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Title: Association of childhood and adult socioeconomic status with adult social connection: A mediation analysis

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Abstract

In this prospective cohort study, we explored associations of childhood socioeconomic status (SES) with social connection in adulthood, and to which extent these associations can be explained by SES in adulthood. We used data from the longitudinal Young Finns Study (n=1,775, 3-18 years at baseline). Childhood SES was assessed through parental income and educational attainment in 1980, and participants' own adult SES through income and educational attainment in 2007. The outcomes were three indicators of social connection measured in 2018–2020: 1) loneliness, 2) perceived social support and 3) frequency of social contact. SES indicators were analyzed separately using regression models and causal mediation analysis via marginal structural models. In the mediation analyses, low parental income was associated with higher loneliness, lower perceived social support, and less frequent social contact in adulthood while adjusting for parental and own educational attainment. The associations with loneliness and perceived social support were partially mediated by participants' income in adulthood. Conversely, the associations between parental educational attainment and social connection in adulthood were smaller, with confidence intervals including the null. These results emphasize that poor family financial conditions

during childhood may have long-lasting implications for the development and maintenance of social connection throughout the lifespan.

Keywords: loneliness; social support; social contact; socioeconomic status; childhood environment; prospective study

Introduction

Research on social connection explores various dimensions of social interactions, such as social network size, social support, social isolation, and feelings of loneliness [1]. Although these concepts overlap to some extent, they differ on the degree of subjectivity (e.g., loneliness vs. social isolation) and the specific emphasis placed on either the structure of the social network (e.g., social network size) or its functional attributes (e.g., social support) [2]. In various countries and across different cultures, all dimensions of social connection have been associated with life satisfaction and health outcomes [3–6].

As awareness about the importance of social connection for wellbeing continues to grow, so does the interest in understanding the risk factors that can compromise them. One of the well-established risk factors for impaired social connection is socioeconomic status [7–10]. Socioeconomic status (SES) refers to social and economic standing of an individual in society, often measured as income level, occupational status, educational attainment, or level of deprivation in their residential area [11].

Numerous cross-sectional studies have investigated the association of SES with social connection in adulthood. Individuals with higher SES have been consistently shown to have larger social networks, report less loneliness, and perceive greater levels of available support [12]. Adults from lower socioeconomic backgrounds also tend to report more social and emotional loneliness [8], social isolation (fewer close ties), lack of a confidant or partner, non-participation in regular social activities, and more frequent deficits in instrumental and social support [13]. Living in deprived neighborhoods has been associated with a greater risk of loneliness [14,15] , and belonging to a socioeconomically disadvantaged group with more frequent social isolation[16].

Conversely, few longitudinal studies have explored the association of early-life SES with social connection in adulthood previously. Retrospective studies have reported associations between early-life adversity and loneliness in older adulthood. For instance, childhood socioeconomic disadvantage was associated with higher levels of loneliness in later life, mediated by adulthood conditions (SES and health) in a retrospective study from the U.S. [17]. Similarly, retrospectively reported low SES measured as father's social class, family relative income levels and residential disadvantage in childhood was associated with later-life loneliness in a sample of older adults (>65 years) in Ireland [18]. In a sample of Finnish older adults, those reporting higher levels of loneliness were more likely to recall having been afraid of a family member, having experienced a cold childhood household or death of a parent in childhood or youth compared to participants that reported low levels of loneliness across time [19]. However, to our knowledge, there are no prospective longitudinal studies – what would reduce the risk of recall and selection bias [20] – focusing on how socioeconomic factors from childhood to adulthood may affect social connection in middle adulthood.

Educational attainment and income are two of the most frequently used indicators of SES, and despite being highly correlated, they represent different social circumstances [11,21–23]. Education describes the knowledge assets of a person, is normally completed during young adulthood, and strongly determined by parental characteristics. It is also a strong predictor of future income and employment [11,24]. Education has been associated with social engagement and social attitudes later in life [25,26], and is a predictor of factors relevant to social participation such as health status [27]. Income, instead, is mainly an indicator of material resources, determining access to several assets and services. Income fosters social standing, and together with other material resources it can influence participation in society [11,24]. Therefore, in childhood, parental education and family financial conditions may also be differently associated with a child´s development and future adult outcomes.

In this study, we used prospective data to examine whether low family SES during childhood and adolescence is associated with poorer social connection in adulthood and whether low adult SES mediates these associations. We examined educational attainment and income as two separate indicators of SES.

Method

Sample

Data were from the Cardiovascular Risk in Young Finns Study cohort, which comprises prospective intergenerational measurements on an array of biological, lifestyle and socioeconomic factors over several decades [28]. Data collection has been carried out in all five Finnish university cities with medical schools and their rural surroundings (i.e. in Helsinki, Kuopio, Oulu, Tampere and Turku). In the first study wave (1980), 4,320 children and adolescents aged 3, 6, 9, 12, 15 and 18 years were randomly chosen from the population

register of these areas to produce a representative sample of Finnish children that would allow studying children and adolescents from different parts of Finland (both urban and rural) and from different socioeconomic background and living conditions. Of those invited (N = 4,320), 3,596 (83%) participated in the baseline study conducted in 1980. The cohort has been followed since, with the latest data collection phase conducted in 2018-2020. The overall participation rates in the follow-up studies have varied between 60 and 80% [28,29]. For this study, we used data from the study phases conducted in 1980, 2007, and 2018-2020. The study was reviewed and approved by the Ethics Committee of the Hospital District of Southwest Finland.

In this study, we included participants with complete data on social connection indicators measured in 2018–2020 (n=1,775). To handle missing values in the mediators and exposures, we conducted multiple imputation by chained equations (MICE) including all participants (n=3,596) and excluding those with imputed social connection measures in 2018–2020 from the analyses (n=1,821 excluded) [30]. In addition to all variables in the analysis models, data on adult educational attainment and income from 2011 and data on occupational status and unemployment from 1980, 2007 and 2011 were included in the imputation as auxiliary variables. As a result, the final dataset included participants with complete data on the outcomes (2018–2020), with imputed values for the missing data on the exposures (parental educational attainment missing N=25, parental income missing N=55) and mediators (educational attainment missing N=261, and income missing N=307). The final sample thus consisted of 1,775 participants.

Measures

Social connection

Social connection in midlife was assessed with three indicators: loneliness, perceived social support, and frequency of social contact. These were self-reported by participants in 2018-2020.

Loneliness was measured with the Three-Item Loneliness Scale (TILS), a short version of the R-UCLA Loneliness Scale [31]. It asks respondents to rate feelings of lack of companionship, feeling left out, and feeling isolated from others on a three-point Likert scale ("often", "some of the time," "hardly ever or never"). These responses were summed together, resulting in a final score ranging from 3 ("not lonely") to 9 ("very lonely").

Social support was measured with the Multidimensional Scale of Perceived Social Support (MSPSS) [32]. It is a 12-item measure of perceived adequacy of social support from three sources: family, friends, and a significant other, using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). The original scores were inverted so that higher scores indicated lower perceived social support. The final score ranged from 12 to 60.

Frequency of social contact was measured with the question "How often do you have contact with friends or relatives that you do not live with?" assessing three sources of contact: face to face, through phone, and online. For all the three sources, respondents answered using a 5-point Likert scale (1=daily or almost daily, 5=never). The final score was scaled to range from 1 to 5, with higher scores indicating less frequency of social contact.

Standardized scores of perceived social support and frequency of social contact were used in the analyses.

Socioeconomic status

Educational attainment. Parental educational attainment was measured as completed years of schooling and categorized as less than upper secondary school (less than 9 years), upper secondary school (from 9 to 12 years), and academic education (13 years or more). In two-parent families, data from the more educated parent was used. The responses were dichotomized for the analysis (0/1), with less than upper secondary school as the "low educational attainment" group (=1).

Participant's own adult educational attainment was measured as the highest level of completed or attended education in 2007 and categorized as *low*=primary and lower secondary education, *intermediate*=upper secondary education, and *academic*= polytechnic or university degree. This variable was then dichotomized (0/1), with low and intermediate education classified as "low educational attainment" (=1).

Income level. Parental income in childhood was measured as the family's combined gross annual income reported by the parents on an eight-point scale (<15,000 Finnish marks (FIM), 15,001-25,000, 25,001-35,000, 35,001-45,000, 45,001-55,000, 55,001-75,000, 75,001-100,000, >100,000). The amount of money corresponding with 15,000 FIM in 1980 was 8,898.85 Euros in 2023.

Participant's income in adulthood was measured using gross annual income reported by the participant on an eight-point scale (<10,000€, 10,001-20,000€, 20,001-30,000€, 30,001-40,000€, 40,001-50,000€, 50,001-60,000€, 60,001-70,000€, >70,000€). For the analysis, both income measures were dichotomized (0/1) with families and participants in the lowest 25% classified as "low income" group (=1).

Participant's age (in years) was included as baseline confounder in all the models. As participants in the Young Finns Study were selected from six age cohorts the variable age could only take six discrete values in our data (i.e., 3, 6, 9, 12, 15, or 18).

Sex (male/female) was included as a confounder of the mediator-outcome association (i.e., between adult SES indicators and social connection) not affected by the exposure.

Statistical analysis

The associations between the exposures (parental educational attainment and income measured in 1980), mediators (own educational attainment and income measured in 2007), and outcomes (loneliness, perceived social support and frequency of social contact measured in 2018-2020) were first analyzed using regression models. To explore the exposure-outcome and the mediator-outcome associations we used ordinal (when loneliness was the outcome) and linear (when perceived social support and frequency of social contact were the outcome) regression. For the exposure-mediator associations we applied logistic regression. All regression models were adjusted for participant's age at baseline. In addition, the regression models using income as the socioeconomic indicator were adjusted for parental educational attainment. Mediator-outcome regressions were adjusted for sex (male/female) and the corresponding exposure-induced time-dependent confounder (parental income or adult educational attainment).

Figure 1 represents the hypothesized associations between the variables over time, where parental educational attainment or income was the exposure, participants' own educational attainment or income in adulthood was the mediator, and one of the social connection indicators was the outcome. In our underlying hypothesis, we assumed that educational attainment is causally upstream of income [11,24]. Therefore, in models exploring the

association of parental educational attainment with adult social connection, family income was included as an exposure-induced time-dependent confounder of the mediator-outcome association. Correspondingly, in models exploring the association of family income with social connection in adulthood, parental educational attainment was included as a baseline confounder, and participant's own adult educational attainment was included as an exposure-induced time-dependent confounder of the mediator-outcome association. Age was included as baseline confounder in all models and sex as a confounder of the mediator-outcome associations not affected by the exposure.

In the presence of confounding affected by the exposure, natural direct and indirect effects cannot be identified [33–35]. However, the randomized interventional analogues of natural direct and indirect effects can be estimated in this setting [35], and these were the estimands of interest in this study (for details, please see Appendix S1). The randomized interventional analogues were estimated using marginal structural models [36,37] through direct counterfactual imputation estimation [38]. The three indicators of adult social connection (loneliness, perceived social support, and frequency of social contact) were evaluated in separate models.

For a reliable estimation of these effects, causal mediation models require the fulfilment of the identifiability assumptions of consistency, positivity and, exchangeability [39,40]. For a deeper discussion on the identifiability assumptions see Appendix S2, and for an empirical evaluation of positivity see Table S1.

Exposure-induced confounding is controlled in marginal structural models by inverse probability weighting [35]. The estimates of the randomized interventional analogues of natural direct and indirect effects were obtained from weighted ordinal regression (loneliness) and weighted linear regression (perceived social support and frequency of social contact) models. Bootstrapping (1,000 samples) was used to calculate the confidence intervals [38].

We also considered interaction effects between the exposure and mediator in our models [41].

We conducted several sensitivity analyses. First, we have replicated the causal mediation models using complete case analysis (n=1,408). Second, we estimated the E-values, an indicator of the robustness of the associations to unmeasured confounding [37,42]. Third, we replicated the analyses categorizing individuals who completed less than upper secondary school as the "low adult educational attainment" group to assess the potential impact of our initial categorization. Fourth, to explore potential bias due to the dichotomized confounders and mediators, we conducted sensitivity analyses including educational attainment and income as ordinal variables on their original scales. We anticipated that the higher dimensionality of the data in this analysis would result in random violations of the positivity assumption and lower precision of the marginal structural model estimates given our sample size. Therefore, we conducted these analyses using the parametric g-formula, which is more robust against random violations of positivity and, under the assumption of correct model specification, results in higher statistical efficiency (i.e., smaller variance of the estimator) compared to marginal structural models. [39,43,44]. Additionally, we ran these models using income as a continuous variable to decrease dimensionality.

All analyses were conducted in R (version 4.3.2) using the "mice" (for multiple imputation) [45] and "CMAverse" (for causal mediation analysis) [38] packages. The analyses were performed in the five imputed datasets and the parameter estimates were pooled using Rubin's rule. The code behind this analysis has been made publicly available and can be accessed at https://bit.ly/lca2_repository.

Results

Table 1 describes the characteristics of the sample (N=1,775, 57% female). In childhood, 33.5% of the participants had low parental educational attainment, and 25.9% had low family income. Participants excluded from the study sample due to missing values for the outcomes were more often younger, male, and belonged to families with low household income (Table S2).

Results from regression models evaluating the exposure-outcome, exposure-mediator and mediator-outcome associations are given in **Table 2**. Low family income was associated with higher loneliness in adulthood (OR=1.54, 95% CI=1.26–1.89), lower perceived social support (β=0.21, 95% CI=0.09–0.32), and lower frequency of social contact (β=0.19, 95% CI=0.07–0.30), while adjusting for age and parental educational attainment. Although the point estimates for parental educational attainment were directionally similar to family income, the associations between parental educational attainment and social connection in adulthood were smaller, and the confidence intervals included the null value (loneliness, OR=1.08, 95% CI=0.89-1.31; perceived social support, β=0.09, 95% CI=-0.02-0.19; frequency of social contact, β=0.08, 95% CI=-0.02-0.19). As the exposure-mediator models show (see **Table 2**), childhood and adulthood indicators of SES were relatively strongly associated (educational attainment: OR=2.39, 95% CI=1.88–3.03; income: OR=1.86, 95% CI=1.42–2.42).

The results from the causal mediation models are presented in **Table 3** and **Table 4**. While the confidence intervals for the associations between parental educational attainment and participant's social connection in adulthood included the null value (loneliness OR_{total}= 1.20, 95% CI :0.96-1.44, perceived social support β_{total}= 0 .08, 95% CI: -0.02-0.19; frequency of social contact β_{total}= 0.08, 95% CI: -0.02-0.19), parental income was associated with participant's social connection in adulthood (loneliness OR_{total}=1.58, 95% CI :1.24-1.92,

perceived social support β_{total}=0.19, 95% CI: 0.06-0.33; frequency of social contact β_{total}=0.18, 95% CI: 0.04-0.31).

Based on the effect decomposition into the randomized interventional analogues of the natural direct and indirect effects, growing up in a low-income family was directly associated with higher loneliness (OR_{direct}=1.46 95% CI: 1.15-1.77), lower perceived social support (β_{direct}=0.15, 95% CI: 0.01-0.28), and lower frequency of social contact (β_{direct}=0.16, 95% CI: 0.02-0.29). In the case of loneliness and perceived social support, the associations were partially mediated by participants' own income during adulthood (loneliness $OR_{indirect}$=1.08, 95% CI:1.02-1.14, perceived social support $\beta_{indirect}$=0.05, 95% CI: 0.01-0.08; frequency of social contact $\beta_{indirect}$=0.02, 95% CI: 0.00-0.05).

In models including an interaction term between the exposure and the mediator, the point estimates and confidence intervals suggested no meaningful interaction effects. Additionally, the randomized interventional analogues of the total, direct, and indirect effects remained largely unchanged. The pooled estimates and their 95% confidence intervals from the models including the interaction terms are presented in Tables S3 and S4.

Sensitivity analysis

Results from complete case analyses (n=1,408) lead to the same main conclusions with slightly larger effect sizes in the income models (loneliness OR_{total}=1.71, 95% CI :1.36-2.12, perceived social support β_{total}=0.19, 95% CI: 0.05-0.33; frequency of social contact β_{total}=0.20, 95% CI: 0.07-0.35). Complete results from these analyses are presented in Tables S5 and S6.

The E-values for the models exploring the associations of family educational attainment with social connection were always equal to 1, which is the lowest possible E-value [37,42]. The E-values for the models exploring the associations of parental income with participant's social connection suggested that for unmeasured confounding to nullify the results of the observed direct associations, an unmeasured confounder would require a strength of an association that would range across imputed datasets from 2 to 2.45 times (E-value 95% CI lower limit range from 1.77 to 1.81) larger than the observed association for loneliness, from 1.60 to 1.65 (95% CI lower limit range from 1.24 to 1.31) for social support, and from 1.59 to 1.63 (95% CI lower limit range from 1.20 to 1.28) for frequency of social contact. The corresponding E-values for the indirect associations were 1.31 to 1.42 times (95% CI lower limit range from 1.14 to 1.22) for loneliness, 1.14 to 1.18 (95% CI lower limit range from 1.00 to 1.06) for social support, and 1.10 to 1.14 (95% CI lower limit 1.00) for frequency of social contact.

When classifying participants with less than upper secondary school as having low adult educational attainment, the results were essentially similar to those observed with our initial categorization of adult educational attainment (see Tables S7 and S8).

Results from analyses with non-dichotomous indicators of educational attainment and income as mediators and confounders were in line with those from the main analysis. When income indicators were kept as ordinal variables, the results from the income models lead to the same conclusions as the main models: there was an association between growing up in a low-income family and poorer social connection in adulthood, which was partially mediated by adult income. In the models examining educational attainment, some of the total effect estimates had confidence intervals compatible with small associations, although the lower bounds of the 95% CI were close to zero (see results in Tables S9 and S10). Analyses with the income indicators treated as continuous variables lead to the same overall conclusions as

the main analysis for both educational attainment and income models (see results in Tables S11 and S12).

Discussion

We explored the association between SES in childhood and social connection in adulthood using a prospective Finnish cohort with up to 40 years of follow-up. In our study, low parental income was associated with higher loneliness, lower perceived social support, and lower frequency of social contact in adulthood. The associations of low parental income with adult loneliness and perceived social support were partially mediated by participants' own income as adults. Although the point estimates for the associations between parental educational attainment and social connection in adulthood were directionally similar to family income, these associations were generally smaller, with confidence intervals including the null [46].

Overall, our findings are in line with the prior studies suggesting that financial disadvantage over the life course is associated with a poorer quantity and quality of social connection in adulthood [8,12,13,47,48]. Moreover, they align with previous retrospective evidence reporting an association between socioeconomic adversity during childhood and higher loneliness in older adulthood [17–19,49]. In particular, our findings emphasize the longitudinal association of financial conditions early in life with social connection in mid-adulthood while adjusting for parental and adulthood educational attainment levels.

One of our main findings is the difference in the associations between socioeconomic indicators with adult social connection: while childhood financial conditions were associated with social connection in adulthood conditional on educational attainment, we saw no consistent evidence for an association between parental educational attainment and adult

social connection conditional on income levels. A recent cross-sectional study reached similar conclusions: while lower educational attainment, lower income, and lower occupational prestige were all initially associated with higher loneliness among a German sample aged more than 40 years old, when all three were analyzed together only income and occupational prestige remained associated with higher loneliness [48].

The association of low family income during childhood with poorer social connection in adulthood was not fully explained (i.e., mediated) by adult income in our study. This suggests that family income is likely to be associated with adult social connection through other life-course pathways (i.e., other mediating factors not considered in this study) [50–52]. From a life-course perspective, childhood and adolescence are sensitive developmental phases during which social, cognitive, and emotional development are strongly modifiable by psychosocial risk factors, such as low parental SES, which could potentially impede optimal development in subsequent life stages [52–54]. Children from families at socioeconomic risk are exposed to more early-life stress, which may adversely affect their social development [54–58]. For instance, meta-analytic evidence suggests that early-life adversity is associated with stress sensitization leading to a blunted cortisol response to social stress [59]. Moreover, children and specially adolescents are at a key life phase for the development of social networks [60], and are particularly vulnerable to social isolation and loneliness [61–64]. Low parental economic resources during this developmental phase may hinder relationships' formation and social interactions with peers [64], which can in turn increase adolescents' risk of loneliness [53,65]. Indeed, previous studies have indicated that loneliness is more prevalent in adolescents from low socioeconomic backgrounds [53,66]. Furthermore, effective parental social support may be easily affected by low income and financial struggles due to higher parenting stress and poorer mental and physical health [67–69]. All these could contribute to lower quality and

quantity of social interactions since early in life, potentially decreasing the amount of time available for socialization and raising the threshold for establishing social connections and participation in society [70–72].

However, to some extent, the overall association (total effect) of parental income with adult loneliness and perceived social support was mediated by adult income. Several intermediate factors may help explain how low income in adulthood might impair social connection. For instance, individuals with low SES are more likely to live in deprived neighborhoods [14,15], which has been previously associated with higher loneliness [71]. Previous evidence has also indicated that individuals with low SES are more likely to suffer from poor physical and mental health [12,55,73,74], more chronic stress [15,75], have poorer sleep quality [76], lower physical activity level [77] and poorer nutrition [54,78]. Poorer health may adversely affect both the objective and subjectively perceived quantity and quality of social connection, although the associations between social connection and health are likely bidirectional [9,79–81].

Our study has limitations. First, our models only include one measurement point for social connection. Therefore, we were not able to evaluate if low family income was associated with social connection already in childhood and adolescence, these associations then carrying over into adulthood. Loneliness is to some extent trait-like [82,83] and previous longitudinal evidence has suggested that adolescents and young adults who report loneliness are at a high risk of lower income in midlife [64]. Second, one of the key assumptions of causal mediation models is the absence of unmeasured confounding. Although we have estimated the E-values, they always depend on the initial value of the effect estimates and there are no clear guidelines for their interpretation [84]. The long-time interval between the childhood and adult measurements inevitably increases the risk of exposure-induced confounding of the mediator-outcome association[41]. Therefore, we cannot exclude the possibility of unmeasured or residual

confounding significantly affecting our findings. Similarly, we cannot completely rule out the existence of relevant variations within our exposure categories that would compromise consistency. Third, in our analysis we used dichotomous exposures which yet made us lose information. Fourth, we may have lacked statistical power to detect an interaction effect between childhood and adulthood income. Moreover, it would be of interest to explore the potential mediating (and confounding) role of other SES indicators such as employment status. Fifth, we used cohort data from Finland, which is a high-income country with lower levels of income inequality compared to most other countries [85], and the Young Finns Study dataset, which is very homogeneous in terms of ethnicity, comprising white individuals of Finnish origin. These aspects may limit the generalizability of our findings. The association between SES and social connection may also be moderated to a certain extent by macro-level factors not considered in this study, such as income inequality and welfare state expenditure [72], which have been associated with levels of social cohesion, less mutual trust, and greater social distance between people [72,86–88]. Finally, selective attrition due to the long follow-up likely introduced bias in our findings. The findings from the complete case analysis aligned with the findings after multiple imputation; however, given the frequency of missing values in the outcome, we deleted the imputed outcomes prior to our analyses (i.e., "multiple imputation, then deletion" procedure), which could lead to biased estimates in settings in were the auxiliary variables used for the imputation are associated with missingness in the outcome[89]

The strengths of this study include the prospective data from 1,775 individuals spanning across 40 years. Social connection was assessed using three different indicators that explore both structural and functional aspects of social interaction and differ by levels of subjectivity [2]. The use of causal mediation analysis and marginal structural models allowed us to adjust

for exposure-induced confounding, consider exposure-mediator interactions, and evaluate the robustness of our estimates using sensitivity analyses.

Conclusions

Growing up in a low-income family was associated with higher levels of loneliness, reduced perceived social support, and lower frequency of social contact in middle adulthood. To some extent, the associations with loneliness and perceived social support were explained by participants' low income in adulthood. Conversely, we observed no consistent evidence for an association between parental educational attainment and adult social connection. Our findings suggest the potential long-lasting consequences of adverse childhood financial circumstances for social connection in adulthood.

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Table 1. Characteristics of the final pooled sample.

	Final sample (N=1,775)
Sex	
Female	1011 (57.0%)
Male	764 (43.0%)
Age (1980)	
Mean (SD)	10.8 (4.99)
Median [Min, Max]	12.0 [3.0, 18.0]
Parental educational attainment	
Intermediate/academic	1180 (66.5%)
Low	595 (33.5%)
Parental income	
Highest 75%	1316 (74.1%)
Low (lowest 25%)	459 (25.9%)
Educational attainment	
Intermediate/academic	684 (38.5%)
Low	1091 (61.5%)
Income	
Highest 75%	1362 (76.7%)
Low (lowest 25%)	413 (23.3%)
Three-Item Loneliness Scale	
3	562 (31.7%)
4	375 (21.1%)
5	296 (16.7%)
6	406 (22.9%)
7	78 (4.4%)
8	35 (2.0%)
9	23 (1.3%)
Multidimensional Scale of Perceived Social Support (MSPSS)	
Mean (SD)	21.6 (9.04)
Median [Min, Max]	20.0 [12.0, 60.0]
Frequency of social contact	
Mean (SD)	2.47 (0.751)
Median [Min, Max]	2.33 [1.00, 4.67]

Note. Higher scores in the TILS indicate higher loneliness. Higher scores in the MSPSS indicate lower perceived social support. Higher scores in the frequency of social contact measure indicate less frequent social contact.

Table 2. Pooled estimates and 95% Confidence Intervals from the regression models estimating the associations between exposures (parental educational attainment/income), mediators (participant's educational attainment/income) and outcomes (loneliness/perceived social support/social contact).

SES Indicator (Exp/Med)		Outcomes		
		Loneliness [b]	**Social support [c]**	**Social contact [c]**
Educational attainment	**Exposure→ outcome**	1.08 (0.89-1.31)	0.09 (-0.02-0.19)	0.08 (-0.02-0.19)
	Exposure→mediator [a]	2.39 (1.88-3.03)	2.39 (1.88-3.03)	2.39 (1.88-3.03)
	Mediator→ outcome	1.12 (0.93-1.34)	0.02 (-0.08-0.12)	0.08 (-0.02-0.18)
Income	**Exposure→ outcome**	1.54 (1.26-1.89)	0.21 (0.09-0.32)	0.19 (0.07-0.30)
	Exposure→mediator [a]	1.86 (1.42-2.42)	1.86 (1.42-2.42)	1.86 (1.42-2.42)
	Mediator→ outcome	1.53 (1.23-1.91)	0.25 (0.13-0.37)	0.17 (0.04-0.29)

Note: SES: socioeconomic status. Exp/Med: Exposure/Mediator. [a] Odds ratio from the regressions exploring the associations between exposure and mediator using logistic regression. [b] Odds ratio from the regressions that had loneliness as dependent variable and were fitted using ordinal regression. [c] Standardized estimates for the regressions that had perceived social support or frequency of social contacts as dependent variable and were fitted using linear regression. The results are adjusted for age in the models for educational attainment, and for age and parental educational attainment for the income level models. Moreover, mediator-outcome regressions were adjusted for time-varying confounders (parental income or adult educational attainment) and sex.

Table 3. Effect decomposition for the association of parental educational attainment with social connection in adulthood via adult educational attainment.

Outcome	Effect	Pooled estimate	95 % CI
Loneliness	Direct	1.17	0.93-1.41
	Indirect	1.02	0.98-1.06
	Total	1.20	0.96-1.44
Perceived social support	Direct	0.08	-0.02-0.19
	Indirect	0.00	-0.02-0.02
	Total	0.08	-0.02-0.19
Frequency of social contact	Direct	0.07	-0.04-0.18
	Indirect	0.02	-0.01-0.04
	Total	0.08	-0.02-0.19

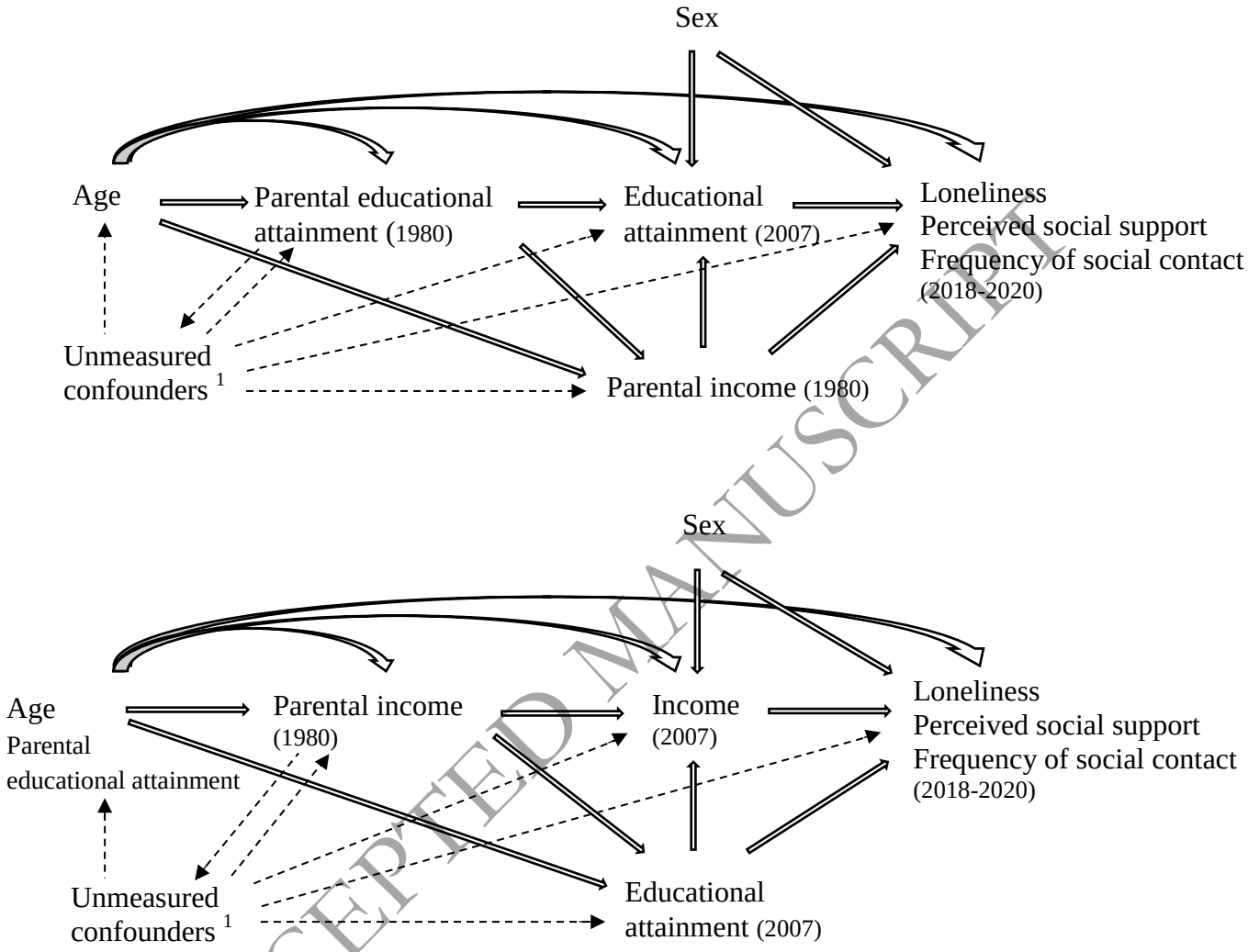
Note: The estimates of the randomized interventional analogues of natural direct and indirect effects were obtained from weighted ordinal regression (loneliness) and weighted linear regression (perceived social support and frequency of social contact). Effects are reported on the ratio scale (loneliness) or on the difference scale with standardized values (perceived social support and frequency of social contact).

Table 4. Effect decomposition for the association of parental income with social connection in adulthood via adult income.

Outcome	Effect	Pooled estimate	95 % CI
Loneliness	Direct	1.46	1.15-1.77
	Indirect	1.08	1.02-1.14
	Total	1.58	1.24-1.92
Perceived social support	Direct	0.15	0.01-0.28
	Indirect	0.05	0.01-0.08
	Total	0.19	0.06-0.33
Frequency of social contact	Direct	0.16	0.02-0.29
	Indirect	0.02	0.00-0.05
	Total	0.18	0.04-0.31

Note: The estimates of the randomized interventional analogues of natural direct and indirect effects were obtained from weighted ordinal regression (loneliness) and weighted linear regression (perceived social support and frequency of social contact). Effects are reported on the ratio scale (loneliness) or on the difference scale with standardized values (perceived social support and frequency of social contact).

Figure 1. Directed Acyclic Graphs representing the hypothesized associations between childhood SES (parental educational attainment/parental income) and social connection in adulthood, mediated by participants' own SES (educational attainment/income) in adulthood. We assumed that educational attainment is causally upstream of income.



[1] Unmeasured confounders are potential confounders of the exposure-outcome, exposure-mediator, and mediator-outcome associations (not affected and affected by the exposure)