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Early-life Socioeconomic Circumstances and Physical Activity in Older Age: Women Pay the Price

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Abstract

Health in older age is patterned by early-life socioeconomic circumstances (SEC) and sex. However, whether and why these factors interact is unclear. We examined a cultural explanation of this interaction by distinguishing cultural and material aspects of SEC, in the context of physical activity—a major determinant of health. We used data from 56,331 adults aged 50 to 96 years from the Survey of Health Ageing and Retirement in Europe (SHARE), a 13-year, large-scale, population-based cohort. Confounder-adjusted logistic linear mixed-effect models showed that the association between the cultural aspects of early-life SEC disadvantage and physical activity was found among women, but not consistently observed in men. Furthermore, these associations were only partially compensated for by adult-life socioeconomic trajectories. The material aspects of early-life SEC were not associated with physical activity. These findings highlight the need to distinguish different aspects of SEC, as they may relate to health behaviors in diverse ways.

Keywords: sex, early-life socioeconomic circumstances, health, physical activity, aging

Statement of relevance

Scientists have long shown that the socioeconomic conditions in which children grow up impact their health behaviors in adulthood – particularly physical activity. But is it economic or cultural level that is key? Does this impact depend on sex? This longitudinal study of 56'000 Europeans tested whether cultural (number of books at home at age 10 and parents' occupation) and material (overcrowding at home and housing quality) disadvantages predicted physical activity, and whether these associations differed by sex. Cultural, but not material disadvantage, played a key role in physical activity in adulthood. Crucially, this effect was more pronounced for women than for men. Specifically, 28% of culturally advantaged men and 31% of disadvantaged men were physically inactive, versus 30% and 38% respectively in women. The cultural environment during childhood plays a determining role in physical activity in adulthood, particularly in women who seem more vulnerable to disadvantaged cultural conditions than men.

Early-life Socioeconomic Circumstances and Physical Activity in Older Age: Women Pay the Price

Health and health behaviors are patterned by socioeconomic circumstances (SEC) (Cutler et al., 2008) and sex (Macintyre et al., 1996): people from disadvantaged SEC and women have poorer health than people from advantaged SEC and men. However, how SEC and sex interact has been under-researched (Eagly et al., 2012; Parker et al., 2020), although many aspects of daily life are structured by sex, suggesting that men and women respond differently to adverse SEC (Macintyre & Hunt, 1997). For example, living in disadvantaged SEC is associated with smoking and excessive alcohol consumption in men, and unhealthy eating and physical inactivity in women (Mackenbach et al., 1999). This suggests the social patterning of health behaviors differs for men and women. This study pursues this line of research by further investigating the impact of the SEC-by-sex interaction on one major health factor: physical activity.

A few studies conducted on children confirmed the social patterning of physical activity by sex (Cairney et al., 2015; Gorely et al., 2009; Seabra et al., 2013). Compared with high-socioeconomic-status girls, low-socioeconomic-status ones report lower preference for physical activity, while no such effect is observed in boys (Anokye et al., 2013; Seabra et al., 2013). In addition, participation in active free play decreases in girls from lower-income neighborhoods at a faster rate from ages 9 to 13 relative to girls from high-income neighborhoods (Cairney et al., 2015). In contrast, boys' participation rates are similar across neighborhood income levels.

However, why and how SEC interact with sex remains largely unknown. The cultural hypothesis proposes the role of sex roles and social norms, which might operate through at least two mechanisms (Bourdieu, 1978; Macintyre & Hunt, 1997; Mackenbach et al., 1999). First, sex roles may create differences in the access to coping mechanisms against the stress associated with disadvantaged SEC. For example, smoking, alcohol consumption, and physical activity, are more socially acceptable in men, while unhealthy eating and physical inactivity are more socially acceptable in women (Macintyre & Hunt, 1997). Second, the social norms associated with physical activity could also play a role. According to Bourdieu (1978), while aesthetics, absence of physical contact, and education are promoted in an advantaged socioeconomic environment, strength, physical contacts, and competition are instead valued in disadvantaged socioeconomic environments. Of particular relevance here, activities that are valued in an advantaged milieu are often perceived as appropriate for both men and women (e.g., horseback riding, tennis). In contrast, activities valued in a disadvantaged milieu are more often typically masculine (e.g., boxing, soccer) (for a review see Chalabaev et al., 2013). Consequently, access to physical activities is restricted to "masculine" sports (e.g., rugby, cycling) for women living in disadvantaged SEC, while women living in advantaged ones have access to "feminine" (e.g., dance, synchronized swimming) or "sex-neutral" (e.g., volleyball, table tennis) activities. In contrast, men have access to activities that are congruent with a masculine sex role both in advantaged (e.g., fencing, golf) and disadvantaged (e.g., weightlifting, cycling) SEC. This could explain why the social patterning of physical activity is gendered.

Although cultural explanations of the SEC-by-sex interaction have been put forward by several authors, empirical support is lacking. We propose to test this hypothesis by distinguishing the cultural and material dimensions of SEC. This may allow to disentangle whether disadvantaged early-life SEC are a risk factor for physical inactivity because families lack the economic resources necessary to facilitate their children's participation in physical activity, or because their cultural background does not encourage involvement in physical activities, especially for girls (Johnston et al., 2007; Stalsberg & Pedersen, 2010). Until now,

this cultural hypothesis has been overlooked, as most research explained SEC differences in physical activities using mechanisms related to material, or economic, resources, such as lack of access to transportation to facilities for physical activity, lack of economic resources to pay for leisure-time activities and sports, and lack of time (Chinn et al., 1999; Sherwood & Jeffery, 2000), or in terms of the increased biopsychosocial stress linked with low material socioeconomic conditions (McNeill et al., 2006).

In addition, while SEC and sex seem to interact during childhood, whether this interaction persists through the lifespan remains an open question, as their effects have usually been examined separately (Anokye et al., 2013). A recent study showed that women who grew up in disadvantaged SEC were less physically active later in life, compared with women who grew up in advantaged SEC (Cheval, Sieber, et al., 2018). Crucially, from a statistical standpoint, the association between early-life SEC and physical inactivity was fully mediated by adulthood SEC, especially by the level of education. This suggests that the influence of the socioeconomic milieu in which women grew up can be fully compensated for their adult-life socioeconomic trajectories. Moreover, past research suggests that the cultural dimension of SEC may have stronger effects through the lifespan than the material one because of its impact on health behaviors (Cutler et al., 2008). However, no study to our knowledge has investigated whether the early-life SEC-by-sex interaction persists in later life.

To fill these gaps, this study investigated whether the early-life SEC-by-sex interaction on physical activity in later life depends on the SEC dimension (material or cultural). This question was examined in a 13-year large-scale cohort of adults aged 50 and older. Indicators of material early-life disadvantages included overcrowding and low housing quality at age 10, and indicators of cultural ones included low occupational position of the household's main breadwinner and low number of books at home at age 10. Finally, to further understand the potential long-lasting effect of early-life SEC, we assessed whether the associations between early-life disadvantage and physical activity in later life were mediated by adulthood SEC, as in Cheval, Sieber, et al. (2018).

First, we predicted that, compared to men, women would be less physically active (H1). Second, we expected that people would be less physically active when they grew up in disadvantaged early-life SEC than in advantaged ones. Based on previous studies showing the importance of the cultural dimension in explaining physical activity, we hypothesized that the cultural aspect of disadvantage would be more strongly associated with lower physical activity than the material one (H2). Third, we hypothesized that the associations between early-life SEC and physical activity would be particularly pronounced in women (H3). Fourth, we hypothesized that the associations of sex and early-life SEC with physical activity could be, at least partly, explained by adulthood SEC (H4). Finally, we explored these effects on the evolution of physical activity over time.

Method

Study population and design

We used the Survey of Health Ageing and Retirement in Europe (SHARE; Börsch-Supan et al., 2013), a 13-year large-scale population-based European cohort of adults aged 50 and older, with repeated measurements in seven waves every two years between 2004 and 2017.

Physical activity was assessed at wave 1, 2, 4, 5, 6 and 7. Early-life SEC were assessed once, either at wave 3 or 7. Participants were eligible for the study if they participated either in the third wave or seventh wave and had at least one measure of physical activity. The relevant local research ethics committees in the participating countries approved SHARE. All participants provided written informed consent.

Measures

Physical activity. Physical activity was derived from the following two questions: “How often do you engage in activities that require a low or moderate level of energy such as gardening, cleaning the car, or going for a walk?” and “How often do you engage in vigorous physical activity, such as sports, heavy housework, or a job that involves physical labor?” (Cheval et al., 2020; Cheval, Rebar, et al., 2019; de Souto Barreto et al., 2017). Participants answered using a 4-point scale: 1: more than once a week; 2: once a week; 3: one to three times a month; 4: hardly ever or never. Participants who did not answer “more than once a week” to either item were classified as physically inactive. As described in previous research (Cheval, Sieber, et al., 2018), this strategy reduces the potential misclassification bias which would lead to physically inactive participants being incorrectly classified as physically active. Yet, a robustness analysis was conducted to test the models with a different cut point (see the Robustness Analysis section for more details) and showed results consistent with the main analyses.

Early-life SEC. Early-life SEC included four binary indicators reflecting cultural and material dimensions of participants' SEC at the age of 10 (Wahrendorf & Blane, 2015). The cultural dimension of early-life SEC included the number of books at home, and the occupational position of the household's main breadwinner (first and second vs. higher skill levels of the International Standard Classification of Occupations). The number of books was used as a proxy of a focus on education (Evans et al., 2010; van Bergen et al., 2017) and was dichotomized into 0-10 vs. more books at home. Occupational position was built according to a reclassification of the main occupational groups of the International Standard Classification of Occupations based on skill levels (Wahrendorf et al., 2013). The first and second skill levels were grouped as “disadvantaged” occupational position, whereas the third and fourth levels were grouped as “advantaged” occupational position. The material dimension of SEC included a measure of overcrowding (more vs. less than one person per room in the household) and housing quality (absence vs. presence of either fixed bath, cold running-water supply, hot running water supply, inside toilet, or central heating) (Cheval, Boisgontier, et al., 2018; Der Linden et al., 2019). Overcrowding (Marsh, 1999) and housing quality (Dedman et al., 2001; Stafford & McCarthy, 2006) are independent social characteristics related to the household that have been described as a determinant of health. Previous studies have supported the validity of the operationalization of the aforementioned SEC indicators in distinguishing advantaged and disadvantaged individuals (Pinto Pereira et al., 2015; Pinto Pereira et al., 2014). However, whether this categorization can be generalized across countries still needs to be examined (see the Limitations section).

Sex. Sex was derived from the question: “What is your sex?”. Participants could answer either “male” or “female”. To be consistent with the terminology used by SHARE, we used sex rather than gender here. However, the present study focused on socially constructed roles and behaviors associated with a person's biological sex, which reflect gender according to the American Psychological Association (APA) guidelines (American Psychological Association, 2012).

Adult-life SEC mediators. The following variables were included as potential adult-life SEC mediators: participants' highest educational attainment (primary, secondary, or tertiary) during the follow-up, main occupational position based on the skill classification of the main job over the life course (low skill, high skill, or no paid work), and satisfaction with current household income, using the question, “Is the household able to make ends meet?”, with a scale ranging from 1 (with great difficulty) to 4 (easily). Primary, secondary and tertiary categories corresponded to the codes 0 and 1 (less than primary and primary education), 2, 3, and 4 (lower and upper secondary and post-secondary non-tertiary education), 5 and 6 (short-cycle tertiary education and bachelor's or equivalent degree) of the International Standard

Classification of Education 97 classification. We computed the mode of this variable over the follow-up to retain as many observations as possible (Aartsen et al., 2019; Cheval, Chabert, Orsholits, et al., 2019; Sieber et al., 2019).

Covariates and potential confounders. All analyses were adjusted for age, body mass index, attrition [no dropout, dropout (participants who responded to neither wave 6 nor wave 7), death], birth cohort [war (between 1914 and 1918 and between 1939 and 1945), Great Depression (between 1929 and 1938), no war and no economic crisis (before 1913, between 1919 and 1928, and after 1945)], and for country of residence (Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Luxembourg, Netherlands, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland). All these variables have been found to be related to later-life health (Cheval, Chabert, Sieber, et al., 2019; Sieber et al., 2020).

Statistical analysis

Logistic mixed-effects models were used to account for the nested structure of the data (i.e., multiple observations within a single participant) (Boisgontier & Cheval, 2016). The final random structure included random intercepts for participants and random linear slopes for age at the participant's level. These random effects estimated each participant's probability of engagement in physical activity and the rate of change of this probability of engagement over time. Age was centered on the midpoint of the sample's age range (73 years) and was then divided by 10. This approach allows a simpler interpretation of the parameters and reduces the risk of model convergence issues. The coefficients yielded the effects of the physical activity rate of change over a 10-year period. For time-varying covariates, we used the mode to reduce observation loss. Odds Ratios (OR) were reported as a measure of effect size by exponentiating the values of the estimates obtained in the logistic mixed-effects model, with 1.5, 2.5, and 4.3 being used as cut-offs for small, medium, and large effect size, respectively (Cohen, 1988).

Model 1 tested the association between sex and the probability of physical activity. In addition, this model included interaction terms between sex and age (both linear and quadratic) to examine whether sex was associated with (both linear and non-linear) change in the probability of physical activity over the years. A statistically significant interaction would indicate that the evolution of the probability of physical activity over the years depended on the participant's sex. In model 2, we tested the association between early-life SEC indicators and the probability of physical activity and change over the years. All early-life SEC indicators were included in model 2 as well as in the subsequent models. In Model 3, we added interaction terms between sex and the early-life SEC indicators, as well as a three-way interaction between sex, early-life SEC indicators, and age (linear and quadratic) to examine whether the effects of early-life SEC on the probability of physical activity and of its change over the years were moderated by the participant's sex. In Model 4, we tested whether the effects of early-life SEC and sex on the probability of physical activity and of its change over the years were explained by adult-life SEC. Statistical assumptions associated with MEM (i.e., normality of the residuals, linearity, multicollinearity, and undue influence) were checked and met for all models.

Sensitivity analyses

We performed a series of sensitivity analyses excluding 1) participants with dementia, 2) participants who died during the survey, and 3) participants who dropped out during the survey. Table S3 provides more details on all covariates used in the sensitivity analyses.

Robustness analysis

A robustness analysis was conducted to test the models with a different cut-off point for the measure of physical activity. Specifically, participants who answered "hardly ever or never"

to at least one of the physical-activity items were classified as physically inactive, whereas participants who answered “more than once a week” or “once a week” to at least one of the physical-activity items were classified as physically active. The objective of this classification was to reduce the potential misclassification bias, which could lead to physically active participants being erroneously classified as physically inactive.

Results

After the descriptive statistics, the results are reported in three sections: The first describes analyses of the association between sex and physical activity; the second describes analyses of the association between early-life SEC and physical activity, and the third describes results concerning the moderation of the association between early-life SEC and physical activity by sex. Table S2 provides the results of the mixed-effects models with full details.

Descriptive results

Table 1 shows the characteristics of the participants by sex at baseline. Briefly, our study sample consisted of 56,331 people (56.3% women), aged between 50 and 96. During the course of the study 3,013 (5.3%) participants died, and 7,234 (12.8%) dropped out for other reasons. The average number of observations per respondent was 2.91 (total number of observations was 164,022). Tables S1 present additional descriptive statistics stratified by physical activity levels and early-life SEC.

Main analyses

Sex and moderate physical activity. As hypothesized (H1), results showed that at 73 years (because age was centered at 73 years, the midpoint of the sample's age range) women were less likely to be physically active than men (adjusted odds ratio [OR] = .69, 95% confidence interval [CI] = .66–.72, $p < .001$). In addition, compared to men, women demonstrated a steeper decrease in the probability of being physically active over the years (OR = .75, 95%CI = .72–.79, $p < .001$, for linear effect of age; OR = .95, 95%CI = .92–.98, $p < .001$, for quadratic effect of age (Table S2; Table 2, Model 1).

Early-life SEC and physical activity. As hypothesized (H2), results showed that, at 73 years, cultural aspects of disadvantaged early-life SEC were associated with lower probability of physical activity (OR = .76, 95%CI = .72–.80, $p < .001$, for low number of books; OR = .87, 95%CI = .81–.93, $p < .001$, for occupational position of the main breadwinner associated with low skill). By contrast, material aspects of disadvantaged early-life SEC were not associated with the probability of physical activity (OR = .96, 95%CI = .90–1.02, $p = .188$, for overcrowding; OR = 1.04, 95%CI = .98–1.10, $p = .173$, for housing quality). In addition, low occupational skill of the main breadwinner (OR = .88, 95%CI = .82–.94, $p < .001$) and poor housing quality (OR = .94, 95%CI = .90–1.00, $p = .033$) were associated with a steeper linear decrease in the probability of physical activity over the years. Number of books and overcrowding were, however, not associated with the probability of physical activity change over aging (Table S2; Table 2, Model 2).

The moderating role of sex in the associations between early-life SEC and physical activity. As predicted (H3), interactions between the cultural aspects of early-life SEC disadvantage and sex on the probability of physical activity were significant (OR = .88, 95%CI = .79–.98, $p = .019$, for number of books; OR = .84, 95%CI = .73–.97, $p = .014$, for occupational position of the main breadwinner). When these interactions were further analyzed, results revealed that the occupational position of the main breadwinner was not significantly associated with the probability of physical activity in men (OR = .95, 95%CI = .86–1.06, $p = .383$), while this variable was associated with lower probability of physical activity in women (OR = .81, 95%CI = .74–.88, $p < .001$). Moreover, the association between the number of books and

physical activity was significantly stronger in women (OR = .72, 95%CI = .67–.78, $p < .001$) than in men (OR = .82, 95%CI = .76–.89, $p < .001$). By contrast, no significant interactions were found between the material aspects of disadvantaged early-life SEC and sex (OR = .97, 95%CI = .86–1.09, $p = .633$, for overcrowding and OR = .99, 95%CI = .89–1.11, $p = .891$, for housing quality). Finally, no significant three-way interactions between early-life SEC, sex, and age (linear and quadratic) were found ($ps > .167$), thereby suggesting that sex did not significantly moderate the effect of early-life SEC on the evolution of the probability of physical activity over the years (Table S2; Table 2, Model 3; Figure 1).

Mediating role of adulthood SEC in the associations between early-life SEC, sex, and physical activity. The associations of sex and early-life SEC with the probability of physical activity were only partially attenuated by the life-course socioeconomic conditions. Specifically, sex and number of books, but not the occupational skill of the main breadwinner, remained associated with the probability of physical activity, and the occupational skill of the main breadwinner remained associated with a steeper linear decrease in the probability of physical activity over the years (Table S2; Table 2, Model 4a). Moreover, housing quality turned out to be associated with the probability of physical activity (OR = 1.12, 95%CI = 1.05–1.18, $p < .001$), while its association with the linear decrease in the probability of physical activity over the years became marginal ($p = .075$). The associations between cultural aspects of disadvantaged early-life SEC and the probability of physical activity remained more pronounced in women than in men (although the effect of the number of books became marginal, $p = .091$; Table S2; Table 2, Model 4b). In this fully adjusted model, number of books was associated with lower probability of physical activity in both men and women, while the association between main breadwinner and the probability of physical activity was only observed in women.

Sensitivity and robustness analyses. Results of the sensitivity and robustness analyses were consistent with those of the main analyses (Table S3).

Discussion

Main findings

The effects of sex and early-life SEC on health in older age have been largely examined separately (Eagly et al., 2012). Here, we examined their interaction on physical activity, and tested a cultural explanation of this interaction. Results showed that the cultural dimension of early-life disadvantaged SEC was more strongly associated with physical activity in women than in men. This suggests that these barriers act in a multiplicative manner, rather than in an additive way, calling into question the widespread assertion that SEC are a well-established risk factor for physical inactivity. In fact, SEC may be an important risk factor in women, but less in men.

In addition, the association between early-life SEC and physical activity was only partially attenuated by life-course SEC, suggesting that early-life SEC have a long-lasting impact on health behaviors, which cannot be fully compensated for by socioeconomic mobility during adulthood. Taken together, these results further support the need for adopting an intersectional perspective (Eagly et al., 2012) when examining health inequalities. However, the size of the association was small (ORs < 1.5). This suggests that other variables (e.g., motivation) could affect physical activity.

Comparison with other studies

Observing SEC-by-sex interactions only for the cultural aspects of SEC provides support to the cultural hypothesis. Cultural factors, such as social norms and sex roles, may lead women and men to have a differential access to health behaviors, with physical activity being more

socially acceptable in men than in women, especially in disadvantaged SEC (Bourdieu, 1978; Macintyre & Hunt, 1997; Mackenbach et al., 1999)

Moreover, observing that the social patterning of physical activity is sex dependent is in line with past studies conducted on children (Cairney et al., 2015; Seabra et al., 2013). It adds to the existing literature by showing that cultural early-life SEC have long-lasting effects. A potential explanation is that sex roles are learnt very early, during childhood, and that their effects are implicit (Boiché et al., 2014). Therefore, girls' tendency to avoid physical activities may turn into habits that may be difficult to change in adulthood. These findings stand in contrast with Cheval, Sieber, et al. (2018)'s study, which found that the association between early-life SEC and physical inactivity was fully mediated by adulthood SEC. This difference can be explained by the fact that our study disaggregated the material and cultural aspects of early-life disadvantage, while the previous one did not. Therefore, consistent with recent suggestions (Cheval, Orsholits, et al., 2019), results confirm the need to differentiate various aspects of early-life disadvantage to better gauge their specific links with health in later life.

Strengths and limiting conditions

This study has several strengths. First, the repeated measurement of physical activity allowed to investigate its evolution over 46 years (from age 50 to 96). Second, our study was based on large-scale data (N = 56,331). Third, we measured four different indicators of SEC (two cultural and two material), allowing a more fine-grained measure of this early-life disadvantage. Fourth, we applied an analytical approach well-suited to examine not only level differences, but also change as a person ages.

However, this study also has limitations. First, we used self-reported measures of physical activity, which may generate a misclassification bias (Prince et al., 2008), be subject to lack of granularity, and include examples that may prime individuals' response toward activities related to house chores and recreational activities. Nevertheless, we believe the potential measurement errors associated with self-reports are unlikely to explain the observed associations between SEC, sex, and physical activity. Moreover, the observed associations remained consistent across the multiple ways of modelling the dependent variable (i.e., three different cut points) and across the different population samples (i.e., three sensitivity analyses using different samples). Finally, applying a cut-off to both the moderate and vigorous-intensity items addresses some limits of our measure (e.g., difficulty for participants to categorize their physical activities according to the intensity). Second, early and adult-life SEC were assessed using self-reported retrospective data, which is subject to memory bias or social desirability. However, previous studies suggest sufficient validity of this self-reported socioeconomic information to discriminate between advantaged and disadvantaged individuals based on the specific cut-off points (Pinto Pereira et al., 2015; Pinto Pereira et al., 2014; Solís et al., 2015). In addition, and unlike previous literature relying on crude assessments of early-life SEC (e.g., using a limited number of early-life indicators) (Stringhini et al., 2013; Wannamethee et al., 1996), we used a comprehensive and rich measure of early-life SEC. However, these indicators were not exhaustive and may still have been insufficient to accurately distinguish between the different SEC groups. Consequently, we cannot fully exclude potential misclassification bias. Third, the SHARE design has two selection biases, related to the recruitment procedure that occurs at age 50+ (respondents may be more likely to be in better health than non-respondents) and to the loss of participants during the follow-up. This latter bias was limited by adjusting for attrition in the analyses, and by excluding participants who died or dropped out during the follow-up in the sensitivity analyses. Fourth, the cultural interpretation of the SEC-by-sex interaction remains speculative as individual motivations for physical activity were not measured. Fifth, the cut-off scores used in SHARE to operationalize early-life SEC are the same across countries, which may limit their validity in distinguishing advantaged and disadvantaged

SEC. Likewise, although a discussion of how the findings observed can be moderated by the country is outside of the scope of the current paper, we believe that future studies need to investigate this question. This will allow to determine whether and how the influence of sex and SEC can be increased vs. decreased depending on the type of country type or welfare regime (Sieber et al., 2019; Sieber et al., 2020).

Conclusions

This is one of the first studies that provide empirical support to a cultural explanation of the SEC-by-sex interaction on health behaviors. In women, but not in men, the number of books in the household remained significantly associated with a lower probability of physical activity after adjustments for life-course socioeconomic trajectories, suggesting that habits developed within the social milieu during childhood may partly determine behavior on a lifelong basis.

Author Contributions

M. P. B. and B. C. are joint senior authors. B. C. and A. C. developed the study concept and designed the analyses. B. C. analyzed the data. B. C., M. P. B., and A. C. drafted the manuscript. All the authors critically appraised the manuscript, worked on its content, and approved the final version for submission.

Conflict of interest

The authors declare no conflict of interest.

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Ethical approval

This study was part of the SHARE study, approved by the relevant research ethics committees in the participating countries, and all participants provided written informed consent.

Data sharing

This SHARE dataset is available at <http://www.share-project.org/data-access.html>.

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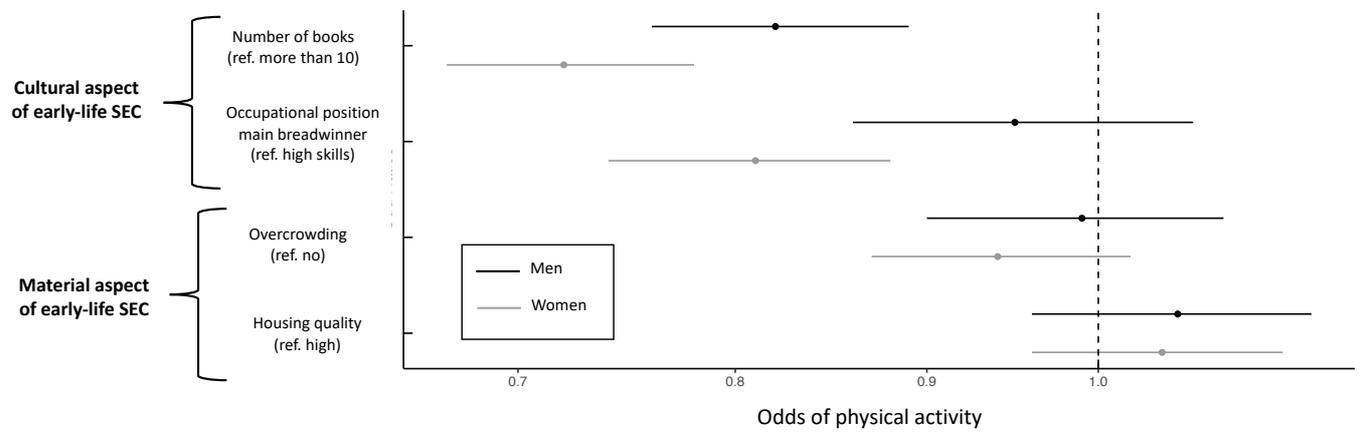
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Figure 1.

Association of cultural and material aspects of early-life SEC disadvantage and physical activity depending on sex



Note. Odds ratios (OR) and 95% confidence interval steaming from Model 3 are reported.

Table 1.
Sample characteristics by sex

	Women		Men		<i>P</i> value
Physical-activity outcomes					
Physically inactive	8415	26.6%	5772	23.4%	
Physically active	23202	73.4%	18942	76.6%	<0.001
Early-life SEC					
Number of books					
Less than 10	12230	38.7%	9977	40.4%	
More than 10	19387	61.3%	14737	59.6%	<0.001
Occupational position of the main breadwinner					
Low skills	25727	81.4%	20063	81.2%	
High skills	5890	18.6%	4651	18.8%	.573
Overcrowding					
Yes	23726	75.0%	18183	73.6%	
No	7891	25.0%	6531	26.4%	<0.001
Housing quality					
Low quality	8618	27.3%	6582	26.6%	
High quality	22999	72.7%	18132	73.4%	0.10
Adult-life SEC					
Education					
Primary	8186	25.9%	5156	20.9%	
Secondary	17232	54.5%	13588	55.0%	
Tertiary	6199	19.6%	5970	24.1%	<0.001
Main occupational position					
Low skills	19403	61.4%	15980	64.7%	
High skills	8477	26.8%	8428	34.1%	
Never worked	3737	11.8%	306	1.2%	<0.001
Ability to make ends meet					
With great difficulty	3853	12.2%	2464	10.0%	
With some difficulty	6968	22.0%	4954	20.0%	
Fairly easily	9477	30.0%	7431	30.1%	
Easily	11319	35.8%	9865	39.9%	<0.001
Covariates					
Age at baseline (years), SD	62.7	9.3	63.1	8.9	<0.001
Countries					
Belgium	2655	8.4%	2197	8.9%	
Austria	1714	5.4%	1231	5.0%	
Denmark	1592	5.0%	1364	5.5%	
France	2009	6.4%	1446	5.9%	
Germany	2087	6.6%	1830	7.4%	
Greece	1968	6.2%	1497	6.1%	

Israel	786	2.5%	601	2.4%	
Italy	2601	8.2%	2238	9.1%	
Netherlands	1039	3.3%	870	3.5%	
Spain	2618	8.3%	2099	8.5%	
Sweden	1889	6.0%	1627	6.6%	
Switzerland	1304	4.1%	1085	4.4%	
Czech Republic	2509	7.9%	1697	6.9%	
Ireland	338	1.1%	264	1.1%	
Poland	1111	3.5%	874	3.5%	
Estonia	2068	6.5%	1258	5.1%	
Hungary	244	0.8%	175	0.7%	
Portugal	191	0.6%	145	0.6%	
Slovenia	1504	4.8%	1075	4.3%	
Luxembourg	448	1.4%	394	1.6%	
Croatia	942	3.0%	747	3.0%	<0.001
Birth cohort					
After 1945	17703	56.0%	13426	54.3%	
between 1939 and 1945	6352	20.0%	5354	21.7%	
between 1929 and 1938	5709	18.1%	4662	18.9%	
between 1919 and 1928	1853	5.9%	1272	5.1%	<0.001
Attrition					
No drop out	26162	82.7%	19922	80.6%	
Drop out	4027	12.7%	3207	13.0%	
Death	1428	4.6%	1585	6.4%	<0.001

Note. SD = standard deviation; SEC = socioeconomic conditions. *P* values are based on the analysis of variance and chi-square tests for continuous and categorical variables, respectively, testing the effect of sex on these variables.

EARLY-LIFE DISADVANTAGE AND WOMEN PHYSICAL ACTIVITY

Table 2.

Summary of the coefficients obtained from the mixed-effects models for sex, early-life SEC, and the interaction between sex and early-life SEC on physical activity level

Variables	Model 1		Model 3		Model 4a	
	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>
Sex (ref. Men)	.69 (.66-.72)	<.001	.87 (.76-1.01)	0.061	.78 (.74-.82)	<0.001
Early-life SEC	Model 2					
Number of books (ref. more than 10)	.76 (.72-.80)	<.001	.82 (.76-.89)	<0.001	.87 (.82-.92)	<0.001
Occupational position of the main breadwinner (ref. high skills)	.87 (.81-.93)	<.001	.95 (.86-1.06)	0.383	.97 (.90-1.04)	0.332
Overcrowding (ref. no)	.96 (.90-1.02)	.188	.99 (.90-1.08)	0.805	1.02 (.96-1.08)	0.608
Housing quality (ref. high)	1.04 (.98-1.10)	.173	1.05 (.96-1.14)	0.289	1.12 (1.05-1.18)	<.001
Early-life SEC x Sex					Model 4b	
Sex (ref. Men) x Number of books (ref. more than 10)			.88 (.79-.98)	0.019	.91 (.82-1.01)	0.091
Sex (ref. Men) x Occupational position of the main breadwinner (ref. high skills)			.84 (.73-.97)	0.014	.83 (.73-.95)	0.009
Sex (ref. Men) x Overcrowding (ref. no)			.97 (.86-1.09)	0.633	.96 (.86-1.08)	0.544
Sex (ref. Men) x Housing quality (ref. high)			.99 (.89-1.11)	0.891	1.00 (.89-1.12)	0.996

Note. SEC = socioeconomic conditions. All models were adjusted for age, body mass index, attrition, birth cohort, and country of residence. Models 4a and 4b were also adjusted for adult-life SEC mediators – i.e., participants' highest educational attainment during the follow-up, main occupational position, and satisfaction with current household income. Models 4b included interaction terms between sex and early-life SEC. Table S2 provides the full table.

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Supplemental Material

- **Tables S1. Additional descriptive statistics stratified by physical activity levels and early-life SEC**
- **Table S2. Full table for the mixed effects models**
- **Table S3. Summary of the sensitivity analyses and robustness analyses**

Tables S1. Additional descriptive statistics stratified by physical activity levels and early-life SEC

Sample characteristics by physical activity levels

	Physically inactive		Physically active		P value
Sex					
Women	8415	59.3%	23202	55.1%	
Men	5772	40.7%	18942	44.9%	<0.001
Early-life SEC					
No of book					
Less than 10	6543	46.1%	15664	37.2%	
More than 10	7644	53.9%	26480	62.8%	<0.001
Occupational position of the main breadwinner					
Low skills	11830	83.4%	33960	80.6%	
High skills	2357	16.6%	8184	19.4%	<0.001
Overcrowding					
Yes	10983	77.4%	30960	73.4%	
No	3204	22.6%	11218	26.6%	<0.001
Housing quality					
Low quality	4454	31.4%	10746	25.5%	
High quality	9733	68.6%	31398	74.5%	<0.001
Adult-life SEC					
Education					
Primary	4528	31.9%	8814	20.9%	
Secondary	7267	51.2%	23553	55.9%	
Tertiary	2392	16.9%	9777	23.2%	<0.001
Main occupational position					
Low skills	8991	63.4%	26392	62.6%	
High skills	3620	25.5%	13285	31.5%	
Never worked	1576	11.1%	2467	5.9%	<0.001
Ability to make ends meet					
With great difficulty	2255	15.9%	4062	9.6%	
With some difficulty	3563	25.1%	8359	19.8%	
Fairly easily	4333	30.5%	12575	29.9%	
Easily	4036	28.4%	17148	40.7%	<0.001
Covariates					
Age at baseline (years), SD	64.9	10.0	62.2	8.8	<0.001
Countries					
Belgium	1277	9.0%	3575	8.5%	
Austria	765	5.4%	2180	5.2%	

Denmark	400	2.8%	2556	6.1%	
France	913	6.4%	2542	6.0%	
Germany	725	5.1%	3192	7.6%	
Greece	1067	7.5%	2398	5.7%	
Israel	353	2.5%	1034	2.5%	
Italy	1827	12.9%	3012	7.1%	
Netherlands	277	2.0%	1632	3.9%	
Spain	1284	9.1%	3433	8.1%	
Sweden	404	2.8%	3112	7.4%	
Switzerland	409	2.9%	1980	4.7%	
Czech Republic	1370	9.7%	2836	6.7%	
Ireland	134	0.9%	468	1.1%	
Poland	757	5.3%	1228	2.9%	
Estonia	774	5.5%	2552	6.1%	
Hungary	140	1.0%	279	0.7%	
Portugal	168	1.2%	168	0.4%	
Slovenia	514	3.6%	2065	4.9%	
Luxembourg	178	1.3%	664	1.6%	
Croatia	451	3.2%	1238	2.9%	<0.001
Birth cohort					
After 1945	6828	48.1%	24301	57.7%	
between 1939 and 1945	2924	20.6%	8782	20.8%	
between 1929 and 1938	3163	22.3%	7208	17.1%	
between 1919 and 1928	1272	9.0%	1853	4.4%	<0.001
Attrition					
No drop out	11434	80.6%	34650	82.2%	
Drop out	1582	11.3%	5652	13.4%	
Death	1171	8.3%	1842	4.4%	<0.001

Note. SD = standard deviation; SEC = socioeconomic circumstances.

Sample characteristics by cultural aspects of early-life SEC

	Number of books				Main occupational position			
	Less than 10 books		More than 10 books		Low skills		High skills	
Sex								
Women	12230	55.1%	19387	56.8%	25727	56.2%	5890	55.9%
Men	9977	44.9%	14737	43.2%	20063	43.8%	4651	44.1%
Physical activity outcomes								
Physically inactive	6543	29.5%	7644	22.4%	11830	25.8%	2357	22.4%
Physically active	15664	70.5%	26480	77.6%	33960	74.2%	8184	77.6%
Early-life SEC								
No of book								
Less than 10					20384	44.5%	1823	17.3%
More than 10					25406	55.5%	8718	82.7%
Occupational position of the main breadwinner								
Low skills	20384	91.8%	25406	74.5%				
High skills	1823	8.2%	8718	25.5%				
Overcrowding								
Yes	18900	85.1%	23009	67.4%	35491	77.5%	6418	60.9%
No	3307	14.9%	11115	32.6%	10299	22.5%	4123	39.1%
Housing quality								
Low quality	10298	46.4%	4902	14.4%	13816	30.2%	1384	13.1%
High quality	11909	53.6%	29222	85.6%	31974	69.8%	9157	86.9%
Adult-life SEC								
Education								
Primary	9328	42.0%	4014	11.8%	12486	27.3%	856	8.1%
Secondary	11085	49.9%	19735	57.8%	25664	56.0%	5156	48.9%
Tertiary	1794	8.1%	10375	30.4%	7640	16.7%	4529	43.0%
Main occupational position								
Low skills	16113	72.6%	19270	56.5%	31103	67.9%	4280	40.6%
High skills	3401	15.3%	13504	39.6%	11095	24.2%	5810	55.1%
Never worked	2693	12.1%	1350	4.0%	3592	7.8%	451	4.3%
Satisfaction with Income								
With great difficulty	3871	17.4%	2446	7.2%	5606	12.2%	711	6.7%
With some difficulty	5804	26.1%	6118	17.9%	10215	22.3%	1707	16.2%
Fairly easily	6602	29.7%	10306	30.2%	13935	30.4%	2973	28.2%
Easily	5930	26.7%	15254	44.7%	16034	35.0%	5150	48.9%
Covariates								
Age at baseline (years), SD	64.9	9.4	61.5	8.80	63.1	9.2	62.0	9.0
Countries								

Belgium	1844	8.3%	3008	8.8%	3803	8.3%	1049	10.0%
Austria	1163	5.2%	1782	5.2%	2224	4.9%	721	6.8%
Denmark	548	2.5%	2408	7.1%	2299	5.0%	657	6.2%
France	1526	6.9%	1929	5.7%	2804	6.1%	651	6.2%
Germany	1171	5.3%	2746	8.0%	3040	6.6%	877	8.3%
Greece	2158	9.7%	1307	3.8%	3205	7.0%	260	2.5%
Israel	329	1.5%	1058	3.1%	956	2.1%	431	4.1%
Italy	3133	14.1%	1706	5.0%	4356	9.5%	483	4.6%
Netherlands	560	2.5%	1349	4.0%	1517	3.3%	392	3.7%
Spain	2593	11.7%	2124	6.2%	4268	9.3%	449	4.3%
Sweden	566	2.5%	2950	8.6%	2673	5.8%	843	8.0%
Switzerland	645	2.9%	1744	5.1%	1753	3.8%	636	6.0%
Czech Republic	621	2.8%	3585	10.5%	3420	7.5%	786	7.5%
Ireland	204	0.9%	398	1.2%	487	1.1%	115	1.1%
Poland	1159	5.2%	826	2.4%	1855	4.1%	130	1.2%
Estonia	853	3.8%	2473	7.2%	2552	5.6%	774	7.3%
Hungary	102	0.5%	317	0.9%	322	0.7%	97	0.9%
Portugal	278	1.3%	58	0.2%	303	0.7%	33	0.3%
Slovenia	1366	6.2%	1213	3.6%	2063	4.5%	516	4.9%
Luxembourg	260	1.2%	582	1.7%	579	1.3%	263	2.5%
Croatia	1128	5.1%	561	1.6%	1311	2.9%	378	3.6%
Birth cohort								
After 1945	10014	45.1%	21115	61.9%	24556	53.6%	6573	62.4%
between 1939 and 1945	5002	22.5%	6704	19.6%	9660	21.1%	2046	19.4%
between 1929 and 1938	5480	24.7%	4891	14.3%	8867	19.4%	1504	14.3%
between 1919 and 1928	1711	7.7%	1414	4.1%	2707	5.9%	418	4.0%
Attrition								
No drop out	17748	79.9%	28336	83.0%	36939	80.7%	9145	86.8%
Drop out	2757	12.4%	4477	13.1%	6117	13.4%	1117	10.6%
Death	1702	7.7%	1311	3.9%	2734	5.9%	279	2.6%

Note. SD = standard deviation; SEC = socioeconomic circumstances. *P* values are based on the analysis of variance and chi-square tests for continuous and categorical variables, respectively, testing the effect of sex on these variables.

Sample characteristics by material aspects of early-life SEC

	Overcrowding				Housing quality			
	Yes		No		Low quality		High skills	
Sex								
Women	23726	56.6%	7891	54.7%	8618	56.7%	22999	55.9%
Men	18183	43.4%	6531	45.3%	6582	43.3%	18132	44.1%
Physical activity outcomes								
Physically inactive	10983	26.2%	3204	22.2%	4454	29.3%	9733	23.7%
Physically active	30926	73.8%	11218	77.8%	10746	70.7%	31398	76.3%
Early-life SEC								
No of book								
Less than 10	18900	45.1%	3307	77.1%	10298	67.7%	11909	29.0%
More than 10	23009	54.9%	11115	22.9%	4902	32.2%	29222	71.0%
Occupational position of the main breadwinner								
Low skills	35491	84.7%	10299	74.4%	13816	90.9%	31974	77.7%
High skills	6418	15.3%	4123	28.6%	1384	9.1%	9157	22.3%
Overcrowding								
Yes					13648	89.8%	28261	68.7%
No					1552	10.2%	12870	31.3%
Housing quality								
Low quality	13648	32.6%	1552	10.8%				
High quality	28261	67.4%	12870	89.2%				
Adult-life SEC								
Education								
Primary	11378	27.2%	1964	13.6%	6148	40.4%	7194	17.5%
Secondary	23273	55.5%	7547	52.3%	7568	49.8%	23252	56.5%
Tertiary	7258	17.3%	4911	34.1%	1484	9.8%	10685	26.0%
Main occupational position								
Low skills	27463	65.5%	7920	54.9%	10686	70.3%	24697	60.0%
High skills	11142	26.6%	5763	40.0%	2840	18.7%	14065	34.2%
Never worked	3304	7.9%	739	5.1%	1674	11.0%	2369	5.8%
Satisfaction with Income								
With great difficulty	5511	13.1%	806	5.6%	2629	17.3%	3688	9.0%
With some difficulty	9944	23.7%	1978	13.7%	4360	28.7%	7562	18.4%
Fairly easily	12851	30.7%	4057	28.1%	4829	31.8%	12079	29.4%
Easily	13603	32.5%	7581	52.6%	3382	22.2%	17802	43.3%
Covariates								
Age at baseline (years), SD	63.2	9.2	61.8	9.1	66.7	9.2	61.4	8.8
Countries								

Belgium	2258	5.4%	2594	18.0%	927	6.1%	3925	9.5%
Austria	2272	5.4%	673	4.7%	832	5.5%	2113	5.1%
Denmark	1564	3.7%	1392	9.6%	313	2.1%	2643	6.4%
France	2293	5.5%	1162	8.1%	732	4.8%	2723	6.6%
Germany	2626	6.3%	1291	9.0%	472	3.1%	3445	8.4%
Greece	3109	7.4%	356	2.5%	1160	7.6%	2305	5.6%
Israel	1088	2.6%	299	2.1%	186	1.2%	1201	2.9%
Italy	3999	9.5%	840	5.8%	1282	8.4%	3557	8.6%
Netherlands	1289	3.1%	620	4.3%	89	0.6%	1820	4.4%
Spain	3810	9.1%	907	6.3%	1581	10.4%	3136	7.6%
Sweden	2238	5.3%	1278	8.9%	418	2.8%	3098	7.5%
Switzerland	1352	3.2%	1037	7.2%	126	0.8%	2263	5.5%
Czech Republic	3754	9.0%	452	3.1%	753	5.0%	3453	8.4%
Ireland	461	1.1%	141	1.0%	227	1.5%	375	0.9%
Poland	1911	4.6%	74	0.5%	1418	9.3%	567	1.4%
Estonia	2883	6.9%	443	3.1%	2044	13.4%	1282	3.1%
Hungary	398	0.9%	21	0.1%	229	1.5%	190	0.5%
Portugal	283	0.7%	53	0.4%	204	1.3%	132	0.3%
Slovenia	2384	5.7%	195	1.4%	1149	7.6%	1430	3.5%
Luxembourg	366	0.9%	476	3.3%	59	0.4%	783	1.9%
Croatia	1571	3.7%	118	0.8%	999	6.6%	690	1.7%
Birth cohort								
After 1945	22555	53.8%	8574	59.5%	5741	37.8%	25388	61.7%
between 1939 and 1945	8941	21.3%	2765	19.2%	3675	24.2%	8031	19.5%
between 1929 and 1938	8057	19.2%	2314	16.0%	4344	28.6%	6027	14.7%
between 1919 and 1928	2356	5.6%	769	5.3%	3675	9.5%	1685	4.1%
Attrition								
No drop out	34428	82.1%	11656	80.8%	12419	81.7%	33665	81.8%
Drop out	5126	12.2%	2108	14.6%	1471	9.7%	5763	14.0%
Death	2355	5.6%	658	4.6%	1310	8.6%	1703	4.1%

Note. SD = standard deviation; SEC = socioeconomic conditions. p values are based on the analysis of variance and chi-square tests for continuous and categorical variables, respectively, testing the effect of sex on these variables.

Table S2. Full table for the mixed effects models

Age was centred on the midpoint of the sample's age range (73 years). "Age (10-year follow-up)" and "Age2 (10-year follow-up)" estimated the linear and quadratic changes in the engagement in physical activity over a 10-year period.

Row	Variables	Model 1		Model 2		Model 3		Model 4a		Model 4b	
		OR (95% CI)	P								
1	Intercept	3.06 (2.81-3.32)	<0.001	3.99 (3.60-4.42)	<0.001	3.50 (3.09-3.98)	<0.001	1.30 (1.12-1.50)	<0.001	1.12 (0.95-1.32)	0.164
2	Age (10y follow-up)	0.47 (0.44-0.49)	<0.001	0.55 (0.51-0.60)	<0.001	0.54 (0.49-0.60)	<0.001	0.48 (0.43-0.55)	<0.001	0.46 (0.40-0.54)	<0.001
3	Age2 (10y follow-up)	0.81 (0.79-0.83)	<0.001	0.79 (0.75-0.83)	<0.001	0.78 (0.73-0.84)	<0.001	0.83 (0.77-0.90)	<0.001	0.82 (0.75-0.91)	<0.001
4	Sex (ref. Men)										
	Women	0.69 (0.66-0.72)	<0.001	0.69 (0.66-0.72)	<0.001	0.87 (0.76-1.01)	0.061	0.78 (0.74-0.82)	<0.001	0.98 (0.85-1.13)	0.769
5	Age x sex (ref. men)										
	Age x women	0.75 (0.72-0.79)	<0.001	0.76 (0.73-0.80)	<0.001	0.78 (0.68-0.89)	<0.001	0.80 (0.76-0.84)	<0.001	0.84 (0.73-0.96)	0.014
6	Age2 x sex (ref. men)										
	Age2 x women	0.95 (0.92-0.98)	0.001	0.96 (0.93-0.99)	0.004	0.97 (0.89-1.05)	0.433	0.95 (0.92-0.98)	0.002	0.96 (0.88-1.05)	0.391
	Early-life SEC										
7	Number of book (ref. more than 10)										
	Less than 10			0.76 (0.72-0.80)	<0.001	0.82 (0.76-0.89)	<0.001	0.87 (0.82-0.92)	<0.001	0.92 (0.85-1.00)	0.044
8	Age x Number of book (ref. more than 10)										
	Age x Less than 10			0.96 (0.91-1.01)	0.129	0.96 (0.89-1.04)	0.314	0.97 (0.92-1.03)	0.350	0.98 (0.90-1.07)	0.709
9	Age2 x Number of book (ref. more than 10)										
	Age2 x Less than 10			1.03 (0.99-1.06)	0.119	1.02 (0.97-1.08)	0.420	1.01 (0.98-1.05)	0.551	1.01 (0.95-1.07)	0.701
10	Occupational position of the main breadwinner (ref. high skills)										
	Low skills			0.87 (0.81-0.93)	<0.001	0.95 (0.86-1.06)	0.383	0.97 (0.90-1.04)	0.332	1.07 (0.97-1.19)	0.184
11	Age x Occupational position of the main breadwinner (ref. high skills)										
	Age x Low skills			0.88 (0.82-0.94)	<0.001	0.85 (0.77-0.95)	0.003	0.95 (0.90-1.00)	0.075	0.89 (0.80-0.99)	0.034
12	Age2 x Occupational position of the main breadwinner (ref. high skills)										
	Age2 x Low skills			1.00 (0.95-1.04)	0.858	0.99 (0.93-1.06)	0.847	1.00 (0.96-1.04)	0.966	0.97 (0.91-1.04)	0.427
13	Overcrowding (ref. no)										
	Yes			0.96 (0.90-1.02)	0.188	0.99 (0.90-1.08)	0.805	1.02 (0.96-1.08)	0.608	1.03 (0.95-1.13)	0.465
14	Age x Overcrowding (ref. no)										
	Age x Yes			0.98 (0.93-1.04)	0.541	1.01 (0.92-1.10)	0.866	0.99 (0.94-1.05)	0.856	1.02 (0.93-1.12)	0.675
15	Age2 x Overcrowding (ref. no)										
	Age2 x Yes			1.00 (0.97-1.04)	0.800	1.01 (0.95-1.07)	0.746	1.00 (0.96-1.03)	0.806	1.00 (0.94-1.06)	0.985
16	Housing quality (ref. high)										
	Low			1.04 (0.98-1.10)	0.173	1.05 (0.96-1.14)	0.289	1.12 (1.05-1.18)	<0.001	1.12 (1.03-1.22)	0.011
17	Age x Housing quality (ref. high)										
	Age x Low			0.94 (0.90-1.00)	0.033	0.98 (0.90-1.06)	0.583	0.95 (0.90-1.00)	0.075	0.99 (0.91-1.08)	0.786
18	Age2 x Housing quality (ref. high)										
	Age2 x Low			1.01 (0.97-1.05)	0.723	1.04 (0.98-1.11)	0.182	1.00 (0.96-1.04)	0.966	1.03 (0.97-1.10)	0.280
19	Age x sex (ref. Women)										
	Sex x early-life SEC										
20	Sex (ref. men) x Number of book (ref. more than 10)										
	Women x less than 10					0.88 (0.79-0.98)	0.019			0.91 (0.82-1.01)	0.091
21	Age x sex (ref. men) x Number of book (ref. more than 10)										
	Age x women x less than 10					0.99 (0.90-1.10)	0.913			0.98 (0.88-1.09)	0.715
22	Age2 x sex (ref. men) x Number of book (ref. more than 10)										
	Age2 x women x less than 10					1.00 (0.93-1.08)	0.953			0.99 (0.92-1.07)	0.876
23	Sex (ref. men) x Occupational position of the main breadwinner (ref. high skills)										
	Women x low skills					0.84 (0.73-0.97)	0.014			0.83 (0.73-0.95)	0.009
24	Age x sex (ref. men) x Occupational position of the main breadwinner (ref. high skills)										
	Age x women x low skills					1.05 (0.92-1.21)	0.442			1.03 (0.90-1.19)	0.639
25	Age x sex (ref. men) x Number of book Occupational position of the main breadwinner (ref. high skills)										
	Age2 x women x low skills					1.01 (0.92-1.10)	0.849			1.01 (0.92-1.10)	0.846
26	Sex (ref. men) x Overcrowding (ref. no)										
	Women x yes					0.97 (0.86-1.09)	0.633			0.96 (0.86-1.08)	0.544
27	Age x sex (ref. men) x Overcrowding (ref. no)										
	Age x women x yes					0.96 (0.86-1.08)	0.531			0.96 (0.85-1.08)	0.453
28	Age2 x sex (ref. men) x Overcrowding (ref. no)										
	Age2 x women x yes					0.99 (0.92-1.07)	0.849			1.00 (0.92-1.08)	0.936
29	Sex (ref. men) x Housing quality (ref. high)										
	Women x low					0.99 (0.89-1.11)	0.891			1.00 (0.89-1.12)	0.996
30	Age x sex (ref. men) x Housing quality (ref. high)										
	Age x women x low					0.95 (0.85-1.06)	0.342			0.94 (0.84-1.04)	0.234
31	Age x sex (ref. men) x Housing quality (ref. high)										

32	Age2 x women x low				0.95 (0.88-1.02)	0.167			0.94 (0.87-1.02)	0.111	
	Education (ref. primary)										
	<i>Secondary</i>						1.09 (1.02-1.16)	0.008	1.08 (1.01-1.15)	0.023	
	<i>Tertiary</i>						1.32 (1.20-1.44)	<0.001	1.31 (1.19-1.43)	<0.001	
33	Age x Education (ref. primary)										
	<i>Age x Secondary</i>						1.01 (0.96-1.07)	0.719	1.02 (0.96-1.08)	0.586	
	<i>Age x Tertiary</i>						1.03 (0.95-1.13)	0.449	1.05 (0.96-1.15)	0.318	
34	Age2 x Education (ref. primary)										
	<i>Age2 x Secondary</i>						1.06 (1.02-1.10)	0.006	1.07 (1.03-1.11)	0.001	
	<i>Age2 x Tertiary</i>						1.01 (0.95-1.07)	.694	1.02 (0.96-1.09)	0.433	
35	Main occupational position (ref. low skill)										
	<i>High skill</i>						1.15 (1.08-1.22)	<0.001	1.16 (1.08-1.23)	<0.001	
	<i>Never worked</i>						0.72 (0.65-0.79)	<0.001	0.73 (0.67-0.80)	<0.001	
36	Age x Main occupational position (ref. low skill)										
	<i>Age x High skill</i>						1.03 (0.97-1.10)	0.329	1.05 (0.98-1.12)	0.187	
	<i>Age x Never worked</i>						0.96 (0.89-1.04)	0.317	0.96 (0.88-1.04)	0.327	
37	Age2 x Main occupational position (ref. low skill)										
	<i>Age2 x High skill</i>						0.93 (0.89-0.97)	0.001	0.93 (0.89-0.98)	0.002	
	<i>Age2 x Never worked</i>						1.01 (0.95-1.07)	0.759	1.01 (0.95-1.07)	0.822	
38	Satisfaction with Income (ref. with great difficulty)										
	<i>With some difficulty</i>						1.45 (1.32-1.58)	<0.001	1.45 (1.32-1.58)	<0.001	
	<i>Fairly easily</i>						1.85 (1.69-2.02)	<0.001	1.84 (1.69-2.01)	<0.001	
	<i>Easily</i>						1.45 (1.32-1.58)	<0.001	2.53 (2.31-2.77)	<0.001	
39	Age x Satisfaction with Income (ref. with great difficulty)										
	<i>Age x With some difficulty</i>						1.06 (0.97-1.16)	0.231	1.05 (0.96-1.16)	0.283	
	<i>Age x Fairly easily</i>						1.04 (0.96-1.14)	0.338	1.04 (0.95-1.14)	0.378	
	<i>Age x Easily</i>						1.08 (0.99-1.18)	0.094	1.08 (0.99-1.18)	0.101	
40	Age2 x Satisfaction with Income (ref. with great difficulty)										
	<i>Age2 x With some difficulty</i>						1.00 (0.94-1.06)	0.977	1.00 (0.94-1.06)	0.965	
	<i>Age2 x Fairly easily</i>						0.97 (0.92-1.03)	0.298	0.97 (0.92-1.03)	0.350	
	<i>Age2 x Easily</i>						0.95 (0.90-1.01)	0.084	0.96 (0.90-1.01)	0.144	
42	Attrition (ref. no drop out)										
	Drop out	0.83 (0.78-0.90)	<0.001	0.85 (0.79-0.91)	<0.001	0.85 (0.79-0.91)	<0.001	0.88 (0.81-0.94)	<0.001	0.87 (0.81-0.94)	<0.001
	Death	0.43 (0.39-0.47)	<0.001	0.44 (0.40-0.48)	<0.001	0.44 (0.40-0.48)	<0.001	0.47 (0.43-0.51)	<0.001	0.47 (0.43-0.51)	<0.001
43	Birth cohort (ref. born after 1945)										
	1939 to 1945	1.12 (1.05-1.18)	<0.001	1.12 (1.05-1.18)	<0.001	1.12 (1.05-1.18)	<0.001	1.12 (1.06-1.19)	<0.001	1.89 (1.66-2.15)	<0.001
	1929 to 1938	1.34 (1.24-1.45)	<0.001	1.36 (1.25-1.46)	<0.001	1.35 (1.25-1.46)	<0.001	1.39 (1.29-1.51)	<0.001	1.42 (1.31-1.54)	<0.001
	1919 to 1928	1.77 (1.56-2.02)	<0.001	1.79 (1.57-2.03)	<0.001	1.79 (1.57-2.03)	<0.001	1.87 (1.64-2.12)	<0.001	1.89 (1.66-2.15)	<0.001
44	Countries (ref. Belgium)										
	Austria	1.31 (1.19-1.45)	<0.001	1.31 (1.19-1.44)	<0.001	1.29 (1.17-1.42)	<0.001	1.24 (1.12-1.37)	<0.001	1.24 (1.13-1.37)	<0.001
	Denmark	2.94 (2.65-3.26)	<0.001	2.82 (2.55-3.13)	<0.001	2.79 (2.52-3.09)	<0.001	2.48 (2.24-2.74)	<0.001	2.50 (2.25-2.77)	<0.001
	France	1.03 (0.94-1.13)	0.527	1.04 (0.95-1.14)	0.403	1.02 (0.93-1.12)	0.624	1.11 (1.01-1.21)	0.03	1.11 (1.01-1.22)	0.023
	Germany	1.79 (1.63-1.97)	<0.001	1.77 (1.61-1.94)	<0.001	1.75 (1.59-1.93)	<0.001	1.68 (1.53-1.84)	<0.001	1.69 (1.54-1.86)	<0.001
	Greece	0.69 (0.63-0.76)	<0.001	0.74 (0.67-0.81)	<0.001	0.72 (0.66-0.80)	<0.001	1.10 (0.99-1.21)	0.071	1.09 (0.99-1.21)	0.086
	Israel	1.00 (0.88-1.13)	0.978	0.98 (0.86-1.12)	0.78	0.96 (0.85-1.09)	0.552	1.15 (1.01-1.31)	0.032	1.14 (1.00-1.30)	0.042
	Italy	0.45 (0.42-0.49)	<0.001	0.49 (0.45-0.53)	<0.001	0.48 (0.44-0.52)	<0.001	0.64 (0.59-0.70)	<0.001	0.64 (0.59-0.70)	<0.001
	Netherlands	2.54 (2.22-2.91)	<0.001	2.50 (2.18-2.85)	<0.001	2.46 (2.16-2.82)	<0.001	2.34 (2.05-2.67)	<0.001	2.35 (2.06-2.69)	<0.001
	Spain	1.04 (0.95-1.13)	0.421	1.08 (0.99-1.18)	0.07	1.07 (0.98-1.16)	0.144	1.33 (1.22-1.45)	<0.001	1.34 (1.22-1.46)	<0.001
	Sweden	3.63 (3.28-4.01)	<0.001	3.45 (3.12-3.82)	<0.001	3.41 (3.09-3.77)	<0.001	3.23 (2.92-3.57)	<0.001	3.25 (2.93-3.59)	<0.001
	Switzerland	2.14 (1.93-2.38)	<0.001	2.10 (1.89-2.33)	<0.001	2.08 (1.87-2.31)	<0.001	1.99 (1.79-2.21)	<0.001	2.00 (1.79-2.22)	<0.001
	Czech Republic	0.81 (0.75-0.89)	<0.001	0.79 (0.72-0.86)	<0.001	0.77 (0.70-0.84)	<0.001	0.87 (0.79-0.95)	0.002	0.86 (0.79-0.95)	0.002
	Ireland	1.57 (1.20-2.04)	0.001	1.53 (1.18-1.99)	0.002	1.50 (1.15-1.94)	0.003	1.63 (1.25-2.11)	<0.001	1.63 (1.25-2.13)	<0.001

Poland	0.48 (0.43-0.54)	<0.001	0.50 (0.45-0.56)	<0.001	0.49 (0.44-0.55)	<0.001	0.63 (0.56-0.70)	<0.001	0.62 (0.56-0.70)	<0.001
Estonia	1.38 (1.25-1.52)	<0.001	1.33 (1.20-1.47)	<0.001	1.30 (1.18-1.44)	<0.001	1.49 (1.34-1.65)	<0.001	1.49 (1.34-1.65)	<0.001
Hungary	0.61 (0.46-0.82)	0.001	0.59 (0.44-0.78)	<0.001	0.58 (0.43-0.77)	<0.001	0.80 (0.60-1.06)	0.12	0.79 (0.60-1.06)	0.115
Portugal	0.38 (0.29-0.49)	<0.001	0.40 (0.31-0.52)	<0.001	0.40 (0.31-0.51)	<0.001	0.56 (0.43-0.72)	<0.001	0.55 (0.43-0.71)	<0.001
Slovenia	1.96 (1.74-2.20)	<0.001	2.01 (1.78-2.26)	<0.001	1.98 (1.76-2.22)	<0.001	2.36 (2.10-2.66)	<0.001	2.37 (2.11-2.68)	<0.001
Luxembourg	1.66 (1.37-2.01)	<0.001	1.65 (1.36-2.00)	<0.001	1.64 (1.36-1.99)	<0.001	1.65 (1.36-1.99)	<0.001	1.65 (1.36-2.00)	<0.001
Croatia	1.02 (0.87-1.19)	0.802	1.12 (0.95-1.31)	0.166	1.02 (0.88-1.20)	0.760	1.49 (1.27-1.75)	<0.001	1.51 (1.28-1.77)	<0.001

Table S3. Summary of the sensitivity and robustness analyses

	Description	Rationale and main results
	Sensitivity analyses	
1	Excluding 2,504 participants with dementia	<p>Rationale Respondents with dementia may bias the observed associations.</p> <p>Main results Results were consistent with those of the main analysis. In brief,</p> <ol style="list-style-type: none"> 1) Women were less likely to be physically active than men, and were more likely to show a steeper decline across aging than men. 2) Cultural aspects of disadvantaged early-life SEC, but not material aspects of disadvantaged early-life SEC (although $p = .056$ for housing quality), were associated with a lower probability of physical activity and with a steeper decline of this probability across aging. 3) The associations between one dimension of cultural aspects of disadvantaged early-life SEC (i.e., main breadwinner), but not material aspects of disadvantaged early-life SEC, and the probability of physical activity were more pronounced in women than in men (although $p = .079$). The association between the other dimension of cultural aspects of disadvantaged early-life SEC (i.e., number of books) was not significantly moderated by sex ($p = .119$) 4) The associations between cultural aspects of disadvantaged early-life SEC and the probability of physical activity were attenuated after adjustment for adult-life SEC. 5) In the fully adjusted model, one cultural aspect of disadvantaged early-life SEC (number of books) remained significantly associated with the probability of physical activity in women, while these associations were not significant in men (although $p = .074$ for number of books in men).

2	Excluding 3,013 participants who died during follow-up	<p>Rationale Respondents who died during the follow-up were likely to have poorer health status (selective attrition).</p> <p>Main results Results were consistent with those of the main analysis.</p> <ol style="list-style-type: none"> 1) Women were less likely to be physically active than men, and were more likely to show a steeper decline across aging than men. 2) Cultural aspects of disadvantaged early-life SEC were associated with a lower probability of physical activity and with a steeper decline of this probability across aging. Poor housing quality, but not overcrowding, was associated with a higher probability of physical activity and with a steeper decline of this probability across aging 3) The associations between one dimension of cultural aspects of disadvantaged early-life SEC (i.e., main breadwinner), but not material aspects of disadvantaged early-life SEC, and the probability of physical activity were more pronounced in women than in men. The association between the other dimension of cultural aspects of disadvantaged early-life SEC (i.e., number of books) was not significantly moderated by sex ($p = .173$) 4) The associations between cultural aspects of disadvantaged early-life SEC and the probability of physical activity were attenuated after adjustment for adult-life SEC. 5) In the fully adjusted model, one cultural aspect of disadvantaged early-life SEC (number of books) remained significantly associated with the probability of physical activity in women, while in men only the association between number of book and physical activity was significant.
3	Excluding 7,234 participants who dropped out during follow-up	<p>Rationale Respondents who dropped during the follow-up were likely to have specific characteristics that may bias the associations observed (selective attrition).</p> <p>Main results Results were consistent with those of the main analysis.</p> <ol style="list-style-type: none"> 1) Women were less likely to be physically active than men, and were more likely to show a steeper decline across aging than men.

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- 2) Cultural aspects of disadvantaged early-life SEC, but not material aspects of disadvantaged early-life SEC, were associated with a lower probability of physical activity and with a steeper decline of this probability across aging. Poor housing quality was associated with a steeper decline of this probability across aging
 - 3) The associations between Cultural aspects of disadvantaged early-life SEC, but not material aspects of disadvantaged early-life SEC and the probability of physical activity were more pronounced in women than in men (although $p = .076$ for number of books).
 - 4) The associations between cultural aspects of disadvantaged early-life SEC and the probability of physical activity were attenuated after adjustment for adult-life SEC.
 - 5) In the fully adjusted model, one cultural aspect of disadvantaged early-life SEC (number of books) remained significantly associated with the probability of physical activity in women, but not in men.
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Robustness analysis

Rationale

To ensure the robustness of the main results, we tested the models with a different cut-point of the physical activity scale.

Cut-point:

Participants who answered “hardly ever or never” were classified as “physically inactive”, whereas the other participants were classified as “physically active”.

The objective of this cut-off was to reduce a potential misclassification bias in which physically active participants would be classified as physically inactive (i.e., the opposite bias to the one minimized in the main analysis).

Main results

Results were consistent with those of the main analysis.

Women were less physically active than men, and showed a steeper decline of the probability of physical activity across aging. Cultural aspects of disadvantaged early-life SEC were associated with lower probability of physical activity and with a steeper linear decrease in the probability of physical activity across aging. Material aspects of disadvantaged early-life SEC were not associated with the probability of physical activity.

The associations between cultural aspects of disadvantaged early-life SEC and the probability of physical activity were more pronounced in women than in men (although the interaction was marginal for number of books, $p=.083$). As in the main analysis, number of books was associated with lower probability of physical activity in both men and women (OR=.74, $p < .001$ in men and OR=.64, $p < .001$ in women), while the negative association between occupation of the main breadwinner and the probability of physical activity was only observed in women (OR=.96, $p = .602$ in men and OR=.79, $p < .001$ in women).

Sex and number of books, but not occupation of the main breadwinner, remained associated with probability of physical activity, after adjustments for adult-life SEC. The associations between cultural aspects of disadvantaged early-life SEC and the probability of physical activity remained more pronounced in women than in men (although the effect of the number of books remained marginal, $p = .091$). In this fully adjusted model, both occupation of the main breadwinner (OR=.89, $p = .014$) and number of books (OR=.84, $p < .001$) remained significantly associated with the probability of physical activity in women, while only the number of books (OR=.92, $p = .044$) remained associated with the probability of physical activity in men.
