.03 to 1.7)
Education					
Primary		1	-	1	-
Secondary		0.95	(0.71 to 1.29)	0.91	(0.68 to 1.22)
Tertiary		0.70	(0.48 to 1.01)	0.74	(0.51 to 1.05)
Current Marital Status					
Married		1	-	1	-
Divorced/Separated		0.80	(0.53 to 1.21)	0.74	(0.48 to 1.13)
Single (Never Married)		1.43	(0.82 to 2.49)	1.37	(0.78 to 2.42)
Widowed		1.70	(0.94 to 3.07)	1.50	(0.83 to 2.73)
General Medical Services (GMS Status)					
Not Covered		1	-	1	-
Covered		1.10	(0.85 to 1.44)	1.08	(0.83 to 1.41)



1 Intercept 1.21 (0.26 to 5.63) 1.89 (0.42 to 8.5)

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2 \* Parameter estimates based on the complete sample with missing data accounted for with multiple imputation  
3 with predictive mean matching.

4 \*\* Estimation problems due to sparse data.

5 † p-values are from the Type II Sum of Squares Likelihood ratio Chi<sup>2</sup> test for the interaction term.

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Supplementary Table 8. ORs and 95% CIs from a logistic regression model of later life depressive symptoms and individual ACEs reflecting different forms of household dysfunction (n = 2047\*)

	ACE = Parental separation/divorce		Violence against mother		Substance abuse in household		Mental illness in household		Incarceration of household member	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
ACE (and Poor Perceived Social Support)	0.69	(0.16 to 2.93)	2.75	(0.74 to 10.28)	1.51	(0.69 to 3.31)	3.83	(1.91 to 7.68)	6.02	(1.49 to 24.35)
Perceived Social Support (and no ACE)										
Poor	1	-	1	-	1	-	1	-	1	-
Moderate	0.43	(0.31 to 0.59)	0.44	(0.32 to 0.61)	0.41	(0.3 to 0.58)	0.51	(0.36 to 0.72)	0.45	(0.32 to 0.62)
Strong	0.24	(0.17 to 0.35)	0.25	(0.18 to 0.36)	0.25	(0.18 to 0.37)	0.30	(0.2 to 0.43)	0.27	(0.19 to 0.38)
ACE X Perceived Social Support †	p = 0.94		p = 0.17		p = 0.81		p = 0.30		p = 0.06	
ACE + Moderate Social Support	1.78	(0.31 to 10.32)	0.34	(0.06 to 2.1)	1.35	(0.52 to 3.5)	0.49	(0.19 to 1.27)	0.51	(0.07 to 3.52)
ACE + Strong Social Support	1.86	(0.23 to 14.83)	0.68	(0.12 to 3.92)	0.81	(0.25 to 2.67)	0.41	(0.14 to 1.2)	**	**
<i>Covariates</i>										
Age (year)	0.97	(0.95 to 1)	0.98	(0.95 to 1)	0.98	(0.96 to 1)	0.98	(0.96 to 1)	0.98	(0.95 to 1)
Sex										
Male	1	-	1	-	1	-	1	-	1	-
Female	1.32	(1.02 to 1.7)	1.31	(1.02 to 1.68)	1.32	(1.02 to 1.69)	1.35	(1.04 to 1.73)	1.32	(1.03 to 1.71)
Education										
Primary	1	-	1	-	1	-	1	-	1	-
Secondary	0.89	(0.66 to 1.19)	0.90	(0.67 to 1.2)	0.90	(0.67 to 1.21)	0.90	(0.67 to 1.2)	0.89	(0.66 to 1.19)
Tertiary	0.71	(0.49 to 1.02)	0.72	(0.51 to 1.03)	0.71	(0.5 to 1.02)	0.70	(0.49 to 1)	0.72	(0.51 to 1.04)
Current Marital Status										
Married	1	-	1	-	1	-	1	-	1	-
Divorced/Separated	0.72	(0.47 to 1.09)	0.69	(0.46 to 1.02)	0.72	(0.48 to 1.08)	0.72	(0.48 to 1.09)	0.75	(0.49 to 1.13)
Single (Never Married)	1.38	(0.78 to 2.42)	1.31	(0.76 to 2.26)	1.30	(0.74 to 2.27)	1.29	(0.74 to 2.26)	1.40	(0.8 to 2.46)
Widowed	1.43	(0.79 to 2.6)	1.41	(0.8 to 2.51)	1.44	(0.8 to 2.6)	1.51	(0.84 to 2.74)	1.53	(0.85 to 2.76)
General Medical Services (GMS Status)										
Not Covered	1	-	1	-	1	-	1	-	1	-
Covered	1.11	(0.85 to 1.45)	1.13	(0.87 to 1.46)	1.10	(0.85 to 1.43)	1.10	(0.84 to 1.43)	1.10	(0.84 to 1.43)
Intercept	2.57	(0.56 to 11.76)	2.23	(0.5 to 9.94)	1.80	(0.4 to 8.21)	1.56	(0.34 to 7.12)	2.07	(0.45 to 9.44)

\* Parameter estimates based on the complete sample with missing data accounted for with multiple imputation with predictive mean matching.

\*\* Estimation problems due to sparse data.

† p-values are from the Type II Sum of Squares Likelihood ratio Chi<sup>2</sup> test for the interaction term.

**Supplementary Table 9. Beta coefficients and 95% CIs from quantile regression models of the median of depression scale scores (CES-D) and any ACE, any abuse, any neglect, or any household dysfunction (n = 2047\*)**

	ACE =		<u>Any ACE</u>		<u>Any Abuse</u>		<u>Any Neglect</u>		<u>Any Dysfunction</u>	
	$\beta$	95%CI	$\beta$	95%CI	$\beta$	95%CI	$\beta$	95%CI	$\beta$	95%CI
ACE	7.19	(2.54 to 11.85)	11.30	(0.05 to 22.55)	14.07	(6.7 to 21.44)	6.55	(1.1 to 12.01)		
Perceived Social Support (score)**	-0.77	(-0.96 to -0.58)	-0.89	(-1.08 to -0.7)	-0.78	(-0.95 to -0.61)	-0.87	(-1.06 to -0.68)		
ACE X Perceived Social Support	-0.47	(-0.9 to -0.03)	-0.60	(-1.61 to 0.4)	-0.97	(-1.61 to -0.32)	-0.44	(-0.92 to 0.04)		
<i>Covariates</i>										
Age (year)	-0.06	(-0.13 to 0.01)	-0.05	(-0.12 to 0.02)	-0.04	(-0.11 to 0.02)	-0.04	(-0.11 to 0.03)		
Sex										
Male										
Female	0.68	(-0.08 to 1.44)	0.47	(-0.29 to 1.24)	0.56	(-0.15 to 1.28)	0.75	(-0.01 to 1.5)		
Education										
Primary										
Secondary	-0.72	(-1.68 to 0.24)	0.05	(-0.92 to 1.02)	0.26	(-0.7 to 1.22)	-0.92	(-1.85 to 0)		
Tertiary	-1.89	(-3.09 to -0.69)	-1.43	(-2.59 to -0.26)	-0.84	(-1.97 to 0.28)	-1.94	(-3.01 to -0.87)		
Current Marital Status										
Married										
Divorced/Separated	-0.26	(-1.63 to 1.11)	-0.13	(-1.59 to 1.33)	-1.46	(-3.09 to 0.16)	-0.15	(-1.5 to 1.19)		
Single (Never Married)	-0.27	(-2.7 to 2.15)	0	(-2.38 to 2.37)	-0.87	(-3.32 to 1.58)	0.39	(-1.65 to 2.42)		
Widowed	2.43	(0.1 to 4.76)	2.58	(0.52 to 4.64)	1.31	(-1.13 to 3.75)	2.19	(-0.06 to 4.45)		
General Medical Services (GMS Status)										
Not Covered										
Covered	0.17	(-0.58 to 0.93)	0.24	(-0.52 to 1.01)	0.18	(-0.54 to 0.89)	0.09	(-0.68 to 0.86)		
Intercept	19.92	(15.03 to 24.82)	19.99	(15.02 to 24.96)	19.43	(14.7 to 24.15)	19.98	(15.12 to 24.84)		

\* Parameter estimates based on the complete sample with missing data accounted for with multiple imputation with predictive mean matching.

\*\* In contrast to the other models reported, both the outcome (CESD) and Perceived Social Support, are both modelled using their continuous scores, rather than categorising them.