Effect of Early- and Adult-Life Socioeconomic Circumstances on Physical Inactivity

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ABSTRACT

CHEVAL, B., S. SIEBER, I. GUESSOUS, D. ORSHOLITS, D. S. COURVOISIER, M. KLIEGEL, S. STRINGHINI, S. P. SWINNEN, C. BURTON-JEANGROS, S. CULLATI, and M. P. BOISGONTIER. Effect of Early- and Adult-Life Socioeconomic Circumstances on Physical Inactivity. *Med. Sci. Sports Exerc.*, Vol. 50, No. 3, pp. 476–485, 2018. **Purpose**: This study aimed to investigate the associations between early- and adult-life socioeconomic circumstances and physical inactivity (level and evolution) in aging using large-scale longitudinal data. **Methods**: This study used the Survey of Health Ageing and Retirement in Europe, a 10-yr population-based cohort study with repeated measurements in five waves, every 2 yr between 2004 and 2013. Self-reported physical inactivity (waves 1, 2, 4, and 5), household income (waves 1, 2, 4, and 5), educational attainment (wave of the first measurement occasion), and early-life socioeconomic circumstance (wave 3) were collected in 22,846 individuals 50 to 95 yr of age. **Results**: Risk of physical inactivity was increased for women with the most disadvantaged early-life socioeconomic circumstances (odds ratio [OR], 1.49; 95% confidence interval [CI], 1.20–1.86). With aging, the risk of physical inactivity increased for both sexes and was strongest for those with the most disadvantaged early-life socioeconomic circumstances (OR, 1.04 (95% CI, 1.02–1.06) for women; OR, 1.02 (95% CI, 1.00–1.05) for men), with the former effect being more robust than the latter one. The association between early-life socioeconomic circumstances and physical inactivity was mediated by adult-life socioeconomic circumstances, with education being the strongest mediator. **Conclusions**: Early-life socioeconomic circumstances predicted high levels of physical inactivity at older ages, but this effect was mediated by socioeconomic indicators in adult life. This finding has implications for public health policies, which should continue to promote education to reduce physical inactivity in people at older ages and to ensure optimal healthy aging trajectories, especially among women with disadvantaged early-life socioeconomic circumstances. **Key Words:** HEALTH, SOCIOECONOMIC STATUS, AGING, PHYSICAL INACTIVITY

Each year, physical inactivity is responsible for 13 million disability-adjusted life-years (1) and 1.9 million deaths worldwide (2) and costs 67.5 billion international dollars (1). Conversely, physical activity has been shown to reduce medical costs (3), disability (4), morbidity (5,6), and mortality (7,8). As a result, regular physical activity has been promoted (9) and defined as a global health priority (10). Along with factors such as age and sex, socioeconomic circumstances (SEC) have been found to be a major determinant of physical activity. Adults from lower socioeconomic groups engage in physical activity less often than do those from higher socioeconomic groups (11,12). Blue-collar workers, in particular, are more likely to be inactive as compared with white-collar workers/professionals (13). Moreover, this occupational variability is not explained by time spent in paid work (14). People with less education are more likely to decrease their level of physical activity with aging than are people with higher education (15,16). Finally, people living in poor housing conditions more frequently show age-related declines in physical activity (15).

A recent systematic review suggested that the effect of socioeconomic position on physical activity patterns may already originate in childhood, with disadvantaged early-life SEC associated with low levels of physical activity in adult

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Submitted for publication July 2017.
Accepted for publication October 2017.

0195-9131/18/5003-0476/0
MEDICINE & SCIENCE IN SPORTS & EXERCISE®

DOI: 10.1249/MSS.0000000000001472

life (17). Specifically, physical activity in adult-life seems to be associated with level of parental education (18) and childhood household amenities (18,19). However, previous studies investigating the associations between early-life SEC and physical activity patterns in adult life have generally relied on cross-sectional data or data with a short follow-up (17). Thus, evidence of causality between early-life SEC and physical activity, and especially the decline in physical activity as people age, is relatively weak. In addition, previous studies used crude assessments of early-life SEC (e.g., on the basis of a limited number of indicators) (20,21), and misclassification bias may have diluted the estimated effect of early-life SEC on physical activity in adult life. Moreover, to the best of our knowledge, no study has examined how early-life conditions are associated with physical activity patterns in old age. Thus, solid evidence on the associations between early-life SEC and life-course trajectories of physical inactivity and its predictive pathways is still lacking.

The objective of this study is to investigate, on a large scale and longitudinally, the associations between accurate measures of early- and adult-life SEC and the level of and change in physical inactivity as adults grow older. We used data of 22,846 people 50 to 95 yr of age from the Survey of Health Ageing and Retirement in Europe (SHARE), a 10-yr population-based cohort study with repeated measurements in five waves, every 2 yr between 2004 and 2016.

METHODS

Study Design and Participants

Data were retrieved from SHARE, which has been previously described in detail (22). In brief, SHARE is a longitudinal and cross-national database with health and socioeconomic information from 108,420 participants 50 yr and older across 27 European countries. SHARE includes five waves of data that were collected every 2 yr between 2004 and 2013, with some participants having started the study at wave 1 (i.e., in 2004) and others later. In the current study, we used all five waves, but not all variables were measured at each wave. Especially, retrospective life-course data on early-life SEC and main occupation position during adult-life were assessed in the third wave, self-reported maximal education attainment was measured at participants' first measurement occasion, and self-reported physical activity and household income were assessed at the first, second, fourth, and fifth waves. For the current analysis, we included data for individuals 50 to 95 yr of age who participated in the third wave and had at least one measure of self-reported physical activity. SHARE was approved by the relevant research ethics committees in the participating countries, and all participants provided written informed consent (22).

Measures

Early-life SEC. Early-life SEC was determined according to the measure of childhood circumstances by Wahrendorf and Blane (23). This measure was constructed as an index combining four binary indicators of adverse socioeconomic conditions during early life. Each indicator reflects specific conditions of participants at the age of 10 yr. These four items are relevant to assess the long-term effects of early-life SEC on health (24–26). The four indicators were built as follows. First, the occupational position of the main breadwinner was constructed on the basis of a reclassification of the 10 main occupational groups of the International Standard Classification of Occupations (ISCO) according to their skill levels (27). The first and second levels were grouped as ''low'' occupational position, and the third and fourth levels were grouped as ''high'' occupational position. Second, a binary item was constructed for the number of books at home, with ''0–10 books'' being an indicator of social disadvantage (25). Third, the information related to the number of people living in the household and number of rooms (excluding kitchen, bathrooms, and hallways) were combined to construct a measure of overcrowding (i.e., more than one person per room living in the respective household) (26). Fourth, the quality of the household was assessed by presence of a fixed bath, cold running water supply, hot running water supply, inside toilet, and central heating. If none of these were present, the household was coded as ''disadvantaged'' (24). By combining the information for these four indicators, we computed a five-level categorical variable ranging from ''most disadvantaged'' to ''most advantaged.''

Prior confounders. To examine the relationship between early-life SEC and physical inactivity, prior confounding variables potentially associated with both variables were included in all models. Specifically, the following variables were included: body mass index (BMI), birth cohort (war (between 1914 and 1918 and between 1939 and 1945)/the Great Depression (between 1929 and 1928)/no war and no economic crisis (before 1913, between 1919 and 1938, and after 1945)), living with biological parents (both parents/one biological parent/no biological parents), and participant attrition (no dropout/dropout (participants who did not respond to both waves 4 and 5)/death (participants who died during the survey)). All models were stratified by sex.

Adult-life SEC. The added potential mediators were participants' maximal educational attainment, main occupational position during adult life, and household income. The highest educational attainment was based on the International Standard Classification of Education. A tertiary education level was classified as high educational level, and not reaching tertiary education level was classified as low educational level. The main occupational position was based on the ISCO classification (grouped as low and high occupational position, described previously; participants ''who have never done paid work'' were included in the low occupational position). Satisfaction with household income was based on the rating of the question ''Is the household able to make ends meet?'' with a scale ranging from 1 (''with great difficulty'') to 4 (''easily''). We used the mode of this variable to obtain a measure of global satisfaction with household income during adult life.

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Outcome

Two items were used to assess the level of daily life physical activity (28,29). The first item assessed vigorous physical activity (‘‘How often do you engage in vigorous physical activity, such as sports, heavy housework, or a job that involves physical labour?’’). The second item assessed moderate physical activity (‘‘How often do you engage in activities that require a low or moderate level of energy such as gardening, cleaning the car, or doing a walk?’’). Participants answered by using a four-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 ‘‘1’’ to either items were classified as ‘‘physically inactive.’’ This strategy was used to reduce a potential misclassification bias in which physical inactive participants would be classified as physically active. However, the models were also tested using other cutoff points (see the Robustness Analyses section).

Statistical Analysis

Data were analyzed using logistic mixed-effects models, a type of mixed model that was developed to account for the nested structure of the data (e.g., multiple observations within a single participant), thereby providing accurate parameter estimates with acceptable type I error rates (30). Here, observations were nested within participants and participants were nested within countries. Thus, mixed-effects models were required to correctly model the structure of the data. Mixed-effects models do not require an equal number of observations from all participants, which avoids excluding participants with missing observations (31). To identify the best random structure, nested models with various random effects were tested and assessed on the basis of the Bayesian information criterion and likelihood ratio tests. The best random structure encompassed random intercepts for participants and countries, and a random linear slope of age for subjects. Including these random effects in the models resulted in correct estimations of the fixed effects and their associated P values, despite dependent data. Because sex has been shown to influence the relationship between SEC and physical inactivity (14,32,33), women and men were investigated separately. In model 1, the association between early-life SEC and the probability of physical inactivity was examined, adjusting for prior confounders, estimating odds ratios (OR) and 95% confidence intervals (CI), with the most advantaged early-life SEC as a reference group. Age was centered at the midpoint of the sample’s age range (i.e., 73 yr). In addition, interaction terms between early-life SEC and age were included to test whether early-life SEC moderated the adverse effect of aging on physical inactivity. In model 2, education, main occupational conditions, and household income, as well as their interactions with age, were added as potential mediators in the model. The percentage decrease in the effect of early-life SEC on the probability of physical inactivity between models without (model 1) and with (model 2) the mediating variables was calculated as follows: $100(b_{\text{Model 1}} - b_{\text{Model 2}})/b_{\text{Model 1}}$. These percentages provided an estimate of the proportional influence of the potential mediating variables on the relation between early-life SEC and physical inactivity.

Sensitivity Analyses

We performed the following four sensitivity analyses: 1) excluding participants older than 90 yr because above this age, observations within each early-life SEC were very sparse; 2) excluding participants who died during the survey; 3) excluding participants who dropped out; and 4) excluding participants with at least two chronic health conditions.

Robustness Analyses

We performed two robustness analyses. In the first one, participants who answered ‘‘4’’ (‘‘hardly ever or never’’) to both moderate and vigorous items were classified as ‘‘physically inactive.’’ This strategy was used to reduce a potential misclassification bias in which physically active participants would be classified as physical inactive (i.e., the reverse bias to the one avoided in the main analysis). In the second one, participants who did not answer ‘‘1’’ or ‘‘2’’ to either item were classified as ‘‘physically inactive.’’ This cutoff is used to test a potential misclassification bias between the ones associated with the main analysis and the first robustness analysis.

RESULTS

Study participants. From the SHARE study, we investigated a sample of 22,846 participants (63,845 observations; 12,711 women) 50 to 95 yr of age (midpoint of the age range, 73 yr) living in 14 European countries (Austria, Belgium, Czech Republic, Denmark, France, Germany, Greece, Ireland, Italy, the Netherlands, Poland, Spain, Sweden, and Switzerland). This sample is described in Table 1 and stratified by sex and early-life SEC. Results revealed a gradient between early-life SEC and probability of physical inactivity. For women, the proportion of physical inactivity was lower with the most advantaged than most disadvantaged early-life SEC (18% vs 36%). For men, these data were 18% versus 27%. The probability of physical inactivity at baseline (i.e., first measurement occasion) was associated with older age, female sex, increased BMI, disadvantaged early-life SEC, low level of education, low income, and low main occupational position (all $P < 0.001$). During follow-up, 5243 of the 22,846 participants dropped out and 1167 died. Participants who dropped out or died were overrepresented in the groups with disadvantaged early-life SEC versus advantaged early-life SEC ($P < 0.001$) and were overrepresented among participants physically inactive ($P < 0.001$). To statistically control for these differences, participant attrition was included as a covariate in all analyses.

Effect of early-life SEC on physical inactivity. In Table 2 (model 1), we present results for the association

TABLE 1. Participant characteristics by sex and early-life SEC: most advantaged, advantaged, middle, disadvantaged, and most disadvantaged.

	Women (n = 12,711)					Men (n = 10,135)				
	Most Advantaged (n = 709)	Advantaged (n = 2328)	Middle (n = 4141)	Disadvantaged (n = 3184)	Most Disadvantaged (n = 2349)	Most Advantaged (n = 585)	Advantaged (n = 1911)	Middle (n = 3190)	Disadvantaged (n = 2504)	Most Disadvantaged (n = 1945)
Outcome										
Physical activity										
Physically active	580 (82%)	1857 (80%)	3145 (76%)	2300 (72%)	1510 (64%)	477 (82%)	1545 (81%)	2537 (80%)	1877 (75%)	1420 (73%)
Physically inactive	129 (18%)	471 (20%)	996 (24%)	884 (28%)	839 (36%)	108 (18%)	366 (19%)	653 (20%)	627 (25%)	525 (27%)
Prior confounders										
Age, yr (SD)	60.6 (9.4)	60.5 (9.1)	61.2 (9.1)	63.7 (9.6)	66.6 (9.6)	62.0 (9.1)	60.8 (8.5)	61.6 (8.7)	63.5 (9.0)	66.5 (9.1)
BMI	24.8 (4.12)	25.6 (4.4)	26.3 (4.6)	26.8 (4.5)	27.4 (4.6)	26.0 (3.5)	26.6 (3.7)	27.0 (3.7)	27.2 (3.7)	27.2 (3.8)
Birth cohort										
No war and no economic crisis	437 (62%)	1426 (61%)	2417 (58%)	1607 (50%)	1049 (45%)	318 (55%)	1118 (58%)	1745 (55%)	1201 (78%)	755 (39%)
War	159 (22%)	527 (23%)	968 (24%)	782 (25%)	534 (23%)	154 (26%)	458 (24%)	764 (24%)	640 (26%)	484 (25%)
Economic crisis	113 (16%)	375 (16%)	756 (18%)	795 (25%)	766 (32%)	113 (19%)	335 (18%)	681 (21%)	663 (26%)	706 (36%)
Living with biological parents										
Both parents	644 (91%)	2099 (90%)	3765 (91%)	2847 (90%)	2120 (90%)	528 (90%)	1720 (90%)	2890 (90%)	2281 (91%)	1772 (91%)
One biological parent	46 (6%)	176 (8%)	297 (7%)	266 (8%)	192 (8%)	44 (8%)	149 (8%)	243 (8%)	183 (7%)	146 (8%)
No biological parent	19 (3%)	53 (2%)	79 (2%)	71 (2%)	37 (2%)	13 (2%)	42 (2%)	57 (2%)	40 (2%)	27 (1%)
Attrition										
No dropout	592 (83%)	1855 (80%)	3118 (75%)	2163 (68%)	1572 (67%)	452 (77%)	1470 (77%)	2317 (73%)	1674 (67%)	1223 (63%)
Dropout	91 (13%)	405 (17%)	870 (21%)	881 (28%)	624 (27%)	100 (17%)	343 (18%)	702 (22%)	677 (27%)	550 (28%)
Death	26 (4%)	68 (3%)	153 (4%)	140 (4%)	153 (6%)	33 (6%)	98 (5%)	171 (5%)	153 (6%)	172 (9%)
Adult socioeconomic status										
Level of education, yr	14.4 (3.5)	12.4 (3.6)	11.1 (3.6)	8.9 (3.6)	7.0 (3.5)	15.5 (3.6)	13.4 (3.9)	11.9 (4.0)	9.8 (3.9)	8.0 (3.8)
Main occupation class[a]										
Low skill	351 (49%)	1628 (70%)	3414 (82%)	2933 (92%)	2269 (97%)	178 (30%)	943 (49%)	2074 (65%)	2021 (81%)	1748 (90%)
High skill	358 (51%)	700 (30%)	727 (18%)	251 (8%)	80 (3%)	407 (70%)	968 (51%)	1116 (35%)	483 (19%)	197 (10%)
Income[b]	3.2 (0.7)	3.1 (0.8)	2.9 (0.8)	2.6 (0.9)	2.3 (0.8)	3.4 (0.7)	3.2 (0.7)	3.0 (0.8)	2.7 (0.9)	2.4 (0.9)

[a]Reclassification of the 10 main occupational groups of the ISCO according to skill level, into low and high position (34).
[b]"Is household able to make ends meet," continuous, from 1, with great difficulty, to 4, easily.

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TABLE 2. Risk of physical inactivity with early- and adult-life SEC at older age.

	Women (*n* = 12,711)				Men (*n* = 10,135)			
	Model 1		Model 2		Model 1		Model 2	
Variables	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***
Age	1.06 (1.05–1.08)	<**0.001**	1.05 (1.04–1.07)	<**0.001**	1.05 (1.03–1.07)	<**0.001**	1.06 (1.04–1.08)	<**0.001**
BMI	1.08 (1.07–1.09)	<**0.001**	1.07 (1.06–1.08)	<**0.001**	1.06 (1.05–1.08)	<**0.001**	1.06 (1.05–1.07)	<**0.001**
Birth cohort								
No war and no economic crisis	(Reference)		(Reference)		(Reference)		(Reference)	
War	0.83 (0.75–0.91)	<**0.001**	0.84 (0.77–0.93)	**0.001**	0.87 (0.77–0.97)	**0.015**	0.90 (0.80–1.01)	0.068
Economic crisis	0.81 (0.73–0.89)	<**0.001**	0.81 (0.73–0.90)	<**0.001**	0.74 (0.66–0.84)	<**0.001**	0.75 (0.67–0.85)	<**0.001**
Living with biological parents								
Both parents	(Reference)		(Reference)		(Reference)		(Reference)	
One biological parent	0.95 (0.83–1.09)	0.491	0.91 (0.80–1.04)	0.177	0.88 (0.74–1.03)	0.116	0.88 (0.74–1.03)	0.113
No biological parent	1.09 (0.85–1.39)	0.506	1.03 (0.80–1.31)	0.824	1.23 (0.89–1.69)	0.213	1.19 (0.87–1.65)	0.278
Attrition								
No dropout	(Reference)		(Reference)		(Reference)		(Reference)	
Dropout	1.17 (1.01–1.37)	**0.039**	1.10 (0.94–1.27)	0.235	1.17 (0.98–1.40)	0.074	1.11 (0.93–1.31)	0.258
Death	2.03 (1.67–2.46)	<**0.001**	1.91 (1.58–2.33)	<**0.001**	1.94 (1.61–2.34)	<**0.001**	1.85 (1.53–2.23)	<**0.001**
Early-life SEC								
Most advantaged	(Reference)		(Reference)		(Reference)		(Reference)	
Advantaged	1.14 (0.91–1.42)	0.259	1.01 (0.80–1.26)	0.957	1.07 (0.83–1.37)	0.598	1.00 (0.78–1.28)	0.994
Middle	1.34 (1.08–1.65)	**0.007**	1.12 (0.91–1.39)	0.285	0.98 (0.77–1.24)	0.848	0.88 (0.69–1.13)	0.319
Disadvantaged	1.47 (1.19–1.82)	<**0.001**	1.13 (0.91–1.41)	0.279	1.18 (0.93–1.50)	0.178	1.00 (0.78–1.29)	0.973
Most disadvantaged	1.49 (1.20–1.86)	<**0.001**	1.07 (0.85–1.35)	0.562	1.04 (0.81–1.33)	0.746	0.86 (0.66–1.11)	0.243
Age–early-life SEC								
Age–most advantaged	(Reference)		(Reference)		(Reference)		(Reference)	
Age–advantaged	1.01 (0.99–1.03)	0.177	1.01 (0.99–1.02)	0.554	1.01 (0.99–1.03)	0.521	1.00 (0.98–1.02)	0.942
Age–middle	1.01 (1.00–1.03)	0.110	1.01 (0.99–1.02)	0.572	1.01 (0.99–1.03)	0.568	0.99 (0.97–1.01)	0.546
Age–disadvantaged	1.03 (1.01–1.04)	**0.005**	1.01 (0.99–1.03)	0.199	1.02 (1.00–1.04)	0.122	1.00 (0.98–1.02)	0.921
Age–most disadvantaged	1.04 (1.02–1.06)	<**0.001**	1.02 (1.00–1.04)	**0.033**	1.02 (1.00–1.05)	0.038	1.00 (0.98–1.02)	0.981
Level of education			0.97 (0.96–0.99)	<**0.001**			0.99 (0.98–1.01)	0.500
Age–level of education			0.99 (0.99–1.00)	**0.022**			0.998 (0.996–0.999)	<**0.001**
Main occupational position								
High			(Reference)				(Reference)	
Low			1.18 (1.02–1.36)	**0.025**			1.09 (0.95–1.23)	0.216
Age–main occupational position								
Age–high position			(Reference)				(Reference)	
Age–low position			1.02 (1.00–1.03)	**0.007**			1.02 (1.00–1.03)	**0.009**
Income			0.71 (0.67–0.76)	<**0.001**			0.75 (0.70–0.81)	<**0.001**
Age–income			1.00 (0.99–1.00)	0.754			1.00 (1.00–1.01)	0.120

Significant *P* values are highlighted in bold.

between early-life SEC and physical inactivity in a logistic mixed-effects model adjusted for BMI, birth cohort, having lived with one's biological parents, and participant attrition.

For women, risk of physical inactivity at the midpoint of the age range was greater for those with the most disadvantaged (OR, 1.49; 95% CI, 1.20–1.86), disadvantaged (1.47; 1.19–1.82); and middle (1.34; 1.08–1.65) early-life SEC than the most advantaged early-life SEC (Table 2; Fig. 1). Interactions of the most disadvantaged and disadvantaged early-life SEC with age were significant, which indicated that early-life SEC moderated the effect of aging. More specifically, the adverse effects of aging were significantly greater for women who grew up in the most disadvantaged (1.04; 1.02–1.06) and disadvantaged (1.03; 1.01–1.04) early-life SEC than the most advantaged early-life SEC. The OR values for the adverse effect of aging on physical inactivity with the most disadvantaged and disadvantaged early-life SEC were 1.10 (1.08–1.12) and 1.09 (1.07–1.11) per year, respectively, versus 1.06 (1.05–1.08) per year with the most advantaged early-life SEC. Exploring the moderating effect of early-life SEC on age revealed that risk of physical inactivity significantly increased from ages 68 to 95 yr (1.24 (1.02–1.51) and 3.34 (1.95–5.72)) with the most disadvantaged early-life SEC and from ages 66 to 95 yr (1.23 (1.03–1.48) and 2.54 (1.50–4.30)) with disadvantaged early-life SEC (Fig. 2). In addition, risk of physical inactivity was greater for women born in a period without a world war or in the Great Depression (i.e., born before 1913, between 1919 and 1928, and after 1945) than for those born in a period of world war (i.e., born between 1914 and 1918 and between 1939 and 1945: 1.17; 1.09–1.25) or in the Great Depression (i.e., born between 1929 and 1938: 1.17; 1.11–1.27). Risk of physical inactivity was greater for women who dropped out (1.17; 1.01–1.37) or died (2.03; 1.67–2.46) during the survey compared with those who did not drop out and was increased with increasing BMI (1.08 (1.07–1.09) per unit increase in BMI).

For men, the results of the logistic mixed-effects model showed no effect of early-life SEC on risk of physical inactivity at the midpoint of the age range (all $P > 0.10$). The interaction between the most disadvantaged early-life SEC and age was significant, which indicates that early-life SEC influenced the effect of aging. The adverse effects of aging were significantly greater for men with the most disadvantaged than most advantaged early-life SEC (OR, 1.02; 95% CI, 1.00–1.05; model 1). For men, the OR for the adverse effect of aging on risk of physical inactivity was 1.07 (i.e.,

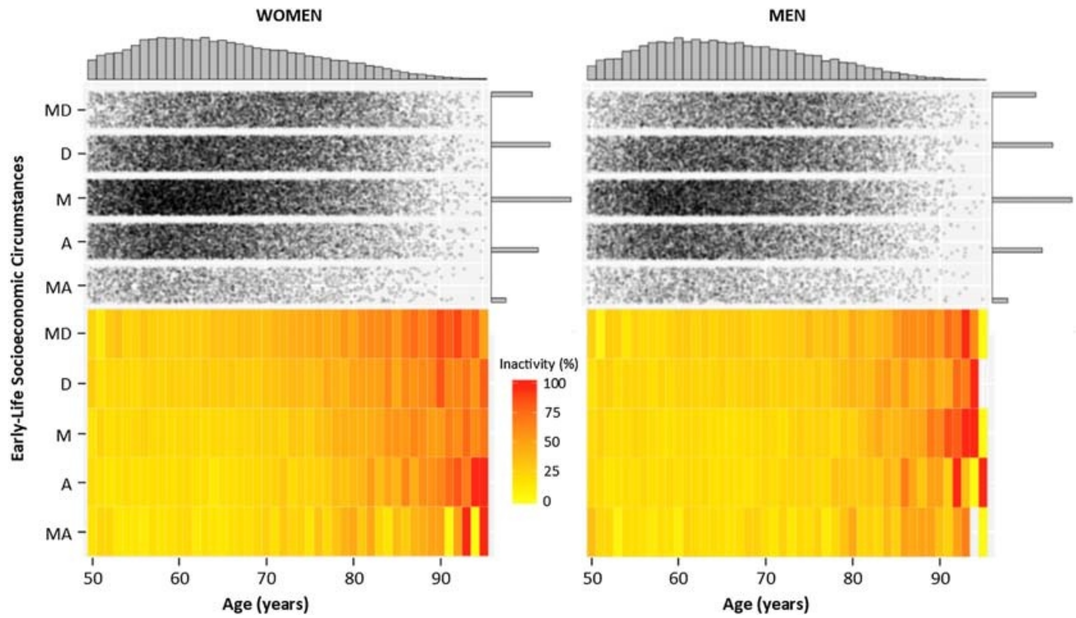

FIGURE 1—Physical inactivity: distribution and percentages across age as a function of early-life SEC at baseline. *Upper panel*: each dot represents an observation of a physically inactive participant stratified by early-life SEC and age. *Lower panel*: color coding indicates the relative prevalence of physical inactivity stratified by early-life SEC and age. A, advantaged; D, disadvantaged; M, middle; MA, most advantaged; MD, most disadvantaged.

1.05 × 1.02; 1.05–1.10) per year with the most disadvantaged early-life SEC versus 1.05 (1.03–1.07) per year with the most advantaged early-life SEC (Table 2; Fig. 2). However, exploring the moderating effect of early-life SEC on age revealed that the effect of the most disadvantaged early-life SEC on risk of physical inactivity was not significant from ages 50 to 95 yr (1.68 (0.91–3.10) at 95 yr; P = 0.097). In addition, risk of physical inactivity in old age was greater for men born in a period without a world war or in the Great Depression than those born in a period of world war (1.13;

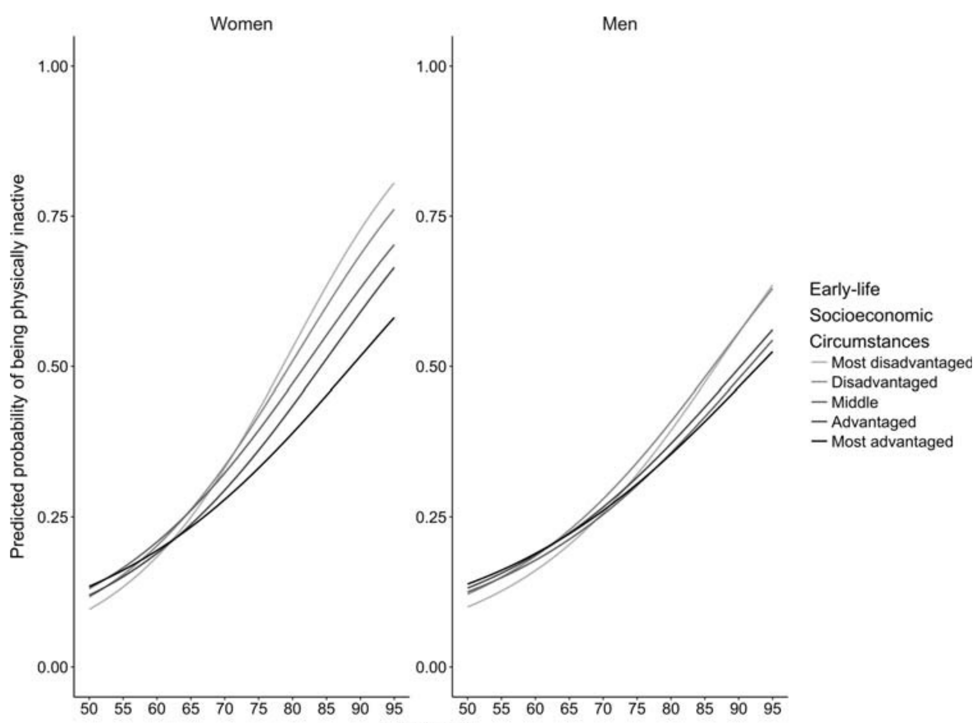

FIGURE 2—Predicted probability of risk of physical inactivity across age depending on early-life SEC.

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1.03–1.23) or in the Great Depression (1.26; 1.16–1.34). Risk of physical inactivity was greater for men who died or dropped out during the survey than those who did not die or drop out (1.94; 1.61–2.34) and was increased with increasing BMI (1.06 (1.05–1.08) per unit increase in BMI).

Effect of early- and adult-life SEC on physical inactivity. Table 2 (model 2) presents the association between indicators of adult-life SEC (education, main occupational position, and household income) and physical inactivity, thus assessing the mediating effect of these indicators on the association between early-life SEC and physical inactivity. For women, risk of physical inactivity was increased with low education (OR, 1.03 (95% CI, 1.01–1.04) per year of education), low main occupational position (1.18 (1.02–1.36)), and low household income (1.29 (1.24–1.33) per unit). The interactions of education and main occupational position with age were significant, which indicates that these two variables moderated the effect of aging. Particularly, the adverse effects of aging were significantly greater for women with low education (1.002 (1.001–1.003) per year of education) and with low main occupational position (1.02 (1.00–1.03)). The increasing risk of physical inactivity with aging was higher with low education (−1 SD) than with high education (+1 SD) (1.11 (1.10–1.12) vs 1.09 (1.09–1.10) per year, on average) and was higher with low than with high main occupational position (1.12 (1.11–1.13) vs 1.10 (1.09–1.11) per year, on average). Adding these indicators as potential mediators in the model including early-life SEC led to a 82.9% reduction in the effect of the most disadvantaged early-life SEC, a 68.4% reduction in that of disadvantaged early-life SEC, and a 59.6% reduction in that of middle early-life SEC. The effect of the most disadvantaged early-life SEC on the increasing risk of physical inactivity with aging was reduced by 41.5% and that of disadvantaged early-life SEC by 51.6%. Including each mediator separately and comparing the reduction of the effect of early-life SEC on physical inactivity revealed that education was the strongest mediator of the association of risk of physical inactivity and early-life SEC (see Fig. 3). The reduction of the OR toward the null (OR, 1.0) was much stronger for education than for income or main occupational position, although including all three mediators still resulted in a more complete mediation.

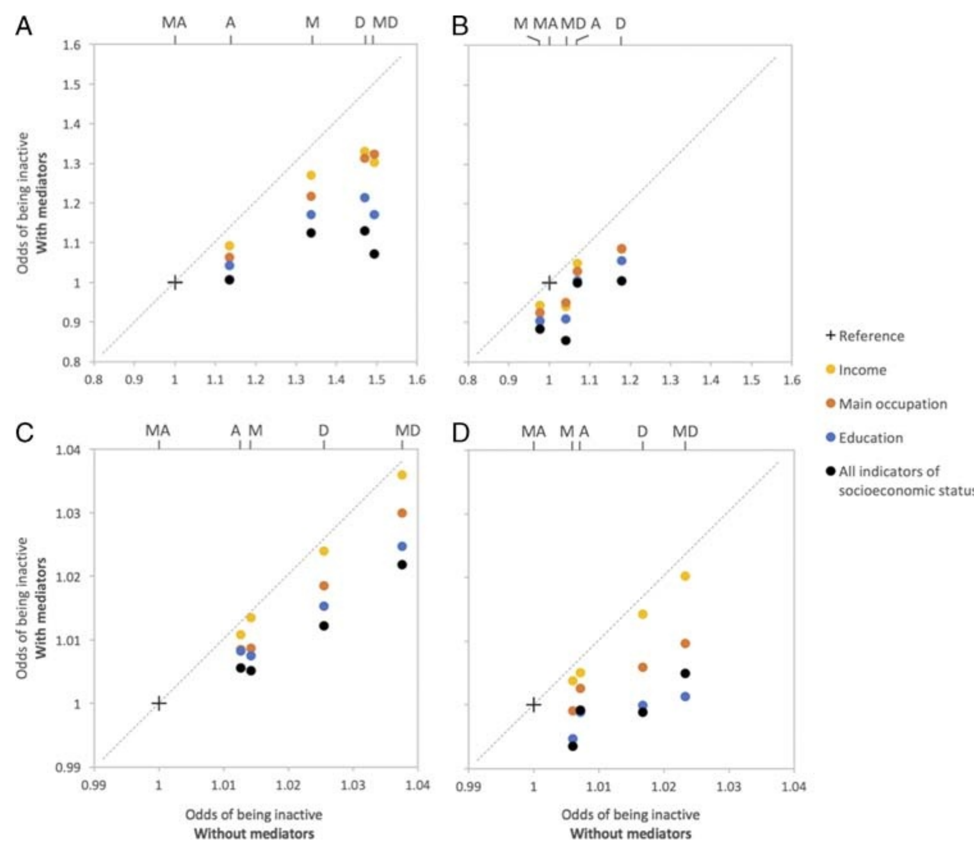

FIGURE 3—Effect of early-life SEC on the level of physical inactivity and its evolution with age mediated by the indicators of adult-life SEC (*black circles*): level of income (*yellow circles*), main occupational position (*orange circles*), and level of education (*blue circles*). *Above the dotted* line, the effect of early-life SEC increases when the indicators are included in the model (i.e., suppressive effect). *Below the dotted* line, the effect of early-life SEC decreases (i.e., mediating effect). Here, all the adult-life indicators mediated the association between the early-life SEC and the risk of physical inactivity, and the strongest mediator was the level of education. A, advantaged; D, disadvantaged; M, middle; MA, most advantaged (reference; *black plus sign*); MD, most disadvantaged. A and B, The mediating effect of indicators of adulthood socioeconomic status on risk of physical inactivity for women and men, respectively. C and D, The mediating effect of indicators of adulthood socioeconomic status on age-related increased risk of physical inactivity for women and men, respectively.

For men, risk of physical inactivity was associated with low household income (OR, 1.25 (95% CI, 1.19–1.30) per unit). The interactions of education and main occupational position with age were significant, which indicates that these two variables influenced the effect of aging. Specifically, the adverse effects of aging on physical inactivity were significantly greater for men with low education (1.002 (1.001–1.004) per year of education) and low occupational position (1.02 (1.00–1.03)). The increasing risk of physical inactivity with aging was higher with low education (−1 SD) than with high education (+1 SD) (1.06 (1.05–1.07) vs 1.04 (1.03–1.04) per year, on average) and was higher with low than with high occupational position (1.06 (1.05–1.08) vs 1.05 (1.03–1.06) per year, on average). Adding these indicators as potential mediators in the model including early-life SEC led to a 98.8% reduction in the effect of the most disadvantaged early-life SEC on aging trajectories. Including each mediator separately and comparing the reduction in the effect of early-life SEC on physical inactivity revealed that education was the strongest mediator of the association of risk of physical inactivity and early-life SEC (see Fig. 3).

Sensitivity analyses. Overall, the results of the sensitivity analyses were consistent with those of the main analyses, except for the interaction effect of the most disadvantaged early-life SEC with aging in men (results not shown). Specifically, for women, in all the sensitivity analyses, the effects of early-life SEC on risk of physical inactivity were significant. In addition, these associations became nonsignificant when the three adult-life socioeconomic indicators were added to the model.

For men, the significant interaction between the most disadvantaged early-life SEC and age became marginal or even nonsignificant in some sensitivity analyses, which suggests that the effect of early-life SEC on age-related increase in physical inactivity was less robust. However, the effect of adult-life socioeconomic indicators on risk of physical inactivity remained unchanged.

Robustness analyses. Overall, the results of the robustness analyses using different cutoff points to categorize participants as physically inactive were consistent with those of the main analyses, except for the effect of early-life SEC on the evolution of physical inactivity with aging, which became nonsignificant. These findings suggest that the effect of early- and adult-life SEC on risk of physical inactivity was robust across physical inactivity classifications but that the effect of these SEC predictors on the evolution of physical inactivity with aging was less consistent.

For men, the effect of most disadvantaged early-life SEC on risk of physical inactivity became marginal in the first robustness analysis and the effect of most disadvantaged and disadvantaged early-life SEC on the risk of physical inactivity became significant in the second robustness analysis. However, the significant interaction between the most disadvantaged early-life SEC and age became nonsignificant in both robustness analyses. Thus, like in women, findings suggest that the effect of early- and adult-life SEC on the evolution of physical inactivity with aging was less robust than their effect on the level of physical inactivity.

DISCUSSION

Main findings. In the present study, we investigated the associations between early- and adult-life SEC and the level of and change in physical inactivity with aging in 12,711 women and 10,135 men 50 to 95 yr of age. For the first time, we examined how early-life SEC may be associated with physical inactivity patterns in old age by using large-scale longitudinal data assessing socioeconomic factors with fine-grained measures reducing misclassification biases. We found the probability of physical inactivity increased with disadvantaged early-life SEC for women but not men. Disadvantaged early-life SEC was also associated with an increased risk of physical inactivity with aging for both sexes. However, this effect on the evolution of physical inactivity with aging was inconsistent across the tested classifications of physical inactivity.

In addition, the effect of early-life SEC was fully mediated by the three indicators of adult-life SEC (education, main occupational position, and household income) for both sexes. More in-depth investigation of the pathways revealed that education was the strongest mediator of the association of risk of physical inactivity and early-life SEC. These results suggest that early-life SEC, especially for women, was indirectly associated with risk of physical inactivity because of the mediating effect of individuals' SEC in adult life. In turn, these differences in the physical inactivity patterns may affect disability, morbidity, and mortality at older age (4–6,8).

Comparison with previous studies. Our findings support previous studies showing an association between early- and adult-life SEC and physical activity at older ages (11–16,35). The sex difference observed is consistent with previous results in adults showing a stronger relationship between socioeconomic status and level of physical inactivity for women than for men (14,32,33). This difference may be explained by the gendered social and cultural expectations that affect how these older cohorts of women engaged in physical activities during their life course (at school, in active life, and in leisure time). Our findings revealed that the effect of early-life SEC on physical inactivity at older ages is fully explained by adult-life SEC. These findings are consistent with the "causal pathways hypothesis," suggesting that the effect of early-life SEC on adult health behaviors results from early-life SEC via its effect on adult-life SEC and health behaviors (36). Our study therefore confirms that SEC across the life course is linked to adult health–related behaviors (37,38). Furthermore, the important role played by education in the mediating process supports the idea that education is a factor in reducing the adverse effects of disadvantaged early-life SEC on health-related behaviors in older adults, especially women. By contrast, the findings that early-life SEC is no longer associated with physical inactivity after controlling for adult-life SEC is not in line with the "accumulation hypothesis," suggesting that disadvantaged SEC across the whole life-course (from childhood to adulthood) has cumulative additive effects on health behaviors, such as physical activity (35,36). Our findings suggest, however, additive effects for the adult stage of the life-course SEC, through educational attainment (young adulthood), occupational position (adult active life), and household income at older age. This fits with the accumulation hypothesis but restricts its process to the adult part of the life-course SEC only. Our findings also suggest that, among women, a bad start in life can be compensated by the life course during adulthood, through education attainment, occupation, and later household income. This result is, however, less true for men, among which early-life SEC was not associated with physical activity.

Strengths and limitations of the study. Compared with previous research, this study is the first to investigate on a large scale and longitudinally the associations between accurate measures of early- and adult-life SEC and the level of and change in physical inactivity as adults grow older. However, several limitations of this study should be considered. First, our early- and adult-life SEC information was extracted from self-reported retrospective life-course data (wave 3) and may therefore be subject to recall bias or social desirability. Previous research suggested that such retrospective life-course data are likely to underestimate true effects (39). Accordingly, although some studies indicated a satisfactory validity of recall measures of socioeconomic status (40), the possibility that retrospective life-course data reduce the ability to detect significant associations requires cautious interpretation of nonsignificant associations. Second, physical inactivity was assessed by a self-reporting questionnaire, which may underestimate the prevalence of physical inactivity. However, because we were interested in comparing the relative difference in level of and change in physical inactivity with aging and early-life SEC, this potential bias in the assessment of physical inactivity is unlikely to explain the pattern of results observed. Third, the effect of early- and adult-life SEC on the evolution of physical inactivity with aging should be interpreted with caution because it did not hold across all the sensitivity and robustness analyses. However, the influence of these SEC indicators on the level of physical inactivity was robust and confirmed that disadvantaged early-life SEC was associated with physical inactivity at older ages, through their effect on adult-life SEC.

Conclusions and policy implications. Our findings show that disadvantaged early-life SEC is associated with higher levels and steeper age-related increases of physical inactivity. These associations are mediated by adult-life SEC, with education being the strongest mediator. The life course may thus compensate for a disadvantaged start in life. Health education campaigns and public health policies promoting physical activity have been only marginally successful in increasing the level of physical activity in disadvantaged socioeconomic groups (34). This lack of success could be due to the fact that we still do not know the best time to intervene in an individual's lifetime, although early childhood and adolescence seem to be critical periods (41,42). The results of the present study are encouraging, because they suggest that it is never too late to reduce the risk of physical inactivity. Particularly, improving SEC of people in young adulthood, middle age, and old age is associated with a decrease in physical inactivity. Accordingly, our findings have implications for public health policy (43). Specifically, they show that interventions should continue to promote education to reduce physical inactivity, even at older ages and especially in women with disadvantaged early-life SEC. By ensuring that negative socioeconomic trajectories in childhood are inflected during adult life, particularly through access to education, social policies can help in reducing the potential adverse influence of disadvantaged early-life SEC on physical activity patterns at older ages.

This work was supported by the Swiss National Centre of Competence in Research "LIVES—Overcoming Vulnerability: Life Course Perspectives," which is financed by the Swiss National Science Foundation (51NF40-160590). M. P. B. is supported by the Research Foundation—Flanders (1504015N). The authors are grateful to the Swiss National Science Foundation for financial assistance. S. S. is supported by an Ambizione grant (PZ00P3_167732) from the Swiss National Science Foundation. The authors declare no conflict of interests.

The results of the study are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation. The results of the present study do not constitute endorsement by the American College of Sports Medicine.

B. C., S. C., and M. P. B. designed the analyses. B. C. and S. C. analyzed the data. B. C. and M. P. B. drafted the manuscript. All authors wrote the manuscript.

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

SHARE data are available at http://www.share-project.org/data-access.html.

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