

ABSTRACT

Background: Depression risk may partly originate from socioeconomic hardship in childhood. We investigated the association of childhood socioeconomic position with depressive symptoms in later adulthood in a Central and Eastern European country.

Methods: We analyzed data from the Czech arm of the Health, Alcohol and Psychosocial factors In Eastern Europe (HAPIEE) study. We estimated the associations of three indicators of childhood socioeconomic position (access to household amenities at age of 10 years, father's education and mother's education) with high depressive symptoms, operationalized as ≥ 16 points on the Center for Epidemiological Studies – Depression 20 scale, controlling for age and sex, current socioeconomic position and other social and health-related factors.

Results: The analytical sample included 4,213 individuals (mean age 58 years, 54% women). All three indicators of childhood socioeconomic position were inversely associated with depressive symptoms in age-sex adjusted models (p for trends: access to household amenities $p < 0.001$; mother's education $p < 0.001$; father's education $p = 0.03$). Adjustment for current socioeconomic position attenuated the associations of depressive symptoms with access to household amenities (p for trend 0.04) and mother's education (p for trend 0.05) and virtually eliminated the association with father's education (p for trend 0.82).

Limitations: Individuals with higher depressive symptoms and more adverse socioeconomic position are likely to be underrepresented in the study sample. Data on childhood socioeconomic position may be reported inaccurately.

Conclusions: Socioeconomic hardship in childhood may have long-lasting consequences on mental health in later adulthood.

Key words: depressive symptoms, childhood socioeconomic hardship, epidemiology, lifecourse

Socioeconomic position in childhood and depressive symptoms in later adulthood in the Czech Republic

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INTRODUCTION

Depression is a common, but often neglected and stigmatizing condition, particularly in Central and Eastern Europe (CEE) (Horackova et al., 2019). While the prevalence of current major depressive episode in the Czech Republic has been estimated to be 6% for women and 2% for men, depressive symptoms are more common and occur in approximately 34% of women and 19% of men (Bobak et al., 2006; Formanek et al., 2019). Depression in adulthood may have roots in adverse conditions that individuals faced while growing up (Nicholson et al., 2008). The most common childhood adversity is socioeconomic hardship (Sacks et al., 2014), which may negatively affect various biological systems, leading to manifest depression later in life (Lorant et al., 2003).

Experience of socioeconomic hardship in childhood can impair adaptive reactions of the autonomic nervous system during stressful experiences and dysregulate emotional reactivity, motivation and affect, making the affected individuals commit to negative emotional schemes (Daches et al., 2017; Holz et al., 2015; McLaughlin et al., 2010; Simons et al., 2017).

Socioeconomic position (SEP) in childhood is also a major determinant of educational achievement and cognitive abilities, which may buffer against stressful life events (Brown et al., 2013) and exhibit strong protective effects against depression (Lorant et al., 2003). Previous studies that suggested a link between socioeconomic hardship in childhood and increased risk of depression later in life (Angelini et al., 2018; Angelini et al., 2016; Bareis and Mezuk, 2016; Comijs et al., 2007; Kamiya et al., 2013; Kasen et al., 2010; Krsteska and Pejaska, 2013; Novelo et al., 2018; Ritchie et al., 2009), were mostly conducted in Western populations, while evidence on the relation between childhood SEP and depression is largely lacking in CEE (Cermakova et al., 2018; Kagstrom et al., 2019; Winkler et al., 2018).

Largely driven by the communist history, the socioeconomic inequalities in CEE countries have been traditionally smaller than in Western Europe (Varga et al., 2014), but the burden of depression is in particular high (Horackova et al. 2019). Given the specific social and historical context, it is plausible that socioeconomic factors affect the risk of depression in CEE differently than in Western populations. Therefore, the aforementioned studies from Western populations cannot be generalized to the CEE region. In the Czech Republic, a country situated in CEE, evidence on socioeconomic inequalities in mental health has only recently started to emerge

(Kondráťová et al., 2018). In addition to historical patterns, the Czech Republic, similarly to other countries in CEE, is undergoing a reform of mental health care that aims to modernize the outdated model of institutionalized care and improve mental health of the population (Formanek et al., 2019; Kagstrom et al., 2019; Winkler et al., 2018). So far, life-course socioeconomic inequalities in mental health have not been largely taken into account within the current mental health care system. Understanding specific predictors of depressive symptoms could target interventions aiming at reducing the burden of depression due to socioeconomic inequalities.

Previous studies have used several operationalisations of childhood SEP (Galobardes et al., 2006 a,b). Housing conditions, the key component of most people's wealth, may be particularly useful to capture material aspects of SEP. Low parental education has been widely recognized as a strong risk factor for various diseases, although it has been debated whether it is the education of the mother or the father which has the strongest effect on later-life health outcomes of their children (Vollmer et al., 2017). Previous authors also suggest that the benefit of high education of the parents is largely explained by the high SEP, which the offspring reaches in adulthood (Quesnel-Vallée and Taylor, 2012). It is unclear, how these different measures of childhood SEP relate to depressive symptoms in CEE. In the present study, we examined how depressive symptoms in later adulthood may be influenced by childhood SEP operationalized by indicators capturing access to household amenities and education of both parents. We hypothesize that all indicators of childhood SEP are associated with depressive symptoms in later adulthood and that SEP in adulthood explains the relationship between parental education and depressive symptoms.

METHODS

Source of data

We analyzed data from the Czech arm of the Health, Alcohol and Psychosocial factors In Eastern Europe (HAPIEE) (Peasey et al., 2006). The HAPIEE study is a prospective cohort study designed to investigate the effects of traditional as well as non-conventional risk factors for non-communicable diseases in CEE during the post-communist transition. The study population in the Czech Republic includes a sample of six following towns: Karvina-Havirov, Hradec Kralove, Jihlava, Kromeriz, Liberec and Usti nad Labem. The methodology of the HAPIEE study has been described in detail elsewhere (Peasey et al., 2006). Briefly, the cohort consists of a random

sample of men and women aged 45–69 years at baseline, stratified by sex and 5-year age groups, and was selected from population registers. The baseline data collection was conducted in 2002–2004. Participants were visited at home by trained staff and completed a structured questionnaire. A total of 8,856 individuals (mean age 58 years, 53% women) took part (response rate 55%) in the first wave of the study. The second wave in 2006–2008 re-examined 5210 individuals (attrition 41%).

The HAPIEE study was approved by the ethics committees at University College London, UK and the National Institute of Public Health in Prague, Czech Republic. This analysis was additionally approved by the ethics committee at the National Institute of Mental Health in Klecany, Czech Republic. All participants gave a written informed consent.

Analytical sample

Among the 5,210 retained participants in the second wave, 288 (6%) had missing data on depressive symptoms. Furthermore, missing data on childhood SEP, specifically on household amenities (n=204, 4%), father's education (n=127, 2%) and mother's education (n=28, <1%) reduced the analytical sample to 4,563 people. After excluding individuals with missing data on covariates (n=350), the final analytical sample in this study consisted of 4,213 persons (age range 45–69 years; 54% women). Flowchart is presented on Supplemental Figure S1.

Variables

Most of the data used in the analysis and described below were collected during the baseline wave (first wave) of the study. Information on mother's and father's education were, however, collected in the second wave of the study.

Depressive symptoms

Depressive symptoms were measured at baseline using the 20-item Center for Epidemiological Studies – Depression (CES-D) scale (Radloff, 1977). CES-D is a widely used and validated self-reported measure of depressive symptomatology in the general population. Individuals are asked to rate how often over the past week they experienced 20 different symptoms associated with depression. The items relate to feelings of depressed mood, hopelessness and loneliness as well

as changes in appetite, concentration, sleep, enjoyment and other factors, as listed in detail elsewhere (Radloff, 1977). Possible response options are 0 (rarely or none of the time), 1 (some or little of the time), 2 (moderately or much of the time) and 3 (most or almost all the time).

The total score ranges from 0 to 60, with higher scores being indicative of greater depressive symptoms. CES-D scores were calculated for individuals who answered at least 16 questions (out of possible 20). If 1 to 4 items were missing, scores on the completed items were added and divided by the number of items completed; then multiplied by 20 (Pikhart et al., 2004).

Individuals who missed 5 or more items were considered as having missing data on depressive symptoms and were omitted from the analysis. Previous studies identified individuals scoring 16 or more points to be at increased risk of clinical depression, with good sensitivity and specificity and high internal consistency (Bobak et al., 2006; Lewinsohn et al., 1997). Therefore, in the present study, we used a cut-off of 16+ to denote the presence of significant depressive symptoms (which we refer to as depressive symptoms).

Childhood socioeconomic position

In the present study, childhood SEP was investigated using three measures: 1) access to household amenities at the age of 10 years; 2) mother's education and 3) father's education. Data on household amenities were collected in the first wave and comprised six items in the household: i) cold tap water, ii) hot tap water, iii) a radio, iv) a fridge, v) own kitchen and vi) own toilet. Possible answers were yes, no, or don't remember. If participants answered "don't remember", these answers were considered as missing data.

We assigned a point for each item participants reported having access to, creating a scale ranging from 0 to 6 points, with higher values indicating access to more amenities and therefore a higher SEP in childhood. We allowed one missing item of the six; for those with one missing value we calculated the mean from the remaining five items and multiplied it by six. Individuals with missing data on two or more items were excluded from the sample. The median score was 4 and interquartile range (IQR) 2. We classified participants into approximate quartiles: lowest (less than 3 items); lower (3 items and more, less than 4 items); higher (4 items and more, less than 5 items) and highest (5 items and more).

Information about parental education was collected in the second wave. Participants reported the highest completed education of their mother and their father, with five possible answers: incomplete primary or no formal education, primary, vocational, secondary (high school diploma), university. As few parents reported having no formal education, we classified parental education into four categories: 1) primary or lower vs. 2) vocational vs. 3) secondary vs. 4) university.

Covariates

Covariates, obtained at baseline, were chosen on the basis of the literature on current social and health-related factors that are associated with childhood SEP and depression (Cermakova et al., 2018; Cermakova et al., 2017; Enache et al., 2016; Horackova et al., 2019; Kucera et al., 2020; Secnik et al., 2017). We included age (years), sex (men vs. women), educational attainment (primary or lower, vocational, secondary or university), marital status (married or cohabiting vs. single or divorced or separated or widowed), paid work during the last year (yes vs. no), material deprivation score (assessed by how often individuals did not have money for food, clothing and household bills (Pikhart et al., 2004)), and social isolation (assessed by questions about contact with relatives or friends (Dragano et al., 2007)).

Health-related covariates included smoking status (current smokers vs. ex-smokers vs. non-smokers), high frequency of alcohol consumption (drinking 5 times / week or more, assessed using a graduated frequency questionnaire (Hu et al., 2016)), obesity (body mass index ≥ 30 , calculated from self-reported weight and height), self-reported hypertension, diabetes mellitus or hypercholesterolaemia, cardiovascular disease (heart attack, angina, ischemic heart disease or stroke) and cancer.

Statistical analysis

We present data as means \pm standard deviation (SD), median and IQR or frequency (n, %), where appropriate. To compare characteristics of the respondents between those with and without depressive symptoms, we used χ^2 test for categorical variables, independent samples t-test for normally distributed continuous variables and Mann-Whitney test for skewed continuous variables. Compared to the individuals from baseline who were not included in the present study, people in the final analytical sample had a lower frequency of depressive symptoms (16% vs.

20%, $p < 0.001$) and higher education (university education: 17% vs. 11%, $p < 0.001$), but did not differ in sex ($p = 0.17$) or age ($p = 0.73$).

To address the possibility of selection bias due to missing data and high attrition, we performed the analyses using inverse probability weighting (IPW) (Weuve et al., 2012). The probability of remaining in the complete case sample ($n = 4\,213$ from the original sample size of 8,856 individuals taking part in the baseline wave of HAPIEE) was estimated using data on depressive symptoms, childhood amenities and the aforementioned covariates (all baseline variables used in the analysis). Interaction terms between depressive symptoms and childhood SEP were not included in the calculation of weights as these were not statistically significant (household amenities $p = 0.62$; father's education $p = 0.79$ and mother's education $p = 0.20$).

We then performed weighted binary logistic regression to estimate the associations of each marker of childhood SEP with depressive symptoms using odds ratios (ORs) and 95% confidence intervals (CIs). We present 3 sets of models, stepwise adding groups of covariates. In Model 1 the ORs were adjusted for age and sex. As previous studies indicate that current socioeconomic and health-related circumstances may overcome the adverse effects of childhood SEP on depressive symptoms (Nicolson et al., 2008; Quesnel-Vallée and Taylor, 2012) and since we hypothesized that SEP in adulthood explains the association of some markers of childhood SEP with depressive symptoms, we used two groups of Further, we incorporated also data on several factors/covariates, combined into two groups, representing mechanisms and pathways that may are hypothesized to act as confounders or mediators, of the relationship of interest. In Model 2, we included indicators of current SEP (current education and material deprivation score) to specifically test, whether ~~the~~ current SEP explains the association of childhood SEP with depressive symptoms, which was previously suggested (Quesnel-Vallée and Taylor, 2012). Model 3 included the remaining ders of the above-social and health-relateddescribed covariates that may affect (confound or mediate) the association of interest.-

First, we modelled each marker of childhood SEP separately (Table 2). Second, we entered markers of childhood SEP simultaneously into the model, adjusting for covariates as described above. Because father's education strongly correlates with education of the mother and shows

the weakest association with depressive symptoms out of the three markers of childhood SEP, we entered only access to household amenities in childhood and mother's education simultaneously into the model (Table 3).

Given the larger burden of depression in women than in men and the literature suggesting that childhood socioeconomic hardship affects women more strongly than men (Lee et al., 2018), we explored whether the association of childhood SEP with depressive symptoms differed by sex, by including two-way interaction terms between sex and childhood SEP in the three sets of Model 1. In addition, to study whether the association of childhood SEP on depressive symptoms differed by age, we included the interaction terms between age group (45-54 years; 55-64 years and 65-69 years) and indicators of childhood SEP. In addition, as the cut-off of 16 points on the CES-D was suggested to overestimate depressive symptoms in the general population (Vilagut et al., 2016) and some authors use sex-specific cut-points (Melchior et al., 2017), we performed a sensitivity analysis, using the cut-off 20 for women and 16 for men. To assess a combined role of both father's and mother's education, we estimated the association of overall parental education with depressive symptoms (see Supplement for details). All analyses were performed in STATA 15.1.

RESULTS

The main analyses included 4,213 individuals (mean age 58 years, 54% women), from whom 671 (16 %) were classified with depressive symptoms (score ≥ 16 on the CES-D scale). The prevalence of depressive symptoms was 20% in women and 11% in men. Compared to individuals without depressive symptoms, those with greater symptoms more often had mothers with lower education ($p=0.004$), but significantly differed neither in the education of their fathers ($p=0.13$), nor in the access to household amenities ($p=0.09$; Table 1). Depressive symptoms were more common among adults who reached lower education ($p<0.001$), higher material deprivation score ($p<0.001$), were more often without a partner ($p<0.001$), were not in paid work ($p=0.01$) and were more socially isolated ($p=0.001$). They also differed in several health aspects, such as that they less frequently consumed alcohol ($p<0.001$), were more commonly obese ($p=0.002$) and reported more frequently hypercholesterolaemia / diabetes mellitus ($p<0.001$) and cancer ($p<0.001$).

Table 2 presents the results of weighted multivariable analysis where each indicator of childhood SEP was modelled separately. All three indicators of childhood SEP were associated with depressive symptoms in age-sex adjusted models. The OR of depressive symptoms for the highest vs. the lowest category of household amenities was 0.62 (95% CI 0.46 to 0.83, p for trend <0.001), which was attenuated after adjustment for current education and current material deprivation score (i.e. indicators of current SEP), but the trend remained statistically significant (OR for the highest vs. the lowest category: 0.76; 95% CI 0.56 to 1.03, p for trend 0.04). After taking into account further social and health-related factors, the OR further attenuated and the trend lost statistical significance (OR for the highest vs. the lowest category: 0.80; 95% CI 0.59 to 1.09; p for trend 0.10).

Similarly, mother's education showed a significant trend in the association with lower odds of depressive symptoms in the age-sex adjusted model (OR for university vs. primary or lower education: 0.34; 95% CI 0.12 to 0.94; p for trend <0.001). The trend remained with a p value of 0.05 after adjustment for current SEP (OR for university vs. primary or lower education: 0.44; 95% CI 0.16 to 1.22) and with a p value of 0.14 in the fully adjusted model (OR for university vs. primary or lower education: 0.49; 95% CI 0.18 to 1.36). Father's education showed a trend in the association to lower odds of depressive symptoms, adjusting for age and sex (OR for university vs. primary or lower education 0.77; 95% CI 0.54 to 1.11, p for trend 0.03) but the OR were close to unity after adjustment for current SEP (OR for university vs. primary or lower education: 1.06; 95% CI 0.72 to 1.57; p for trend 0.82).

Table 3 presents results of the weighted multivariable analysis that mutually adjusted for access to household amenities in childhood and mother's education. After entering both household amenities and mother's education as well as controlling for age and sex, both access to household amenities and mother's education were independently associated with depressive symptoms. The OR for both variables were reduced and lost statistical significance by additionally controlling for current SEP.

~~The interaction terms for indicators of childhood SEP and sex were not statistically significant (household amenities p=0.47; father's education p=0.73 and mother's education p=0.59). The~~

~~interactions between childhood SEP and age group were not statistically significant either (household amenities $p=0.78$; father's education $p=0.71$ and mother's education $p=0.65$).~~

Analyses, which were not weighted, and used the sample with complete cases ($n=4,213$) showed similar trends, but slightly weaker associations (not presented in tables). Similarly, in sensitivity analysis, when defining depressive symptoms by 16+ points in the CES-D scale for men and 20+ for women, using the sample with complete cases, we found similar trends and weaker associations (Supplemental Tables S1 and S2). When assessing the combined effect of the education of both parents, individuals whose both parents had the lowest education had the highest odds of depressive symptoms (Supplemental Table S3). The interaction terms for indicators of childhood SEP and sex were not statistically significant (household amenities $p=0.47$; father's education $p=0.73$ and mother's education $p=0.59$). The interactions between childhood SEP and age group were not statistically significant either (household amenities $p=0.78$; father's education $p=0.71$ and mother's education $p=0.65$).

DISCUSSION

The present study, capitalizing on a large, well-characterized population-based sample of individuals residing in the Czech Republic, suggests that socioeconomic environment, in which people grow up, operationalized by access to household amenities and education of both parents, may have long-lasting effects on mental health in later adulthood. Low education of the mother was associated more strongly with depressive symptoms than education of the father.

Adjustment for current socioeconomic circumstances reduced all associations, to the largest extent the association of father's education with depressive symptoms. The associations of all three indicators of childhood SEP with depressive symptoms were attenuated and lost statistical significance after adjustment for the full set of social and health-related factors in adulthood.

Socioeconomic hardship in childhood may affect the risk of depression in adulthood because it is associated with greater concerns, chronic stress, hopelessness, a lack of control over life, demoralization as well as poor reward performance (Butterworth et al., 2012; Dennison et al., 2017). Childhood poverty correlates with several genetic traits and epigenetic signals associated

with depression (Kim et al., 2018; Ritchie et al., 2009; Simons et al., 2017) and has morphological and functional representations in the brain (Barch et al., 2016; Berens et al., 2017; Holz et al., 2015; Kim et al., 2018). Individuals exposed to early life poverty exhibit a lag in overall brain development and show a decreased volume in several key structures involved in emotion and reward regulation, such as the orbitofrontal cortex, hippocampus, amygdala, anterior cingulate cortex and prefrontal cortex (Holz et al., 2015; Kim et al., 2018). Childhood poverty has been also related to less prefrontal activity, reduced connectivity in the default mode network as well as between hippocampus and amygdala and a number of other brain regions that play a key role in emotion processing (Barch et al., 2016; Holz et al., 2015).

We found that the associations of all three indicators of childhood SEP were reduced when the current SEP of the participants was accounted for, however, different pathways may exist, through which each of the indicators may influence the occurrence of depressive symptoms. As the association of material hardship in childhood, as captured by the measure of access to household amenities, was not fully statistically explained by adult SEP, we suggest that material deprivation in childhood could exhibit long-lasting effects on adult mental health even through mechanisms independent from how adult socioeconomic circumstances shape the risk of depressive symptoms.

Some previous studies have used only father's education as an indicator of childhood SEP (Nicholson et al., 2008), but here we suggest that mother's education may have a large impact on mental health of the children. We further show that the combined effect of low education of both parents is particularly detrimental on mental health in later adulthood. Our study is in general in line with authors proposing that the link between low parental education and poor mental health of their offsprings largely exists because parents with higher education tend to have children that reach a higher SEP in adulthood, which determines their depressive symptoms (Quesnel-Vallée and Taylor, 2012). The difference between the association of mother's and father's education with depressive symptoms was not large, but there may be different mechanisms with respect to how education of each parent influences affect. While the association of father's education with depressive symptoms was largely explained by current SEP of the participants, this was less apparent for mother's education. This is concluded from the ORs that were closer to unity for the association of father's education than for mother's education, when current SEP was adjusted

for. ~~However, a higher sample size may be necessary to show results, which are statistically significant.~~

The SEP in adulthood is a likely mediator of the association of parental education and depressive symptoms (Quesnel-Vallée and Taylor, 2012). The present study indicates that the association between father's education and depressive symptoms was largely mediated by SEP in adulthood, ~~while. By contrast,~~ adult SEP accounted for a smaller proportion of the association between mother's education and depressive symptoms. ~~This indicates that, suggesting that~~ there may be another path, operating through mechanisms not assessed in our study. For example, children may adopt coping strategies of their mothers when they learn how to face stressful situations. ~~Education is indicative of cognitive abilities that determine the skills involved in counteracting stressors, which may in the end affect the development of depression. Good cognitive abilities allow individuals to be more reflective about the sources of distress, weigh options when facing negative environmental pressures and process novel situations more systematically (Brown et al., 2013). This can lead to better adaptive responses to negative situations and thus better solutions and reduction of emotional distress (Brown et al., 2013).~~ It is likely that foundations for these ~~skills~~ are learnt early in life from the parent who spends the most time with the child, which have predominantly been mothers.

It is well known that many women in the past did not get a chance to fulfill their intellectual potential to reach adequate educational attainment (Cooray and Potrafke, 2011). This not only deprived them from a substantial resource against depressive symptoms, but the adverse effects of their low educational attainment may also have been passed on to their children's mental health. In addition, mothers with lower education may have worse mental health themselves, could be less able to meet the needs of the child, and have insufficient resources to support the child in coping with a stressful environment. These mechanisms may adversely affect the socioemotional development of children (Brown et al., 2013).

We speculate that increased educational opportunities, in particular for women, could significantly contribute to breaking the chain of intergenerational cycle of low SEP and poor mental health. Previous authors propose that upward mobility could protect individuals from later-life mental health issues by helping them acquire socioeconomical as well as psychological resources for the maintenance of their mental health (Melchior et al., 2017).

Contrary to the literature suggesting that childhood poverty may have a more adverse effect on the health of women (Lee et al., 2018), our study does not provide support for the hypothesis that women's risk of depression is affected by low childhood SEP to a larger extent than that of men's, as we did not detect a statistically significant interaction. ~~Even though the possibility of confounding effects cannot be excluded, the present study further suggests that the effects of low childhood SEP on late-adulthood depressive symptoms could be counteracted by changing current social circumstances and somatic health. Future studies should address the question, whether some of these factors play a specific mediating role in the context of overcoming childhood socioeconomic disadvantages on later-adulthood mental health.~~

Several limitations of this study need to be mentioned. The HAPIEE study in the Czech Republic comprises participants in six urban areas and is therefore not fully representative of the Czech population. Participants of surveys are in general healthier, have a higher SEP and may have lower prevalence of depressive symptoms than non-respondents, which may lead to selection bias and underestimate our findings. However, the use of IPW ensured that attrition between waves and missing data did not greatly affect our results. Due to self-reported and retrospectively recalled data collection, the childhood SEP (mainly amenities) could have been reported inaccurately, which could underestimate the association with depressive symptoms. In addition, the assessment of depressive symptoms does not only reflect the risk of clinical depression, but other mental health conditions such as psychological distress and minor depression. Finally, information on some important confounders, such as adverse life events, was not available in the study and could not be included in the statistical models.

This study is important in the context of an ongoing mental health care reform in the Czech Republic and could be informative to other countries situated in the region of CEE, which share a similar historical and political context. As there is evidence from randomized controlled trials that depression can be prevented (Cuijpers et al., 2012), strategies for the prevention of depression should be a part of the mental health care reform in CEE. Effective interventions include complex educational, psychotherapeutic, pharmacological, lifestyle, and nutritional approaches. These should be delivered in combination in a stepped-care way over the whole life course of an individual (Cuijpers et al., 2012). To the best of our knowledge, it has not been specifically tested whether the effects of such interventions vary by the level of childhood SEP.

However, given that some targeted prevention strategies have a larger impact in individuals with a lower SEP (Platt et al., 2016), we speculate that targeting individuals with experience of poverty in childhood could bring benefits for the population mental health.

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Declarations of interest: none

Table 1 Characteristics of the analytical sample (n=4 213)

	Depressive symptoms		p value
	Yes (n=671)	No (n=3 542)	
Childhood socioeconomic position			
Access to household amenities, n (%)			
Lowest	100 (15)	438 (12)	0.09
Lower	127 (19)	587 (17)	
Higher	203 (30)	1 149 (32)	
Highest	241 (36)	1 368 (39)	
Father's education, n (%)			
Primary or lower	180 (27)	809 (23)	0.13
Vocational	318 (47)	1 723 (49)	
Secondary	129 (19)	764 (21)	
University	44 (7)	246 (7)	
Mother's education, n (%)			
Primary or lower	390 (58)	1 813 (51)	0.004
Vocational	196 (29)	1 164 (33)	
Secondary	81 (12)	509 (14)	
University	4 (1)	56 (2)	
Social covariates			
Age, mean \pm SD	57.7 \pm 7.2	58.3 \pm 7.1	0.04
Women, n (%)	467 (70)	1 817 (51)	<0.001
Education, n (%)			
Primary or lower	94 (14)	291 (8)	<0.001
Vocational	231 (34)	1 147 (33)	
Secondary	269 (40)	1 459 (41)	
University	77 (12)	645 (18)	
Married/cohabiting, n (%)	455 (68)	2 802 (79)	<0.001
Paid work, n (%)	302 (45)	1 785 (50)	0.01
Material deprivation score, median (IQR)	2 (4)	0 (2)	<0.001
Social isolation, n (%)	234 (35)	1 015 (29)	0.001
Health-related covariates			
Smoking status, n (%)			
Current smoker	156 (23)	833 (23)	0.20
Ex-smoker	178 (27)	1 049 (30)	
Non-smoker	337 (50)	1 660 (47)	
High frequency of alcohol consumption, n (%)	58 (9)	496 (14)	<0.001
Obesity, n (%)	188 (28)	799 (23)	0.002
Hypertension, n (%)	269 (40)	1 309 (37)	0.12
Hypercholesterolaemia or diabetes mellitus, n (%)	259 (39)	1 098 (31)	<0.001
Cardiovascular disease, n (%)	86 (13)	379 (11)	0.11
Cancer, n (%)	67 (10)	173 (5)	<0.001

SD, standard deviation; IQR, interquartile range

Table 2 Associations of childhood socioeconomic position with depressive symptoms using inverse probability weighting in logistic regression

	OR (95% CI)					
	Model 1	p value for trend	Model 2	p value for trend	Model 3	p value for trend
Access to household amenities*						
Lowest	Ref.		Ref.		Ref.	
Lower	0.88 (0.65; 1.18)		0.93 (0.69; 1.27)		0.95 (0.70; 1.30)	
Higher	0.70 (0.53; 0.91)	<0.001	0.79 (0.60; 1.05)	0.04	0.82 (0.62; 1.09)	0.10
Highest	0.62 (0.46; 0.83)		0.76 (0.56; 1.03)		0.80 (0.59; 1.09)	
Father's education*						
Primary or lower	Ref.		Ref.		Ref.	
Vocational	0.80 (0.66; 0.99)		0.88 (0.71; 1.09)		0.90 (0.73; 1.11)	
Secondary	0.73 (0.56; 0.93)	0.03	0.89 (0.68; 1.17)	0.82	0.91 (0.69; 1.20)	0.99
University	0.77 (0.54; 1.11)		1.06 (0.72; 1.57)		1.11 (0.75; 1.64)	
Mother's education*						
Primary or lower	Ref.		Ref.		Ref.	
Vocational	0.75 (0.62; 0.90)		0.86 (0.70; 1.05)		0.88 (0.72; 1.08)	
Secondary	0.69 (0.53; 0.91)	<0.001	0.84 (0.63; 1.12)	0.05	0.89 (0.67; 1.18)	0.14
University	0.34 (0.12; 0.94)		0.44 (0.16; 1.22)		0.49 (0.18; 1.36)	

*Each indicator of childhood SEP was entered separately into the models.

OR, odds ratio; CI, confidence interval

Model 1: adjusted for age and sex

Model 2: adjusted for age, sex, current education and material deprivation score

Model 3: adjusted for age, sex, current education, material deprivation score, marital status, paid work, social isolation, alcohol consumption, smoking, obesity, hypertension, hypercholesterolaemia or diabetes mellitus, cardiovascular disease and cancer

Table 3 Association of access to household amenities and maternal education with depression symptoms using inverse probability weighting in logistic regression

	OR (95% CI)					
	Model 1	p value for trend	Model 2	p value for trend	Model 3	p value for trend
Access to household amenities*						
Lowest	Ref.		Ref.		Ref.	
Lower	0.90 (0.67; 1.21)	0.01	0.94 (0.70 1.28)	0.09	0.96 (0.71; 1.31)	0.16
Higher	0.74 (0.56; 0.97)		0.81 (0.61 1.08)		0.84 (0.63; 1.11)	
Highest	0.68 (0.50; 0.92)		0.79 (0.58 1.08)		0.82 (0.60; 1.13)	
Mother's education*						
Primary or lower	Ref.		Ref.		Ref.	
Vocational	0.78 (0.64; 0.95)	0.002	0.88 (0.72 1.08)	0.11	0.90 (0.74; 1.11)	0.23
Secondary	0.75 (0.57; 0.98)		0.88 (0.66; 1.17)		0.92 (0.69; 1.23)	
University	0.37 (0.13; 1.02)		0.45 (0.16; 1.27)		0.50 (0.18; 1.40)	

*Both childhood SEP indicators were entered into the models simultaneously.

OR, odds ratio; CI, confidence interval

Model 1: adjusted for age and sex

Model 2: adjusted for age, sex, current education and material deprivation score

Model 3: adjusted for age, sex, current education, material deprivation score, marital status, paid work, social isolation, alcohol consumption, smoking, obesity, hypertension, hypercholesterolaemia or diabetes mellitus, cardiovascular disease and cancer

SUPPLEMENT

Supplemental Table S1 Associations of childhood socioeconomic position with depressive symptoms using the cut-off 16 for men and 20 for women on CES-D scale (n=4 213)

	OR (95% CI)					
	Model 1	p value for trend	Model 2	p value for trend	Model 3	p value for trend
Access to household amenities*						
Lowest	Ref.		Ref.		Ref.	
Lower	0.82 (0.58; 1.14)		0.86 (0.61; 1.22)		0.90 (0.63; 1.27)	
Higher	0.69 (0.51; 0.94)	0.002	0.79 (0.58; 1.08)	0.08	0.83 (0.60; 1.14)	0.20
Highest	0.61 (0.44; 0.84)		0.74 (0.53; 1.04)		0.80 (0.57; 1.13)	
Father's education*						
Primary or lower	Ref.		Ref.		Ref.	
Vocational	0.78 (0.62; 0.99)		0.85 (0.67; 1.08)		0.87 (0.68; 1.11)	
Secondary	0.83 (0.63; 1.10)	0.10	1.01 (0.75; 1.36)	1.00	1.05 (0.78; 1.43)	0.78
University	0.70 (0.45; 1.07)		0.94 (0.60; 1.49)		0.99 (0.63; 1.57)	
Mother's education*						
Primary or lower	Ref.		Ref.		Ref.	
Vocational	0.72 (0.58; 0.90)		0.82 (0.66; 1.03)		0.85 (0.68; 1.07)	
Secondary	0.79 (0.59; 1.06)	0.003	0.95 (0.70; 1.30)	0.15	1.03 (0.75; 1.41)	0.38
University	0.23 (0.06; 0.94)		0.29 (0.07; 1.21)		0.33 (0.08; 1.39)	

*Each indicator of childhood SEP was entered separately into the models.

OR, odds ratio; CI, confidence interval

Model 1: adjusted for age and sex

Model 2: adjusted for age, sex, current education and material deprivation score

Model 3: adjusted for age, sex, current education, material deprivation score, marital status, paid work, social isolation, alcohol consumption, smoking, obesity, hypertension, hypercholesterolaemia or diabetes mellitus, cardiovascular disease and cancer

Supplemental Table S2 Association of access to household amenities and maternal education with depression symptoms using the cutoff 16 for men and 20 for women on CES-D scale (n=4 213)

	OR (95% CI)					
	Model 1	p value for trend	Model 2	p value for trend	Model 3	p value for trend
Access to household amenities*						
Lowest	Ref.		Ref.		Ref.	
Lower	0.83 (0.60; 1.16)	0.01	0.87 (0.62; 1.22)	0.12	0.90 (0.63; 1.27)	0.26
Higher	0.73 (0.54; 1.00)		0.80 (0.59; 1.10)		0.84 (0.61; 1.16)	
Highest	0.66 (0.48; 0.93)		0.77 (0.54; 1.08)		0.82 (0.58; 1.16)	
Mother's education*						
Primary or lower	Ref.					
Vocational	0.75 (0.60; 0.94)	0.02	0.84 (0.67; 1.06)	0.26	0.87 (0.69; 1.09)	0.51
Secondary	0.85 (0.63; 1.15)		0.99 (0.72; 1.36)		1.06 (0.77; 1.46)	
University	0.25 (0.06; 1.02)		0.30 (0.07; 1.26)		0.34 (0.08; 1.43)	

*Both childhood SEP indicators were entered into the models simultaneously.

OR, odds ratio; CI, confidence interval

Model 1: adjusted for age and sex

Model 2: adjusted for age, sex, current education and material deprivation score

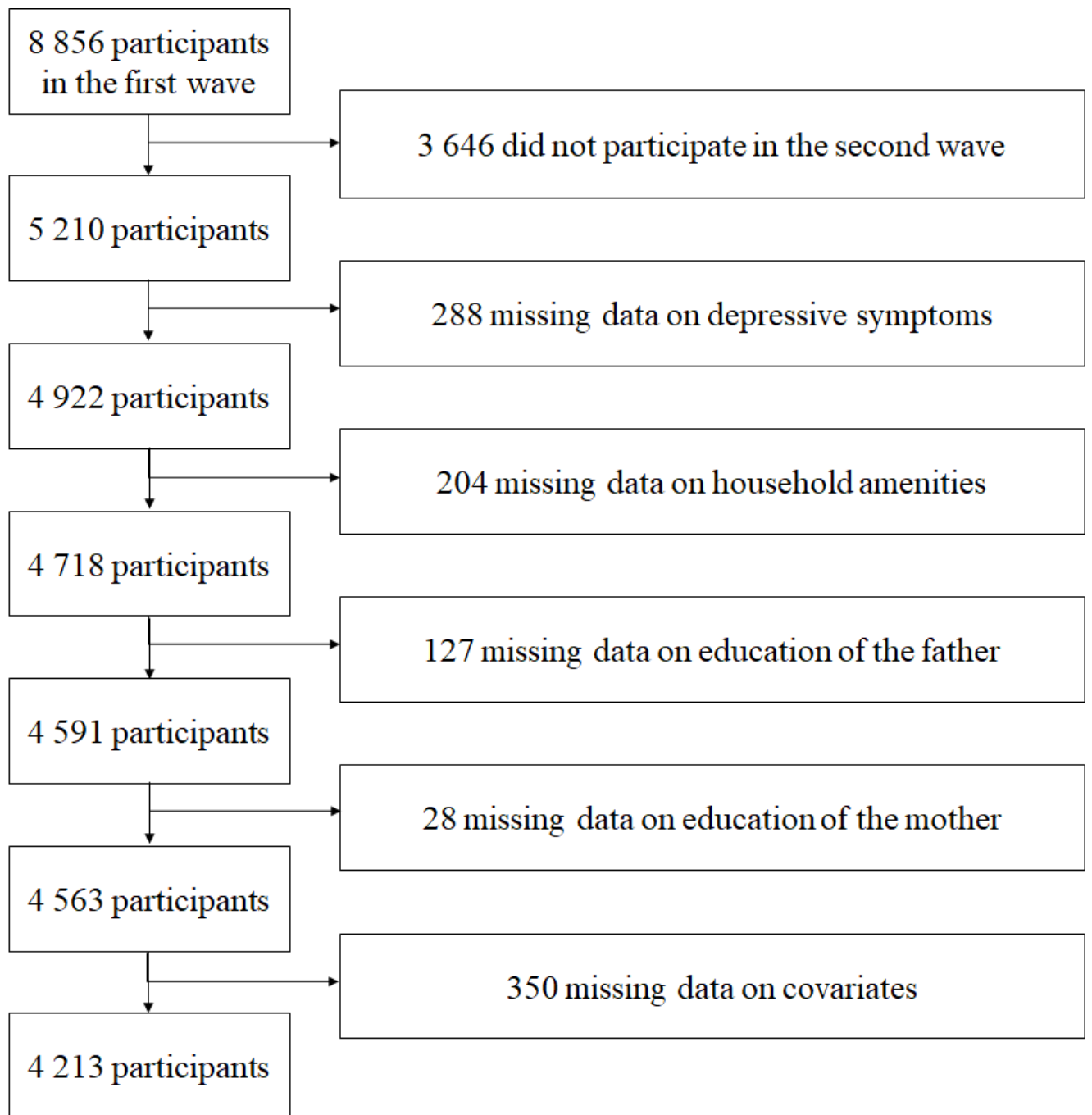
Model 3: adjusted for age, sex, current education, material deprivation score, marital status, paid work, social isolation, alcohol consumption, smoking, obesity, hypertension, hypercholesterolaemia or diabetes mellitus, cardiovascular disease and cancer

Supplemental Table S3 Association of parental education with depressive symptoms (n=4 213)

	n (%)	OR (95% CI)	p value for trend
A) Parental education as an 8-categorical variable			
2 points	891 (21.1)	Ref.	
3 points	1120 (26.6)	0.85 (0.67; 1.08)	
4 points	1098 (26.1)	0.78 (0.61; 0.99)	
5 points	540 (12.8)	0.71 (0.52; 0.95)	
6 points	372 (8.8)	0.60 (0.42; 0.86)	
7 points	159 (3.8)	0.72 (0.45; 1.17)	
8 points	33 (0.8)	0.14 (0.02; 1.07)	
B) Parental education as a 4-categorical variable			
Lowest (2 points)	891 (21.1)	Ref.	0.001
Lower (3 points)	1120 (26.6)	0.85 (0.67; 1.08)	
Higher (4 points)	1098 (26.1)	0.78 (0.61; 0.99)	
Highest (5-8 points)	1104 (26.2)	0.66 (0.51; 0.84)	
C) Parental education as a 4-categorical variable			
Highest (5-8 points)	1104 (26.2)	Ref.	
Higher (4 points)	1098 (26.1)	1.18 (0.93; 1.50)	
Lower (3 points)	1120 (26.6)	1.30 (1.02; 1.65)	
Lowest (2 points)	891 (21.1)	1.52 (1.19; 1.96)	

OR, odds ratio; CI, confidence interval

The variable “parental education” was created as follows: mother’s and father’s educational categories were coded with numbers, where 1 stands for primary or lower, 2 for vocational, 3 for secondary and 4 for university education. We summed the two variables, creating a numerical variable reaching from 2 (primary or lower education of both parents) to 8 (university education of both parents). First, we modelled the association of the 8-categorical variable with depressive symptoms (A). Because of a low frequency of those with points 5-8, we then divided the variable into 4 categories, where 2=lowest parental education, 3=lower parental education, 4=higher parental education and 5-8=highest parental education (B). To present the results in a way that enables assessing the combined effects of lowest mother’s and father’s education at the same time, we have inversely re-coded the variable as well (B). All associations are adjusted for both age and sex.



Supplemental Figure S1 Flowchart

References:

- Angelini, V., Howdon, D.D.D., Mierau, J.O., 2018. Childhood Socioeconomic Status and Late-Adulthood Mental Health: Results from the Survey on Health, Ageing and Retirement in Europe. *The journals of gerontology. Series B, Psychological sciences and social sciences*.
- Angelini, V., Klijs, B., Smidt, N., Mierau, J.O., 2016. Associations between Childhood Parental Mental Health Difficulties and Depressive Symptoms in Late Adulthood: The Influence of Life-Course Socioeconomic, Health and Lifestyle Factors. *PloS one* 11, e0167703.
- Bareis, N., Mezuk, B., 2016. The relationship between childhood poverty, military service, and later life depression among men: Evidence from the Health and Retirement Study. *Journal of affective disorders* 206, 1-7.
- Barch, D., Pagliaccio, D., Belden, A., Harms, M.P., Gaffrey, M., Sylvester, C.M., Tillman, R., Luby, J., 2016. Effect of Hippocampal and Amygdala Connectivity on the Relationship Between Preschool Poverty and School-Age Depression. *The American journal of psychiatry* 173, 625-634.
- Berens, A.E., Jensen, S.K.G., Nelson, C.A., 3rd, 2017. Biological embedding of childhood adversity: from physiological mechanisms to clinical implications. *BMC medicine* 15, 135.
- Bobak, M., Pikhart, H., Pajak, A., Kubinova, R., Malyutina, S., Sebakova, H., Topor-Madry, R., Nikitin, Y., Marmot, M., 2006. Depressive symptoms in urban population samples in Russia, Poland and the Czech Republic. *The British journal of psychiatry : the journal of mental science* 188, 359-365.
- Brown, J., Barbarin, O., Scott, K., 2013. Socioemotional trajectories in black boys between kindergarten and the fifth grade: the role of cognitive skills and family in promoting resiliency. *The American journal of orthopsychiatry* 83, 176-184.
- Butterworth, P., Cherbuin, N., Sachdev, P., Anstey, K.J., 2012. The association between financial hardship and amygdala and hippocampal volumes: results from the PATH through life project. *Social cognitive and affective neuroscience* 7, 548-556.
- Cermakova, P., Formanek, T., Kagstrom, A., Winkler, P., 2018. Socioeconomic position in childhood and cognitive aging in Europe. *Neurology* 91, e1602-e1610.
- Cermakova, P., Nelson, M., Secnik, J., Garcia-Ptacek, S., Johnell, K., Fastbom, J., Kilander, L., Winblad, B., Eriksdotter, M., Religa, D., 2017. Living alone with Alzheimer's disease: data from SveDem, the Swedish Dementia Registry. *Journal of Alzheimer's Disease* 58, 1265-1272.
- Comijs, H.C., Beekman, A.T., Smit, F., Bremmer, M., van Tilburg, T., Deeg, D.J., 2007. Childhood adversity, recent life events and depression in late life. *Journal of affective disorders* 103, 243-246.
- Cooray, A., Potrafke, N., 2011. Gender inequality in education: Political institutions or culture and religion? *European Journal of Political Economy* 27, 268-280.
- Cuijpers, P., Beekman, A.T.F., Reynolds, C.F., 3rd, 2012. Preventing depression: a global priority. *JAMA* 307, 1033-1034.
- Daches, S., Kovacs, M., George, C.J., Yaroslavsky, I., Kiss, E., Vetro, A., Dochnal, R., Benak, I., Baji, I., Halas, K., Makai, A., Kapornai, K., Rottenberg, J., 2017. Childhood adversity predicts reduced

physiological flexibility during the processing of negative affect among adolescents with major depression histories. *International journal of psychophysiology : official journal of the International Organization of Psychophysiology* 121, 22-28.

Dennison, M.J., Rosen, M.L., Sambrook, K.A., Jenness, J.L., Sheridan, M.A., McLaughlin, K.A., 2017. Differential Associations of Distinct Forms of Childhood Adversity With Neurobehavioral Measures of Reward Processing: A Developmental Pathway to Depression. *Child development*.

Dragano, N., Bobak, M., Wege, N., Peasey, A., Verde, P.E., Kubinova, R., Weyers, S., Moebus, S., Mohlenkamp, S., Stang, A., Erbel, R., Jockel, K.H., Siegrist, J., Pikhart, H., 2007. Neighbourhood socioeconomic status and cardiovascular risk factors: a multilevel analysis of nine cities in the Czech Republic and Germany. *BMC Public Health* 7, 255.

Enache, D., Fereshtehnejad, S.M., Kareholt, I., Cermakova, P., Garcia-Ptacek, S., Johnell, K., Religa, D., Jelic, V., Winblad, B., Ballard, C., Aarsland, D., Fastbom, J., Eriksdotter, M., 2016. Antidepressants and mortality risk in a dementia cohort: data from SveDem, the Swedish Dementia Registry. *Acta psychiatrica Scandinavica* 134, 430-440.

Formanek, T., Kagstrom, A., Cermakova, P., Csemy, L., Mlada, K., Winkler, P., 2019. Prevalence of mental disorders and associated disability: Results from the cross-sectional CZEch mental health Study (CZEMS). *European psychiatry : the journal of the Association of European Psychiatrists* 60, 1-6.

Galobardes, B., Shaw, M., Lawlor, D.A., Lynch, J.W., Davey Smith, G., 2006a. Indicators of socioeconomic position (part 1). *Journal of epidemiology and community health* 60, 7-12.

Galobardes, B., Shaw, M., Lawlor, D.A., Lynch, J.W., Davey Smith, G., 2006b. Indicators of socioeconomic position (part 2). *Journal of epidemiology and community health* 60, 95-101.

Holz, N.E., Laucht, M., Meyer-Lindenberg, A., 2015. Recent advances in understanding the neurobiology of childhood socioeconomic disadvantage. *Current opinion in psychiatry* 28, 365-370.

Horackova, K., Kopecek, M., Machu, V., Kagstrom, A., Aarsland, D., Motlova, L.B., Cermakova, P., 2019. Prevalence of late-life depression and gap in mental health service use across European regions. *European psychiatry : the journal of the Association of European Psychiatrists* 57, 19-25.

Hu, Y., Pikhart, H., Kubinova, R., Malyutina, S., Pajak, A., Besala, A., Bell, S., Peasey, A., Marmot, M., Bobak, M., 2016. Alcohol Consumption and Longitudinal Trajectories of Physical Functioning in Central and Eastern Europe: A 10-Year Follow-up of HAPIEE Study. *The journals of gerontology. Series A, Biological sciences and medical sciences* 71, 1063-1068.

Kagstrom, A., Alexova, A., Tuskova, E., Csajbok, Z., Schomerus, G., Formanek, T., Mlada, K., Winkler, P., Cermakova, P., 2019. The treatment gap for mental disorders and associated factors in the Czech Republic. *European psychiatry : the journal of the Association of European Psychiatrists* 59, 37-43.

Kamiya, Y., Doyle, M., Henretta, J.C., Timonen, V., 2013. Depressive symptoms among older adults: the impact of early and later life circumstances and marital status. *Aging & mental health* 17, 349-357.

- Kasen, S., Chen, H., Sneed, J.R., Cohen, P., 2010. Earlier stress exposure and subsequent major depression in aging women. *International journal of geriatric psychiatry* 25, 91-99.
- Kim, Y.K., Ham, B.J., Han, K.M., 2018. Interactive effects of genetic polymorphisms and childhood adversity on brain morphologic changes in depression. *Progress in neuro-psychopharmacology & biological psychiatry*.
- Kondrátová, L., Chrtková, D., Mladá, K., Janoušková, M., Štanglová, A., Roboch, Z., Páv, M., Winkler, P., 2018. SOCIOEKONOMICKÁ SITUACE OSOB S PSYCHOTICKÝM ONEMOCNĚNÍM V ČESKÉ REPUBLICE. *Ceská a Slovenská Psychiatrie* 114.
- Krsteska, R., Pejoska, V.G., 2013. The association of poor economic condition and family relations in childhood with late-life depression. *Psychiatria Danubina* 25, 241-247.
- Kucera, M., Wolfova, K., Cermakova, P. Changes in depressive symptoms of older adults in the Czech Republic. *Journal of Affective Disorders* 15, 139-144.
- Lee, C., Ryff, C.D., Coe, C.L., 2018. Gender, Early Life Adversity, and Adult Health. *The Oxford Handbook of Integrative Health Science*, 63.
- Lewinsohn, P.M., Seeley, J.R., Roberts, R.E., Allen, N.B., 1997. Center for Epidemiologic Studies Depression Scale (CES-D) as a screening instrument for depression among community-residing older adults. *Psychology and aging* 12, 277.
- Lorant, V., Deliege, D., Eaton, W., Robert, A., Philippot, P., Ansseau, M., 2003. Socioeconomic inequalities in depression: a meta-analysis. *American journal of epidemiology* 157, 98-112.
- McLaughlin, K.A., Kubzansky, L.D., Dunn, E.C., Waldinger, R., Vaillant, G., Koenen, K.C., 2010. Childhood social environment, emotional reactivity to stress, and mood and anxiety disorders across the life course. *Depression and anxiety* 27, 1087-1094.
- Melchior, M., Ziad, A., Courtin, E., Goldberg, M., Zins, M., Van Der Waerden, J., 2017. Intergenerational socioeconomic mobility and adult depression: the CONSTANCES study. *American journal of epidemiology* 187, 260-269.
- Nicholson, A., Pikhart, H., Pajak, A., Malyutina, S., Kubinova, R., Peasey, A., Topor-Madry, R., Nikitin, Y., Capkova, N., Marmot, M., Bobak, M., 2008. Socio-economic status over the life-course and depressive symptoms in men and women in Eastern Europe. *Journal of affective disorders* 105, 125-136.
- Novelo, M., von Gunten, A., Gomes Jardim, G.B., Spanemberg, L., Argimon, I.I.L., Nogueira, E.L., 2018. Effects of childhood multiple maltreatment experiences on depression of socioeconomic disadvantaged elderly in Brazil. *Child abuse & neglect* 79, 350-357.
- Peasey, A., Bobak, M., Kubinova, R., Malyutina, S., Pajak, A., Tamosiunas, A., Pikhart, H., Nicholson, A., Marmot, M., 2006. Determinants of cardiovascular disease and other non-communicable diseases in Central and Eastern Europe: rationale and design of the HAPIEE study. *BMC public health* 6, 255.
- Pikhart, H., Bobak, M., Pajak, A., Malyutina, S., Kubinova, R., Topor, R., Sebakova, H., Nikitin, Y., Marmot, M., 2004. Psychosocial factors at work and depression in three countries of Central and Eastern Europe. *Social science & medicine* (1982) 58, 1475-1482.

- Platt, J.M., Keyes, K.M., Galea, S., 2016. Efficiency or equity? Simulating the impact of high-risk and population intervention strategies for the prevention of disease. *SSM Popul Health* 3, 1-8.
- Quesnel-Vallée, A., Taylor, M., 2012. Socioeconomic pathways to depressive symptoms in adulthood: evidence from the National Longitudinal Survey of Youth 1979. *Social science & medicine* 74, 734-743.
- Radloff, L.S., 1977. The CES-D scale: A self-report depression scale for research in the general population. *Applied psychological measurement* 1, 385-401.
- Ritchie, K., Jaussett, I., Stewart, R., Dupuy, A.M., Courtet, P., Ancelin, M.L., Malafosse, A., 2009. Association of adverse childhood environment and 5-HTTLPR Genotype with late-life depression. *The Journal of clinical psychiatry* 70, 1281-1288.
- Sacks, V., Murphey, D., Moore, K., 2014. Adverse childhood experiences: National and state-level prevalence.
- Secnik, J., Cermakova, P., Fereshtehnejad, S.-M., Dannberg, P., Johnell, K., Fastbom, J., Winblad, B., Eriksdotter, M., Religa, D., 2017. Diabetes in a large dementia cohort: clinical characteristics and treatment from the Swedish dementia registry. *Diabetes care* 40, 1159-1166.
- Simons, R.L., Lei, M.K., Beach, S.R.H., Cutrona, C.E., Philibert, R.A., 2017. Methylation of the oxytocin receptor gene mediates the effect of adversity on negative schemas and depression. *Development and psychopathology* 29, 725-736.
- Varga, S., Piko, B.F., Fitzpatrick, K.M., 2014. Socioeconomic inequalities in mental well-being among Hungarian adolescents: a cross-sectional study. *International Journal for Equity in Health* 13, 100.
- Vilagut, G., Forero, C.G., Barbaglia, G., Alonso, J., 2016. Screening for depression in the general population with the center for epidemiologic studies depression (CES-D): a systematic review with meta-analysis. *PloS one* 11, e0155431.
- Vollmer, S., Bommer, C., Krishna, A., Harttgen, K., Subramanian, S.V., 2017. The association of parental education with childhood undernutrition in low- and middle-income countries: comparing the role of paternal and maternal education. *International journal of epidemiology* 46, 312-323.
- Weuve, J., Tchetgen, E.J.T., Glymour, M.M., Beck, T.L., Aggarwal, N.T., Wilson, R.S., Evans, D.A., de Leon, C.F.M., 2012. Accounting for bias due to selective attrition: the example of smoking and cognitive decline. *Epidemiology (Cambridge, Mass.)* 23, 119.
- Winkler, P., Formanek, T., Mlada, K., Cermakova, P., 2018. The CZEch Mental health Study (CZEMS): Study rationale, design, and methods. *International journal of methods in psychiatric research* 27, e1728.

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Ethical issues: The HAPIEE study was approved by the ethics committees at University College London, UK and the National Institute of Public Health in Prague, Czech Republic. This analysis was additionally approved by the ethics committee at the National Institute of Mental Health in Klecany, Czech Republic. All participants gave written informed consent.