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The Long-Term Effects of Early-Life Adversity on Health, Lifestyle, and Cognition

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Abstract

Early life adversity has been demonstrated to produce enduring negative effects across a broad spectrum of biopsychosocial domains. These early adverse experiences may have both direct and indirect impacts on cognitive decline and elevate the likelihood of dementia during older adulthood. Understanding the biopsychosocial outcomes linked to early adversity is vital for shaping health policies and fostering healthy cognitive trajectories throughout life. This research investigates how early adversity, defined as abuse and deprivation, influences certain outcomes—namely physical health, mental health, lifestyle factors, and cognitive functioning—in two UK-based cohorts: the English Longitudinal Study of Ageing (ELSA; N = 12,653, Mdnage = 66, SDage = 9.58) and the UK Biobank (N = 502,360, Mdnage = 58, SDage = 8.09). Adversity data in both samples were collected retrospectively through self-report, and only those types of adversity measured in both cohorts were analyzed. A subsequent post-hoc analysis explored whether education serves as a mediator in the relationships between early adversity and the outcomes assessed. Overall, findings indicate that exposure to early adversity correlates with declines in physical and mental health, less favorable lifestyle patterns, and diminished cognitive performance. The mediating influence of education emerged as a significant factor. Nonetheless, associations varied depending on the adversity subtype and the specific cohort. These findings draw attention to the intricate relationships linking early adversity to multiple outcomes in later life, suggesting diverse underlying mechanisms. Additionally, the importance of conducting analyses across multiple cohorts is emphasized to improve the applicability and robustness of the results.

Keywords: Cognition, Adversity, Physical health, Lifestyle, Mental health

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Introduction

Early life adversity has been linked to enduring harmful effects across a wide range of biopsychosocial outcomes, including physical health, mental health, lifestyle factors, cognition, and brain atrophy [1–16]. Evidence from multiple studies also indicates that early adversity may influence cognition either directly or indirectly, thereby

increasing the risk of developing dementia later in life (e.g., [17–23]). One suggested mechanism is that early adversity prompts the use of unhealthy coping strategies, such as adopting detrimental lifestyle behaviors to manage stress or its consequences (e.g., depression). This can include behaviors like overeating, which may arise in response to stress-induced activation of the hypothalamic-pituitary-adrenal (HPA) axis [4, 6, 16, 24–26]. Such compensatory behaviors could subsequently impair cognitive function and elevate dementia risk [17, 19–23].

Nonetheless, the relationship between early adversity and later-life outcomes, such as cognition, is complex and not always negative (e.g., [27, 28]). Some research suggests that the effects and their intensity vary depending on the type of adversity experienced [11, 29], and even within the same category of adversity (e.g., trauma) (e.g., [2, 4, 8, 30]). This variability highlights the incomplete mechanistic understanding of how adversity impacts outcomes and reflects inconsistencies in how adversity is defined and measured. Broadly, adversity is described as "highly stressful, and potentially traumatic, events or situations" [31]. It encompasses various events that occur at different developmental stages and differ in severity, duration, chronicity, and co-occurrence—referred to as adversity characteristics [11, 29, 31–35]. This heterogeneity, combining diverse adversity types and characteristics, can complicate the interpretation of findings and contribute to inconsistent results, making it challenging to uncover the underlying mechanisms. While disruption of the stress-response system and cumulative allostatic load (the physiological cost of chronic stress) have been proposed as potential mechanisms, alternative pathways remain plausible [36]. Such complexity might explain the inconsistent findings in existing literature. Employing multi-cohort comparisons and replication studies can help clarify these divergent results and enhance understanding of how adversity influences biopsychosocial outcomes and their underlying mechanisms [37].

The primary goal of this study was to examine the impact of distinct adversities within the same category (i.e., abuse or deprivation) on multiple selected outcomes—physical health, mental health, lifestyle behaviors, and cognition—using data from two UK cohorts. The study aimed to identify the specific effect of each adversity type on these outcomes, accounting for multiple adversities simultaneously in a single analytical model. This approach seeks to clarify inconsistencies in the literature and improve understanding of the detrimental effects of early adversity. Disentangling these effects is a critical first step toward mechanistic insights, which may ultimately inform hypothesis-driven research and the development of innovative prevention and treatment strategies.

Materials and Methods

Participants from ELSA

This analysis draws on data from the English Longitudinal Study of Ageing (ELSA) [38], an ongoing longitudinal investigation begun in 2002 with follow-ups every two years. The study tracks changes in socioeconomic factors, health status, and cognitive abilities among adults aged 50 and above. For the current study, early adversity information was taken from wave 3 (2006–2007), while physical and mental health measures were drawn from waves 6 (2012–2013) and 7 (2014–2015). Lifestyle and cognitive data were both sourced from wave 7 (2014–2015). The sample consisted of 12,653 individuals (Mdnage = 66, SDage = 9.58), with females making up 55.53% of participants. Ethical approvals were granted by the London Multi-Centre Research Ethics Committee (27 October 2005, reference 05/MRE02/63) for wave 3, and by the NRES Committee South Central - Berkshire for waves 6 (28 November 2012, 11/SC/0374) and 7 (2013, 13/SC/0532). All research was performed in accordance with the Declaration of Helsinki, with informed consent obtained from all participants.

Participants from UK biobank

The UK Biobank is a large-scale, population-based prospective cohort study initiated in 2006, with ongoing follow-up waves and additional data collection points. Participants were recruited from across the UK, providing extensive data including sociodemographic details, lifestyle behaviors, medical histories, environmental exposures, cognitive assessments, and biomedical information [39]. This study used data from 502,360 participants aged 40 to 73 years (Mdnage = 58, SDage = 8.09), 54.40% of whom were women. Early adversity exposure was assessed using an online questionnaire. Sociodemographic and lifestyle information was collected via touchscreen-based surveys, while cognitive assessments were completed on an unsupervised computerized touchscreen platform. Ethical clearance was secured from the Research Ethics Committee (17 June 2011, Ref 11/NW/0382), and the study adhered to the Declaration of Helsinki principles. Written informed consent was provided by all participants.

ELSA measures

Assessment of early adversity

At wave 3, early adversity was evaluated through a self-administered questionnaire. Participants were asked if they had experienced certain events prior to age 16 and to specify the age at first occurrence. These events included: being a victim of serious physical assault (physical assault); experiencing sexual assault, including rape or harassment (sexual assault); and physical abuse by parents (parental abuse). Both physical assault and sexual assault

were transformed into binary variables coded as 0 (no experience before 16) or 1 (experienced before 16).

To measure childhood socioeconomic deprivation, participants responded to three items reflecting conditions at age 10: number of bedrooms in the household, number of people living in the household, and number of books present at home. A principal component factor analysis identified which items loaded significantly onto a deprivation dimension. Based on this, only "number of bedrooms" and "number of books" were retained to create a factor score representing deprivation. This factor score was then dichotomized into 0 (scores between 2.5 and 100) and 1 (scores between 0 and 2), generating a binary variable for socioeconomic deprivation. Refer to **Table 1** for frequencies of early adversity variables.

Table 1. Frequency table of the early adversity items in the ELSA dataset

Early adversity	No	Yes	Missing
Physical assault	258 (75.88%)	82 (24.12%)	28,910
Sexual assault	6308 (96.44%)	233 (3.56%)	22,709
Parental abuse	6290 (96.52%)	227 (3.48%)	22,733
Deprivation	5078 (68.45%)	2341 (31.55%)	21,831

Physical and mental health

Body mass index (BMI)

During the nurse visit in wave 6, height and weight were measured and used to calculate BMI using the standard formula: weight in kilograms divided by height in meters squared (weight [kg] / height [m^2]).

Self-reported health

In wave 7, participants evaluated their overall health by responding to the question, "Would you say your health is…," selecting an option from a 5-point scale where 0 corresponded to poor health and 4 to excellent health.

depression

Depressive symptoms were measured in wave 7 through the abbreviated eight-item version of the Centre for Epidemiologic Studies Depression Scale (CES-D) [40]. A total score was calculated by adding up the number of questions answered "yes".

Lifestyles

Smoking status

In wave 7, smoking behavior was assessed by asking participants if they currently smoke cigarettes, with responses coded as 0 for No and 1 for Yes.

Alcohol consumption

Participants reported their frequency of alcohol use during the past year in wave 7, answering how often they consumed alcoholic beverages. Responses were scored on a scale from 0 (not at all in the last twelve months) to seven (nearly every day).

Cognition

In wave 7, immediate memory was tested by asking participants to recall a list of 10 words right after hearing them.

Executive functioning was assessed using a verbal fluency exercise in the same wave, where individuals were given 60 seconds to list as many different animals as possible.

Control variables

Both age and educational attainment were controlled for in the analyses. The age variable was taken from wave 7. Educational qualifications were compiled by integrating data from current and prior waves, creating an education scale coded as follows: 1 indicating no formal qualifications; 2 representing NVQ1, CSE, or other equivalent certificates; 3 corresponding to NVQ2 or O-level GCE equivalents; 4 signifying NVQ3 or A-level GCE equivalents; 5 denoting higher education below degree level; and 6 for NVQ4, NVQ5, or equivalent certifications. Descriptive statistics for these variables and outcomes are detailed in **Table 2**.

Table 2. Descriptive statistics of the outcomes and control variables in the ELSA dataset

Variables	n	Mdn	SD	Min	Max
BMI	7651	27.54	5.11	15.10	54.60
Self-rated health	8897	2	1.10	0	4
Depression	9069	1	1.85	0	8

Smoking	6079	0	0.38	0	1
Alcohol	7918	4	2.18	0	7
Immediate memory	8877	6	1.84	0	10
Verbal fluency	8900	21	7.32	0	67
Age	9440	66	9.58	43	89
Education	8160	3	1.87	1	6

Note. n = Number of respondents, Mdn = Median, SD = Standard Deviation, Min = Minimum range value, and Max = Maximum range value

UK biobank materials

Early adversity

The early adversity measures were adapted from the Childhood Trauma Questionnaire (CTS-5) [41] and included items such as: feeling hated by a family member (emotional abuse); experiencing sexual molestation (sexual abuse); feeling loved during childhood (emotional neglect); being physically harmed by family members to the point of bruising (physical abuse); and having someone available to take you to a doctor when necessary (physical neglect). These questions were administered between 2016 and 2017 via an online mental health survey. Participants rated each statement on a 5-point scale ranging from "never true" to "very often true." The responses for physical neglect and emotional neglect were reverse-scored. Afterwards, all responses were converted into binary variables: 0 indicating no experience of the adverse event and 1 indicating the presence of such experience. (For a similar coding approach, see Gheorghe *et al*. (2021) [7]; **Table 3** provides the frequencies of the early adversity items.)

Table 3. Frequency table of the early adversity items in the UK Biobank dataset

Early adversity	No	Yes	Missing
Physical neglect	130,510 (83.54%)	25,713 (16.46%)	346,140
Sexual abuse	141,810 (91.23%)	13,636 (8.77%)	346,917
Emotional neglect	81,556 (52.06%)	75,113 (47.94%)	345,694
Physical abuse	127,162 (81.03%)	29,777 (18.97%)	345,424
Emotional abuse	132,316 (84.36%)	24,528 (15.64%)	345,519

Physical and mental health

BMI

Body Mass Index (BMI) was calculated using height and weight measurements taken during wave 3 (2019–2021), following the standard formula: weight in kilograms divided by height in meters squared (weight [kg] / height [m^2]).

Self-reported health

Participants' overall health was self-rated with the question, "In general how would you rate your overall health," using a 4-point scale ranging from 0 (poor) to 3 (excellent). Although this measure was collected on four occasions, only the data from the most recent wave (wave 3; 2019–2021) were included in the analysis.

Depression

Depressive symptoms were assessed between 2016 and 2017 using the Patient Health Questionnaire-9 (PHQ-9) [42, 43]. Participants indicated how frequently they were bothered by various issues on a scale from 0 (not at all) to 3 (nearly every day). A total depression score was calculated by summing responses across the nine items. Due to right-skewed distribution, a log transformation (LN + 1) was applied to the scores.

Lifestyles

Smoking status

Smoking behavior was recorded at wave 3 (2019–2021) through the question "Do you smoke tobacco now?" Responses were coded as 0 = No and 1 = Yes, with only this wave's data used in the analysis.

Alcohol consumption

Alcohol drinking frequency was assessed at wave 3 (2019–2021) by asking, "About how often do you drink alcohol?" Responses were scored on a scale from 0 (Never) to 5 (Daily or almost daily), and only this wave's responses were analyzed.

Cognition

Visual declarative memory was evaluated during the 2014–2015 period using a pairs-matching task. In this test, participants were required to memorize the location of 3, 6, and 8 card pairs and then match them based on memory. Performance was quantified by the number of errors made,

where a higher error count indicated lower memory performance. In line with Lyall *et al*. (2016) [44], only the 6-pair round was analyzed due to its broader scoring range. Since the distribution of error scores was positively skewed, a natural log plus one (LN + 1) transformation was applied to the data.

Executive function was measured through the Trail Making Test (TMT) administered between 2014 and 2015. Part A (TMTA) required participants to sequentially connect the numbers 1 through 25 as quickly as possible, while Part B (TMTB) involved alternating between numbers (1–13) and letters (A–L) in sequential order (e.g., 1-A, 2-B, etc.). Because TMTB is specifically designed to assess executive functioning by testing cognitive flexibility (the switching component), only this part was selected for analysis [45]. As TMTB scores exhibited a non-normal distribution, a logarithmic transformation was conducted in line with Fawns-Ritchie and Deary (2020) [45].

Verbal and numerical reasoning was assessed using the Fluid Intelligence Test, also conducted in 2014–2015. Participants were given two minutes to complete as many reasoning and logic problems as possible. The total number of correctly answered items served as the outcome variable.

Processing speed was measured through a reaction time (RT) task known as the "snap game" (https://biobank.ctsu.ox.ac.uk/crystal/crystal/docs/Snap.pdf), consisting of 12 rounds. Participants were instructed to press a button as quickly as possible when the two presented cards showed matching symbols. RT was defined as the time (in milliseconds) between the appearance of the cards and the participant's response, regardless of accuracy. Only RT data collected in wave 3 (2019–2021) were used in this analysis. Data from practice rounds (0–4), responses under 50 ms, and those over 200 ms were excluded [46, 47]. No additional participants were removed, as none exceeded the threshold of three standard deviations above the mean RT. Following Künzi *et al*. (2022) [47], an average RT was computed for participants with at least four valid trials, and a log transformation was applied to correct for skewness, consistent with the approach used in Lyall *et al*. (2016) [44].

Control variables

Two control variables were included in the analysis: age at recruitment and years of education. For participants missing data on educational attainment, values were imputed using the available "qualifications achieved" variable. Descriptive statistics for all outcome and control variables are presented in **Table 4**.

Table 4. Summary statistics for outcome and control variables in the UK Biobank cohort

Variable	n	Mdn	SD	Min	Max
BMI	5,355	25.83	4.38	13.88	51.61
Self-rated health	5,353	2	0.66	0	3
Depression (untransformed)	154,302	2	3.69	0	27
Depression (transformed)	154,302	1.10	0.83	0	3.33
Smoking	5,357	0	0.15	0	1
Alcohol	5,360	3	1.40	0	5
Visual episodic memory (untransformed)	118,496	4	3.12	0	45
Visual episodic memory (transformed)	118,496	1.61	0.62	0	3.83
TMTB (untransformed)	103,999	61.18	25.75	20.56	746.53
TMTB (transformed)	103,999	4.11	0.34	3.02	6.62
Fluid intelligence	123,579	6	2.06	0	14
Processing speed (untransformed)	5,043	573.5	107.11	306.83	1,755
Processing speed (transformed)	5,043	6.35	0.17	5.73	7.47
Age	502,360	58	8.09	40	73
Education	495,645	17	2.77	5	35

Note. n = Number of respondents, Mdn = Median, SD = Standard Deviation, Min = Minimum range value, and Max = Maximum range value

Statistical procedures in ELSA

The statistical framework employed in this study was a path analysis conducted using STATA version 17.0

(StataCorp, College Station, TX, USA), with a stricter alpha level of 0.01 to reduce the likelihood of type I errors, considering the substantial sample size [48]. The model evaluated the predictive effects of physical abuse, sexual abuse, parental abuse, and deprivation on multiple outcomes: BMI, self-reported health, depression, smoking, alcohol consumption, memory, and verbal fluency. Correlated error terms were specified between BMI and self-rated health, BMI and smoking, depressive symptoms and self-rated health, and between memory and verbal fluency [44, 45, 49–52].

In terms of control variables, age was modeled as a predictor for BMI, self-reported health, depressive symptoms, memory, and verbal fluency. Education was also included as a predictor for the same variables, with additional predictive paths to smoking status and alcohol intake **(Figure 1)**. Model estimation was carried out using the Full Information Maximum Likelihood (FIML) approach. Model fit quality was judged by the Comparative Fit Index (CFI), where a value of 0.95 or greater indicated good fit, and the Root Mean Squared Error of Approximation (RMSEA), with a threshold below 0.06 signifying acceptable fit [53, 54].

To supplement the main analysis, further tests were conducted to investigate links between adversity types and the outcomes, explore potential differences by sex, and assess whether education served as a mediating factor in the connection between early adversity and various health-related outcomes.

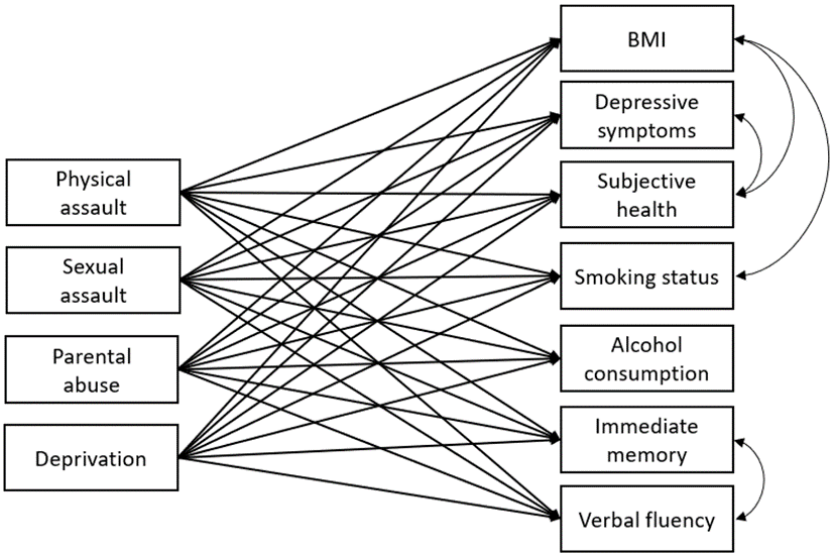

Figure 1. Simplified Illustration of the Model Fitted in the ELSA Dataset. Note. For clarity purposes, the control variables and covariances between adversity items were not drawn

Statistical analyses in the UK biobank

Individuals younger than 40 years old were excluded from the analysis (n = 7). As with the ELSA dataset, a path analysis approach was employed, applying an alpha level of 0.01 to mitigate type I error risks. The model included physical neglect, sexual abuse, emotional neglect, physical abuse, and emotional abuse as predictors of various outcomes: BMI, self-reported health, depression, smoking, alcohol use, visual memory, executive functioning (specifically switching), processing speed, and fluid intelligence. Correlations were specified among the residuals for BMI and self-rated health, BMI and smoking, depressive symptoms and self-rated health, and across the cognitive task outcomes [44, 45, 49–52].

Control variables were also incorporated: age was specified as a predictor of BMI, self-reported health, depression, visual memory, executive functioning (switching), processing speed, and fluid intelligence. Education was used as an additional predictor for these same outcomes, with its predictive influence extended to include smoking and alcohol consumption as well **(Figure 2)**. The Full Information Maximum Likelihood (FIML) estimation method was used, as in the ELSA analysis, and model fit was assessed using standard criteria.

Additional analyses were conducted to explore the relationships between adversity variables and outcomes, potential sex-related differences, and the mediating effect of education in the pathway from early adversity to the observed outcomes.

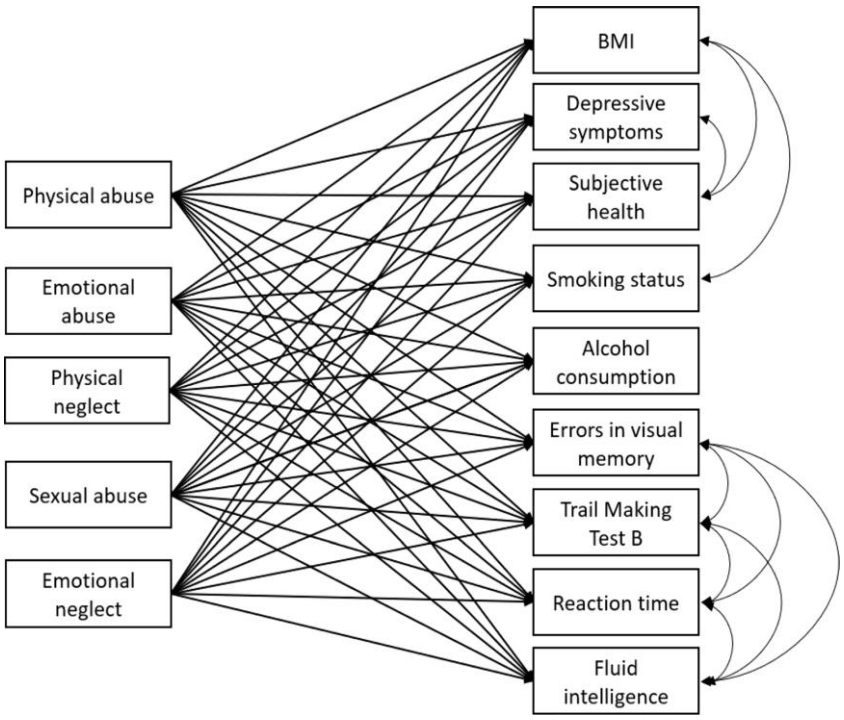

Figure 2. Simplified Illustration of the Model Fitted in the UK Biobank Dataset. Note. For clarity purposes, the control variables were not drawn

Results and Discussion

ELSA dataset

Multicollinearity was not detected among the model's exogenous variables—namely, physical assault, sexual assault, parental abuse, deprivation, age, and education—as all variance inflation factor (VIF) values were at or below 1.15. The model demonstrated strong fit indices, with a CFI of 0.956 and an RMSEA of 0.041 [53, 54]. The standardized coefficients for the model are presented in **Table 5**.

Table 5. Standardized coefficients of the Model in the ELSA dataset

ELSA Dataset						
Outcomes	**Early adversity**				**Control variables**	
	Physical assault	**Sexual assault**	**Parental abuse**	**Deprivation**	**Age**	**Education**
BMI	– 0.178**	0.042*	0.052*	– 0.013	– 0.037	− 0.145**
Subjective health	0.436**	– 0.067**	– 0.119**	– 0.020	– 0.243**	0.215**
Depressive symptoms	– 0.349**	0.079**	0.112**	0.045	0.093**	− 0.145**
Smoking status	– 0.335**	0.056*	0.066**	0.021	-	− 0.114**
Alcohol consumption	0.291**	– 0.071**	– 0.074**	– 0.031	-	0.255**
Immediate memory	0.245**	– 0.008	– 0.051**	– 0.056*	– 0.335**	0.237**
Verbal fluency	0.247**	– 0.012	– 0.042*	– 0.082**	– 0.283**	0.232**

** p-value < or = 0.001, * p-value < or = 0.01

Physical assault

Individuals who had encountered physical assault before turning 16 tended to exhibit lower BMI, rated their health more positively, experienced fewer depressive symptoms, were more likely to be non-smokers, reported consuming alcohol more frequently, and demonstrated stronger capabilities in immediate memory and verbal fluency tasks.

Sexual assault

Those who had experienced sexual assault prior to age 16 were more likely to show higher BMI, gave poorer self-assessments of health, reported more depressive symptoms, were more often smokers, and drank alcohol less frequently. No notable relationship was observed between sexual assault and either immediate memory or verbal fluency performance.

Parental abuse

Childhood physical abuse by parents (before age 16) was linked to greater BMI, more negative subjective health ratings, increased depressive symptoms, higher smoking prevalence, reduced alcohol use, and poorer performance on both immediate memory and verbal fluency assessments.

Deprivation

Exposure to deprivation at age 10 was meaningfully associated with lower scores in immediate memory and verbal fluency. However, this type of early adversity showed no significant link to BMI, subjective health, depressive symptoms, smoking status, or alcohol consumption.

Control variables

Increasing age was significantly associated with worse self-rated health, more depressive symptoms, and decreased performance in immediate memory and verbal fluency, but showed no meaningful connection to BMI. A higher level of education corresponded with lower BMI, improved subjective health, fewer depressive symptoms, greater likelihood of being a non-smoker, more frequent alcohol use, and stronger performance in immediate memory and verbal fluency.

UK biobank dataset

There were no signs of multicollinearity among the exogenous variables in the model—including physical neglect, sexual abuse, emotional neglect, physical abuse, emotional abuse, age, and education—as all VIF values remained at or below 1.22. The model showed a very high degree of fit, with CFI = 0.996 and RMSEA = 0.004 [53, 54]. Refer to **Table 6** for the standardized coefficients derived from this model.

Table 6. Standardized coefficients of the Model in the ELSA dataset

	UKB Dataset						
	Early adversity					Control variables	
Outcomes	**Physical abuse**	**Emotional abuse**	**Physical neglect**	**Sexual abuse**	**Emotional neglect**	**Age**	**Education**
BMI	0.041	0.023	0.019	– 0.003	0.018	– 0.056**	– 0.130**
Subjective health	0.005	– 0.066**	– 0.013	– 0.027	– 0.077**	0.028	0.088**
Depressive symptoms	0.033**	0.133**	0.013**	0.067**	0.078**	– 0.145**	– 0.048**
Smoking status	0.002	0.040	– 0.001	– 0.024	0.004	-	0.006
Alcohol consumption	– 0.015	– 0.030	– 0.052*	– 0.025	0.007	-	0.062**
Errors in visual memory	– 0.004	0.002	0.021**	0.006	0.001	0.128**	– 0.015**
Trail Making Test (Switching)	0.0004	0.004	0.096**	0.012**	0.004	0.369**	– 0.163**
Reaction time	– 0.023	0.034	0.026	0.037	– 0.015	0.346**	– 0.076**
Fluid intelligence	– 0.004	0.008	– 0.112**	– 0.011**	0.006	– 0.071**	0.307**

** p-value < or = 0.001, * p-value < or = 0.01

Physical abuse

Childhood physical abuse was significantly linked to increased depressive symptoms in later life. However, no significant relationships were observed between physical abuse and other variables such as BMI, subjective health, smoking status, alcohol consumption, visual memory errors, TMTB completion time, reaction time (RT), or fluid intelligence performance.

Emotional abuse

Experiencing emotional abuse during childhood was significantly associated with lower self-rated health and elevated depressive symptoms in later years. No significant connections were found between emotional abuse and BMI, smoking status, alcohol use, visual memory errors, TMTB completion time, RT, or fluid intelligence performance.

Physical neglect

Physical neglect in early life significantly predicted higher depressive symptom levels, less frequent alcohol consumption, more mistakes on the visual memory task, slower performance on the TMTB, and poorer fluid intelligence scores later in adulthood. No significant associations emerged between physical neglect and BMI, subjective health, smoking status, or RT.

Sexual abuse

Childhood sexual abuse was significantly associated with greater depressive symptoms, delayed TMTB completion

times, and lower fluid intelligence scores in later life. No significant relationships were found between sexual abuse and BMI, subjective health, smoking status, alcohol intake, visual memory errors, or RT.

Emotional neglect

Experiencing emotional neglect during childhood significantly predicted reduced self-rated health and increased depressive symptoms in later life. No significant links were observed between emotional neglect and BMI, smoking status, alcohol consumption, visual memory errors, TMTB completion time, RT, or fluid intelligence performance.

Control variables

Older age was significantly associated with lower BMI, fewer depressive symptoms, increased errors on the visual memory task, longer times to complete the TMTB, slower reaction times, and decreased fluid intelligence performance in later life. Age showed no significant relationship with subjective health. Higher educational attainment significantly predicted lower BMI, better self-rated health, reduced depressive symptoms, greater alcohol consumption frequency, fewer visual memory errors, faster TMTB completion, quicker reaction times, and enhanced fluid intelligence scores. Years of education were not significantly associated with smoking status.

ELSA dataset

Analysis of the ELSA dataset revealed that nearly all early adversities, except sexual assault—which showed no relationship with cognition—and deprivation—which was linked solely to cognitive outcomes, had associations with BMI, subjective health, depressive symptoms, smoking habits, alcohol use, and cognitive measures such as immediate memory and verbal fluency. These findings generally agree with existing studies that demonstrate early adversity's negative influence on BMI, subjective health, depressive symptoms, smoking, alcohol consumption, and cognitive abilities [2–6, 9–16, 55]. However, some unexpected patterns emerged.

In contrast to other adversities like physical assault and parental abuse, sexual assault experienced before age 16 did not relate to performance in immediate memory or verbal fluency. This may indicate that these aspects of cognition are either resilient to the harmful effects of early sexual abuse or that the cognitive consequences of sexual abuse are fully mediated through other factors such as mental health conditions, lifestyle behaviors, or educational attainment.

Physical assault before 16 was associated with a range of seemingly paradoxical outcomes: lower BMI, fewer depressive symptoms, abstinence from smoking, higher self-perceived health, and better cognitive function. At the same time, it was linked to increased alcohol consumption. These contradictory findings highlight the need for further research to fully understand these dynamics. One potential reason is the relatively small number of individuals reporting physical assault (n = 340), which may have limited statistical power or introduced bias. Another possibility is that the measure of physical assault lacked clarity or overlapped with other adversities, causing confusion in responses. Additionally, without data on the chronicity of these experiences, it is plausible that most participants endured only a single incident, which could contribute to resilience—demonstrated by positive outcomes despite adversity [56, 57].

The positive link between physical assault and elevated alcohol use contrasts with findings for sexual assault and parental abuse, both associated with lower alcohol intake. Literature suggests that light to moderate alcohol consumption might be related to better cognition and a protective effect against cognitive decline [58–60]. Nonetheless, these findings must be interpreted cautiously, as heavy and prolonged alcohol use has well-documented detrimental effects on health and cognitive function, which likely outweigh any benefits from moderate drinking [58–60].

Regarding deprivation, only cognition showed significant associations—specifically poorer immediate memory and verbal fluency—which is consistent with previous research connecting childhood socioeconomic disadvantage to reduced cognitive performance in later life [61–65]. The absence of significant links between deprivation and physical health, mental health, or lifestyle factors could stem from the greater severity and co-occurrence of other adversities included in the analysis, potentially overshadowing the effects of deprivation [8, 11]. Another explanation is that deprivation's influence on these outcomes is indirect, operating through mediators like educational attainment.

UK biobank dataset

Within the UK Biobank dataset, experiencing physical abuse, emotional abuse, physical neglect, sexual abuse, or emotional neglect was linked to higher levels of depressive symptoms, consistent with prior research [2, 3, 5, 11–13, 15]. Reflecting earlier findings that early adversity negatively impacts subjective health [66–68], both emotional abuse and emotional neglect were associated with elevated depressive symptoms and lower self-rated health. This shared pattern might indicate a common underlying mechanism related to the emotional dimension of adversity, which contrasts with previous literature that emphasizes mechanisms tied to threat or deprivation components of adversity [36, 55, 69]. Notably, and diverging from past studies, no other significant relationships emerged between emotional abuse or emotional neglect and the remaining outcomes of interest [4–6, 10, 11, 14, 16, 55]. It is plausible that emotional

adversity predominantly influences subjective perceptions such as self-esteem and sense of control (e.g., subjective health and self-reported depressive symptoms), which may indirectly impact objective indicators like BMI and cognition. This contrasts with physical adversity (including neglect or sexual abuse), which appears to exert a more direct influence on cognitive performance [66, 70, 71]. Future research incorporating mediation models involving self-perception or self-esteem, alongside self-assessed cognitive measures, could shed more light on these observations.

Regarding physical adversities (physical abuse, physical neglect, and sexual abuse), no clear outcome pattern specifically tied to the physical aspect was observed, as all these adversities were related to increased depressive symptoms. Nevertheless, both physical neglect and sexual abuse correlated with higher depressive symptom levels and slower completion times on the Trail Making Test Part B (TMTB). Physical neglect, in particular, demonstrated the strongest associations, linking to increased depressive symptoms, reduced frequency of alcohol consumption, and diminished cognitive performance across tasks assessing visual memory, TMTB, and fluid intelligence. These findings align with established literature documenting early adversity's detrimental effects on mental health and cognition [2, 3, 5, 10–13, 15]. However, the current results do not corroborate prior evidence suggesting negative impacts on physical health and lifestyle behaviors [3, 9, 11, 12, 16]. It is conceivable that mediating factors underlie the relationship between physical neglect and both physical health and smoking status. Moreover, the results pertaining to alcohol consumption should be interpreted carefully, as some studies report beneficial associations between alcohol intake and cognitive or health outcomes [58–60].

Early sexual abuse was linked specifically to cognitive tasks involving executive functions, such as the trail-making test and fluid intelligence measures, implying possible effects on the prefrontal and frontal brain regions. This is supported by evidence showing sexual abuse impacts grey matter volume in the frontal cortex during a critical developmental window (ages 14–16) [72]. Consequently, it is possible that sexual abuse in this sample occurred predominantly within this age range, potentially explaining the lack of significant associations with memory-related tasks (linked to the hippocampus).

Physical abuse was solely associated with elevated depressive symptoms. More broadly, the lack of significant links between most adversities and the outcomes studied might be partly explained by education (except in the case of smoking status). Education was significantly related to nearly all outcomes except smoking, suggesting it may mediate, fully or partially, the connections between adversity and these outcomes. Interestingly, no significant associations were found between any early adversity and BMI or smoking status, diverging from both existing literature and findings from the ELSA dataset. While the influence of education might mediate effects on BMI, the absence of association with smoking status may be due in part to the high volume of missing data in the UK Biobank for this variable (497,006 missing values), and the small number of smokers at assessment (n = 118). These factors could explain both the lack of significant results for smoking and the discrepancies between cohorts. Additionally, no early adversity was significantly related to reaction time, a finding likely explained by the strong effect of age on reaction time, where advancing age is associated with slower responses, thus accounting for much of the variance in reaction time in this model [73, 74].

Cohort comparisons

In both cohorts examined, the majority of early adversities showed detrimental links to physical health, mental health, lifestyle behaviors, and cognitive functioning. Crucially, variations emerged depending on the specific adversity experienced, which corresponds with existing evidence emphasizing the need to differentiate among types of adversity due to potentially distinct underlying processes [32, 36]. Moreover, almost all early adversities analyzed—such as physical assault, sexual assault, and parental abuse in the ELSA cohort, and physical abuse, emotional abuse, physical neglect, sexual abuse, and emotional neglect in the UK Biobank—were reliably associated with increased depressive symptoms. This aligns with prior findings, except for the case of physical assault within ELSA, where this link was absent [2, 3, 5, 11–13, 15]. The same explanations outlined earlier—such as a small number of reports, possible effects of the adversity's chronicity, and enhanced resilience—may account for this discrepancy. It is also worth noting that the 'physical assault' category in ELSA does not perfectly correspond to any category in the UK Biobank dataset, where 'physical abuse' more closely resembles ELSA's parental abuse. Although care was taken to select comparable adversities across both cohorts, a complete match was not feasible, with the strongest parallels seen between parental abuse (ELSA) and physical abuse (UK Biobank), and between sexual assault (ELSA) and sexual abuse (UK Biobank).

Differences between the cohorts might also be influenced by variations in how adversities and outcomes were measured. Furthermore, cohort-specific characteristics such as educational attainment and age may contribute to these differences, particularly regarding subjective health and cognitive performance. Given that the ELSA cohort is older, age-related declines in subjective health and cognition may be more prominent in this group.

Mediation

Education was found to be linked with many of the measured outcomes in both cohorts, suggesting it might serve as a full or partial mediator in the pathways connecting early adversity with these outcomes [9]. Notably, education has been recognized as a significant factor contributing to resilience [75]. To explore this possibility, additional mediation analyses were conducted, which supported the role of education as a mediator. In the ELSA cohort, education mediated all relationships between deprivation and outcomes such as BMI, subjective health, depressive symptoms, smoking status, alcohol consumption, immediate memory, and verbal fluency. However, education did not significantly mediate the associations between other adversities—physical assault, sexual assault, and parental abuse—and these outcomes. In the UK Biobank cohort, education mediated the effects of all early adversities (physical abuse, emotional abuse, physical neglect, sexual abuse, and emotional neglect) on nearly every outcome assessed—including BMI, subjective health, depressive symptoms, alcohol consumption, visual memory, Trail Making Test B, reaction time, and fluid intelligence—except for smoking status. These findings highlight the critical mediating influence of education on how early adversities, encompassing deprivation and abuse, relate to physical health, mental health, lifestyle choices, and cognition.

Strengths and limitations

A key strength of this study lies in its utilization of large sample sizes, which likely enhance the representativeness of the findings for the general population. Additionally, employing cross-cohort models strengthens the potential generalizability of the observed effects [76]. Consequently, the relationships identified between early adversities and depressive symptoms—despite differences in how depressive symptoms were measured across cohorts—appear particularly robust.

Nonetheless, the early adversities examined, although closely matched, do not perfectly coincide across the cohorts. Future research incorporating cohorts with fully overlapping adversity measures would not only reinforce the observed links with depression but also help replicate and thereby solidify other findings reported here. Moreover, studies involving cohorts from various countries and with diverse characteristics are necessary to broaden the applicability of these results. The use of longitudinal data, rather than cross-sectional designs, would also provide valuable information on temporal sequencing and causal pathways among the variables studied.

Another limitation arises from inconsistencies in adversity assessment methods across studies, complicating replication efforts and limiting the generalizability of outcomes. Additionally, both the cohorts' composition and the reliance on retrospective, self-reported adversity introduce various biases, including survival bias, selection bias, resilience bias, recall bias, and biases related to social and mental health factors [77–83]. However, it is important to recognize that self-reported adversity has demonstrated reasonable reliability and may, in fact, be underreported [84, 85].

Conclusion

The present research seeks to contribute to ongoing investigations into the links between early adversity and physical health, mental health, lifestyle, and cognitive outcomes. Findings indicate that most adversities exert negative effects across these domains, though exceptions exist. Importantly, variations in results depending on the specific adversity type and the particular outcome examined suggest that distinct underlying mechanisms may be involved. Education emerged as a significant mediator in the associations between early adversity and physical health, mental health, lifestyle, and cognition.

Furthermore, comparisons between cohorts affirm that early adversity generally correlates with elevated depressive symptoms but also reveal differences between cohorts, underscoring the necessity for greater consistency—especially in adversity assessment methods but also in outcome measures. Achieving such uniformity is critical to enable future research to elucidate the mechanisms driving these associations and to highlight the potential key role of certain adversity components, possibly including emotional factors, as hinted by the present findings.

Therefore, continued research focusing on specific types of early adversity and their diverse impacts across different cohorts is vital. This will enhance understanding of these relationships and aid in uncovering the underlying processes, ultimately informing interventions aimed at fostering resilience.

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