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Early-Life Socioeconomic Status and Physical Activity in Later Life: Evidence from Structural Equation Models

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Abstract

Objectives—This study examines the association between early-life socioeconomic status (SES) at age 18 and physical activity (PA) at age 65, elucidates mechanisms explaining this association, and explores gender differences in mediating pathways.

Methods—Multi-group structural equation modeling is applied to the 1957–2004 data from the Wisconsin Longitudinal Study.

Results—Early-life SES is positively associated with exercise in later life. This association is mediated by socioeconomic resources, health problems, obesity, and depressive symptoms (women only) in 1993 and sports participation in 1957. All mediators explain over 95% of the effect of early-life SES.

Discussion—This study emphasizes the importance of complex multiple pathways linking early family SES to later-life PA. We identify chains of risks that need to be broken to improve PA among older adults. Our findings also suggest that interventions aimed at maintaining optimal physical functioning in old age should begin at least at midlife.

Keywords

socioeconomic status; physical activity; life course; structural equation modeling

Research has consistently documented the health benefits of physical activity (PA) in later life (Powell, Paluch, & Blair, 2011). Yet, older adults are less likely than younger people to meet PA standards necessary for maintaining good health (Hawkins, Cockburn, Hamilton, & Mack, 2004). Moreover, some sociodemographic groups tend to have a more sedentary lifestyle than others (Cleland, Ball, Magnussen, Dwyer, & Venn, 2009). It is important to explore social inequality in PA among older adults to identify population subgroups at risk for physical inactivity. From a life-course perspective, inequalities in health and health behaviors in later life cannot be fully understood without incorporating early-life

experiences (Umberson, Crosnoe, & Reczek, 2010). An analysis of life-course influences on PA will help to establish mechanisms through which socioeconomic disparities lead to inequalities in health behaviors and to identify life-course stages when interventions can be the most effective.

Very little is known about the long-term effects of early-life socioeconomic status (SES) on PA in adulthood (Cleland, Dwyer, & Venn, 2008). Kuh and Cooper (1992) found that father's education, mother's education, and father's occupational class in childhood were associated positively with PA among men and women at age 36. Similarly, retrospectively reported father's occupation was positively associated with PA in adulthood among men (Blane et al., 1996). Moreover, mother's education was related positively to maintaining higher levels of cardiorespiratory fitness from childhood to young adulthood (Cleland et al., 2009). These studies suggest that individuals from higher-SES family background are more physically active in adulthood than their peers from lower-SES families.

Existing research that explored long-term effects of early-life SES on PA is characterized by several limitations. Participants were typically followed into adulthood but not later life (Cleland et al., 2009; Kuh & Cooper, 1992). Therefore, it is not known whether the reach of childhood SES extends to PA in later years. Further, most studies were based on retrospective measures of early-life SES that may be subject to recall bias and lead to the underestimation of the true effects of childhood circumstances (Galobardes, Lynch, & Davey Smith, 2004). In addition, early-life SES was often measured with one indicator, such as father's occupation (Blane et al., 1996). Finally, little attention has been devoted to mediating pathways linking early-life SES with exercise in old age as well as gender differences in these pathways.

The present study uses data from the Wisconsin Longitudinal Study to examine how early-life SES in 1957 (at age 18) affects PA in 2004 (at age 65) and to elucidate potential mechanisms conveying this effect. Structural equation modeling is applied to estimate mediating pathways across the life course and compare the relative importance of each mediator and groups of mediators. Consistent with a life course perspective, our approach spans several life-course stages and emphasizes their interconnectedness. Moreover, our analysis incorporates measurement models based on multiple indicators of SES, health problems, and PA.

Mechanisms Linking Early-Life SES and PA in Later Life

The life-course approach emphasizes that early socioeconomic conditions initiate life-course sequences of unequal distribution of resources, opportunities, and constraints that ultimately influence health behaviors and health outcomes (Ferraro & Schippee, 2009; Hamil-Luker & O'Rand, 2007; Umberson et al., 2010). The pathway model in life-course epidemiology focuses on mediating mechanisms and suggests that early-life environment is consequential mainly because it shapes life-course trajectories of beneficial or harmful exposures (Ben-Shlomo & Kuh, 2002; Stringhini et al., 2011). Early-life socioeconomic disadvantage may impede the life-course accumulation of health-enhancing resources, whereas an auspicious start in life sets in motion beneficial trajectories (Ferraro & Schippee, 2009; Hamil-Luker &

O'Rand, 2007). Therefore, it is important to understand how the linkage between early-life SES and health behaviors unfolds over time and the pathways that connect early-life conditions to health habits in later life (Umberson et al., 2010). Existing research suggests potential mechanisms explaining the association between early-life SES and PA in later life: the intergenerational transmission of health habits, socioeconomic achievement, health problems, obesity, and mental health.

Early-Life Processes: Intergenerational Transmission of Health Habits

The lives of family members are inextricably linked, and shared experiences within families have enduring effects on health and health behaviors that span across generations (Umberson et al., 2010). Research documents intergenerational continuity in health behaviors, including PA (Schwandt, Haas, & Liepold, 2010). Higher-SES parents are more physically active than their lower-SES counterparts (Kuh & Cooper, 1992; Stringhini et al., 2011). Children growing up in higher-SES families are more likely to be exposed to parental PA and, thus, more likely to emulate an active lifestyle of their parents (Richards, Poulton, Reeder, & Williams, 2009). Moreover, higher-SES parents participate in more sports and recreational activities with their children (Richards et al., 2009). Because higher-SES parents tend to have more physically active children than low-SES parents (Kantomaa, Tammelin, Nayha, & Taanila, 2007), early-life exercise patterns may be a mechanism linking parents' socioeconomic resources to offspring's PA in later life. Early experiences with exercise continue to influence exercise in adulthood (Kuh & Cooper, 1992). Higher levels of school sports and leisure-time PA in childhood and adolescence are associated positively with regular exercise approximately 20 years later, although the reported associations are modest in size (Cleland et al., 2009; Kuh & Cooper, 1992). These findings suggest that higher SES of the family of origin is associated with higher levels of exercise in early life and old age. Moreover, PA in childhood and adolescence is a possible mechanism linking early-life SES to exercise in later life.

Adulthood Processes: Socioeconomic Achievement

Socioeconomic circumstances of the family of origin may be related to later-life PA indirectly via socioeconomic characteristics in adulthood. Parents' SES is positively associated with individuals' own SES in adulthood (Sewell & Hauser, 1975). In turn, socioeconomic conditions in adulthood were consistently shown to be related to PA, with low-SES persons being less active than their high-SES counterparts (Kuh & Cooper, 1992; Stringhini et al., 2011). Individuals from an advantaged family background may be more physically active in adulthood because they accumulate higher levels of human capital and socioeconomic resources, which promote an active lifestyle. A study based on cross-sectional baseline data from the Whitehall II survey showed that lower early-life SES was associated with a greater likelihood of sedentary lifestyle in adulthood, and this association was fully mediated by adult SES (Brunner, Shipley, Blane, Davey Smith, & Marmot, 1999). Thus, individuals' own SES in adulthood is likely to be an important pathway between early-life SES and PA in later life.

Adulthood Processes: Health Problems

Early-life SES may affect PA decades later through adult health status. Individuals from higher-SES family background tend to have better health in adulthood than persons with low early-life SES (Cohen, Janicki-Deverts, Chen, & Matthews, 2010). In turn, existing research suggests a complex reciprocal relationship between PA and health. On the one hand, PA improves general physical and mental health and prevents the onset of a wide range of health problems (Powell et al., 2011). On the other hand, health may promote or impede PA, especially in later life. Poor health, chronic illness, and functional limitations predict reductions in physical activity among older adults (Duke, Brownlee, Leventhal, & Leventhal, 2002; Cohen-Mansfield, Marx, & Guralnik, 2003). We hypothesize that the positive association between early-life SES and PA in later life will be mediated by health in adulthood.

Adulthood Processes: Body Weight

Body weight can be a potential mediator of the association between parental SES and adult offspring's exercise. First, higher early-life SES is associated with a lower risk of overweight and obesity in adulthood (Brisbois, Farmer, & McCargar, 2011). Second, body weight, especially obesity, was shown to affect initiation and maintenance of exercise (Sherwood & Jeffery, 2000). Excessive weight may be a barrier to exercise in later life because obesity leads to functional limitations, impaired upper- and lower-mobility, and reduced flexibility and strength in older adults (Clark, Stump, Hui, & Wolinsky, 1998; Ferraro, Su, Gretebeck, Black, & Badylak, 2002). Based on these findings, the present study evaluates the role of obesity as a mechanism conveying the effect of early-life SES on PA in later life.

Adulthood Processes: Depression

Because socioeconomic characteristics of the family of origin are related to mental health in adulthood and later life (McLaughlin et al., 2010), it is possible that the effect of early-life SES on PA in later life is partly conveyed through psychological functioning. Research documents a close relationship between psychological distress and exercise (Teychenne, Ball, & Salmon, 2008). Depressed individuals are less likely to engage in health-promoting behaviors, including adequate levels of PA (Arikawa, O'Dougherty, Kaufman, Schmitz, & Kurzer, 2012; Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002). Because mental health is related both to early-life SES and exercise in adulthood, it is hypothesized that depression is a plausible mediator of the relationship between socioeconomic family background and later-life PA.

Gender Differences

Age-related decline in exercise is greater among women than men (Sherwood & Jeffery, 2000). Middle-aged and older men exhibit significantly higher levels of moderate and vigorous PA than their female peers (Haley & Andel, 2010), whereas women have significantly higher prevalence of inactivity than men (Ham & Ainsworth, 2010). Little is known, however, about the ways in which the effect of early-life SES on PA in later life as

well as life-course pathways mediating this effect differ by gender. Existing research suggests that some hypothesized mediators can be more prone to gender differences than other mediators. Specifically, we do not expect gender differences in the mediating role of SES, health problems, and body weight in adulthood. Higher parents' SES increases both sons' and daughters' socioeconomic achievement (Sewell & Hauser, 1975), and adult SES is positively related to PA among both men and women (Stringhini et al., 2011). With respect to health problems and obesity, research does not reveal consistent gender differences, with some studies documenting a similar effect of parents' SES for men and women (Kivimäki et al., 2006), other studies reporting a stronger effect of early-life SES among men (Catalano et al., 2005), and yet other studies emphasizing the importance of family of origin for women (Hamil-Luker & O'Rand, 2007).

In contrast, we expect gender differences in the mediating effects of early-life PA and adult depression. Low parents' SES has a more adverse effect on girls' than boys' PA (Carson, Spence, Cutumisu, & Cargill, 2010; Hardy, Reinten-Reynolds, Espinel, Zask, & Okely, 2012). Moreover, girls' PA levels tend to decline in adolescence (Butt, Weinberg, Breckon, & Claytor, 2011), and the correlation of PA in childhood and adulthood is stronger for men than women (Telama et al., 2005). Thus, we hypothesize that sports participation in early life will mediate a greater proportion of the effect of early-life SES among men than women. With respect to depression, we expect a stronger mediating effect for women than men. Parents' low SES increases depression (McLeod & Nonnemaker, 2000), and the effect of childhood adversity on depression in adulthood is stronger among women than men (McLaughlin, Conron, Koenen, & Gilman, 2010). In turn, depression is associated with higher body weight and lower PA among women but not men (Beydoun & Wang, 2010). Using multi-group structural equation models, we explore whether the effect of early-life SES differs by gender, and whether childhood PA and adult depression convey the effects of early-life SES differently for men and women.

METHODS

Sample

The Wisconsin Longitudinal Study (WLS) is a long-term cohort study of 10,317 White men and women who graduated from Wisconsin high schools in 1957. Participants were interviewed at ages 17–18 (in 1957), 36 (in 1975), 53–54 (in 1993), and 64–65 (in 2004). This study's analytic sample contains 2,615 men and 3,163 women who participated in the 1957 baseline survey and in the 1993 and 2004 interviews. About 70% of the 1957 sample participated in 2004. Analysis of sample attrition reveals that those who dropped out of the study after 1993 were more likely to be men, to have lower SES, to report worse health and more depressive symptoms, and were less likely to be married. Yet, non-participants and persons who remained in the study did not differ with respect to early-life SES and PA. Thus, this study may be more representative of higher-SES individuals with better health. To the extent that SES and health are related positively to exercise, the findings may underestimate socioeconomic disparities in PA.

The focal outcomes

The measures of *light exercise* and *vigorous exercise* in 2004 are based on the self-reported number of hours per month spent in light (such as walking, gardening, golfing, and bowling) and vigorous (such as aerobics, jogging, swimming, and bicycling) activities. Because the original measures were positively skewed, we use a natural log transformation of exercise variables in all models.

The focal predictors

Measures of family SES in 1957 include *father's and mother's education* measured in years, *family income* measured in \$100's, and *father's occupation* represented with five categories (unskilled worker, farmer, skilled worker, white-collar worker, and professional). We also include measures reflecting father's entire occupation: *occupational education* (log transformed) indicating the proportion of individuals in a given occupation who completed one or more years of college, and *occupational income* (log transformed) representing the proportion of individuals in a given occupation who earned more than \$10,000.

Mediators in 1993

SES includes *education* (completed years of schooling), occupation of the current or last job (professional/managerial, clerical/sales/service, crafts/operatives/laborers), a natural log of *household wealth*, *occupational education* (log transformed) reflecting the percentage of persons in a given occupation who completed one year of college or more, and *occupational income* (log transformed) representing the percentage of persons who earned at least \$14.30 per hour in 1989.

Health problems were assessed using the following self-reported measures: *self-rated health* (1 = excellent, 2 = good, 3 = fair, 4 = poor, and 5 = very poor), the number of *physical symptoms* (such as headaches, dizziness, nausea, chest pain, and shortness of breath), and the number of *chronic illnesses* diagnosed by a medical professional (such as cancer, heart disease, high blood pressure, diabetes, and asthma). *Body mass index* (BMI) was measured as weight in kilograms divided by the square of height in meters. A binary indicator of *obesity* was coded 1 for BMI ≥ 30 and 0 for BMI < 30 . *Depressive symptoms* were evaluated using the Center for Epidemiologic Studies Depression (CES-D) Scale ($\alpha = .88$).

Mediators in 1957

Physical activity in adolescence is reflected as sports participation in high school obtained from participants' high school yearbooks. This measure is the sum of the number of varsity sports, club sports, and intramural sports.

Control variables in 2004

Marital status was coded 1 for the married and 0 for the unmarried. *Parental status* was measured as the total number of children. *Smoking* was represented with three categories: never smoked, former smoker, and current smoker. A binary indicator of *alcohol use* was coded 1 for moderate drinking and 0 otherwise.

Statistical Analysis

Structural equation modeling (SEM) is applied to examine life-course pathways linking early-life SES to PA in later life. The structural model is presented in Figure 1, which shows a *direct* path from early-life SES to PA at age 65 and potential *indirect* pathways mediated by sports participation in 1957 as well as socioeconomic characteristics, health problems, obesity, and mental health in 1993.

We use multiple group analysis to examine whether path coefficients differ significantly for men and women. We estimate a series of models for each hypothesized mediator. The initial model in each series imposes equality constraints such that all structural paths are constrained to be equal for men and women. Then a number of nested models are tested relaxing an equality constraint for each path at a time and comparing the model fit by subtracting χ^2 of the less restrictive model from χ^2 of the more restrictive model. A significant improvement in model fit ($\chi^2 = 3.841$ with one degree of freedom) is interpreted as evidence of a significant gender difference in a given path. The best-fitting models identified in this way are shown in Tables 2 and 3. For models with significant gender differences, χ^2 improvement and significance are reported in the description of results and in the note to Table 3.

All structural equation models were estimated using Mplus 6.12. The covariance matrix was analyzed. All variables had 2% missing values on average. We used multiple imputation procedure based on Bayesian estimation.

RESULTS

Summary statistics for all study variables are shown in Table 1. The measurement part of the structural equation model estimating the effect of SES in 1957 on PA in 2004 is provided in Table 2. Standardized factor loadings and residual variances are reported for all indicators. Fit indices suggest that the indicators measure each factor well.

Variables and Factors as Outcomes of SES in 1957 and Predictors of PA in 2004

The effects of SES in 1957 on mediators and control variables are presented in Model 1 of Table 2. Early-life SES is strongly and positively related to men's and women's SES in 1993. Among both men and women, higher parental SES is also associated with fewer health problems and a lower risk of obesity. Although obesity and health problems are strongly correlated (standardized correlation 0.103, $p < .001$), the effect of SES in 1957 on each of them persists even after adjustment for the other. Further, higher parents' SES is associated with fewer depressive symptoms, although this association is significant among women only. Moreover, SES in 1957 is related positively to the number of sports in high school among men ($\beta = .239$, $p < .001$) and women ($\beta = .077$, $p < .05$), yet this effect is significantly stronger among men. With respect to control variables, higher early-life SES is associated with fewer children and a greater likelihood of moderate drinking. In addition, women from higher-SES families were less likely to be married and more likely to smoke than their peers from lower-SES families.

Model 2 of Table 2 shows the effects of mediators on PA in 2004. For both men and women, higher SES in 1993 increases PA, whereas health problems, depressive symptoms, and obesity decrease exercise. In contrast, the effect of early-life PA on exercise at age 65 differs by gender. The number of sports in high school is associated positively with PA in 2004, and this effect is significantly stronger among men ($\beta = .806$, $p < .001$) than women ($\beta = .675$, $p < .05$).

The Total and Mediated Effects of SES in 1957 on PA in 2004

In the first model we estimated the effect of early-life SES on exercise at age 65 net of control variables (model fit indices: $\chi^2 = 356$, $df = 49$, $CFI = .921$, $RMSEA = .047$). This model indicates that individuals from higher-SES families of origin have higher levels of PA at age 65 than their peers from lower-SES family background ($\beta = 1.117$, $p < .001$). Moreover, the effect of early-life SES is similar for men and women, as indicated by the lack of model fit improvement when the effect of parents' SES was allowed to vary by gender ($\chi^2 = 2.14$, $df = 1$, $p > .05$). Table 3 shows the decomposition of the effect of SES in 1957 into direct and indirect effects via each mediator and groups of mediators.

Mediators in 1993

Indirect effects indicate that SES, health problems, and obesity are significant mediators of the association between early-life SES and PA in 2004 among both men and women. In contrast, the indirect effect of early-life SES via depressive symptoms is observed only among women (the difference between the best-fitting model and the model in which the path from SES in 1957 to depression in 1993 was constrained equal for men and women is $\chi^2 = 46$, $df = 1$, $p < .001$). We also test whether the mediating effects of obesity and health problems are significant net of each other. After adjustment for obesity, the indirect effect of early-life SES via midlife health problems declines by 20% but remains large and statistically significant ($\beta = .129$, $p < .001$). The mediating effect of obesity changes only trivially (from .238 to .225) when the health problem factor is included in the model. Interestingly, the indirect effect of early-life SES via health in 1993 is greatly reduced and becomes not significant ($\beta = .018$) after adjustment for late-life SES, which suggests that the mediating effect of health is fully explained by SES in 1993. Conversely, the effects of obesity and depression, although diminished, persist and remain statistically significant after midlife SES is taken into account. All 1993 mediators combined explain 92% of the total effect of early-life SES among women and 81% among men. The remaining direct effect of SES in 1957 on PA in 2004 becomes $\beta = .211$ ($p < .01$) among men and $\beta = .091$ ($p < .05$) among women.

Mediators in 1957

The indirect effect of early-life SES on later-life PA via high school sports is significantly stronger among men ($\beta = .193$, $p < .001$) than women ($\beta = .052$, $p < .05$). The difference between this best-fitting model and the model in which the paths SES in 1957 $\rightarrow$ high school sports $\rightarrow$ PA in 2004 were constrained equal for men and women is $\chi^2 = 76$, $df = 1$, $p < .001$. Sports participation in high school explains 4.7% and 17.3% among women and men, respectively. The direct effect of early-life SES on PA in 2004 remains large and

statistically significant after the mediating role of high school sports participation is taken into account.

Mediators in 1993 and 1957

All mediators combined explain over 95% of the total association between parental SES and PA in 2004 among both women and men. With all the variables in the final model, the direct effect of early-life SES becomes small in magnitude and not statistically significant ($\beta = .018$ and $.039$ among women and men, respectively).

DISCUSSION

Using data from the Wisconsin Longitudinal Study (WLS) and structural equation modeling, this study examines how SES in early life (adolescence) and midlife (age 54) affects PA at age 65. The findings contribute to a small but growing body of research exploring long-lasting effects of early-life SES on PA (Cleland et al., 2009; Kuh & Cooper, 1992).

Compared to prior research, the strengths of this study are parents' SES measured when participants were adolescents, multiple dimensions of socioeconomic family background, information on sports participation in adolescence, and a comprehensive examination of mediating mechanisms. Moreover, because the WLS participants were followed for over 50 years, it was possible to ascertain whether the reach of parental SES extended to offspring's PA in later life, and not just young adulthood as in most existing studies. Consistent with the pathway model, we show that early-life socioeconomic conditions give rise to a web of socioeconomic, psychosocial, and behavioral life-course mechanisms that form self-perpetuating chains of risks or resources (Ferraro & Shippee, 2009). The findings reveal that men and women from higher-SES families of origin have higher levels of PA at age 65 than their peers from lower-SES family background. Significant mediators of the association between early-life socioeconomic resources and late-life exercise are SES, health problems, obesity, and depressive symptoms (women only) in 1993 and sports participation in 1957. All mediators explain over 95% of the total effect of early-life SES.

Socioeconomic Achievement in Adulthood

Early-life SES is strongly and positively related to SES in 1993. In turn, higher SES in 1993 increases PA in 2004. Socioeconomic achievement in adulthood mediates 44% of the effect of parental SES on later-life PA. The mediating effect of SES is equally important for men and women. Thus, an important pathway through which early-life SES influences later-life PA is by shaping socioeconomic achievement at subsequent life-course stages. Older individuals who grew up in lower-SES families have lower levels of PA than their peers with early-life socioeconomic advantage partly because of life-course stratification processes and impeded accumulation of socioeconomic resources conducive to a health-enhancing lifestyle.

Health Problems in Adulthood

Lower SES of the family of origin is associated with more health problems in 2004. In turn, worse health is related to lower levels of PA and mediates 14.5% of the effect of parental SES on later-life PA. Interestingly, the mediating effect of health problems is fully explained

by socioeconomic achievement in adulthood. These findings provide further evidence of life-course accumulation of risks and resources launched by early-life SES. Individuals from advantaged family background have higher SES in adulthood, which leads to their better health and more active lifestyle in midlife and old age. Moreover, good health and PA reinforce each other, given their inextricable reciprocal link (Haley & Andel, 2010; Powell et al., 2011). In contrast, socioeconomic disadvantage over the life course increases the risk of health problems and physical inactivity. Exercise is one of the mechanisms that contribute to SES differences in chronic diseases and mortality (Stringhini et al., 2011). Among specific causes of death, childhood SES is the most closely related to cardiovascular mortality (Galobardes et al., 2004). Because regular exercise decreases the risk of heart disease (Mitchell et al., 2010), our study points to an important pathway linking early-life SES and cardiovascular mortality in later life.

Obesity in Adulthood

This study shows that men and women from higher-SES families of origin are less likely to be obese in adulthood than their peers from disadvantaged family background, and obesity in 1993 is inversely related to PA in 2004. Among both men and women, obesity explains 15% of the effect of early-life SES on PA at age 65. Moreover, the mediating effect of obesity persists and remains statistically significant after adjustment for SES and health problems in 1993. Low childhood SES was consistently shown to be associated with chronic conditions for which both obesity and sedentary lifestyle are risk factors, such as cardiovascular disease (Wilson, D'Agostino, Sullivan, Parise, & Kannel, 2002). Moreover, socioeconomic disadvantage of the family of origin is related to elevated markers of chronic inflammation in adulthood and late life (Phillips et al., 2009). Persistent low-grade inflammation is associated positively with obesity (Harvey, Lashinger, & Hursting, 2011) and inversely with exercise (Lavie, Church, Milani, & Earnest, 2011). A combination of obesity and physical inactivity may be a critical pathway to chronic inflammation (Lavie et al., 2011). In turn, inflammation is implicated in the etiology of a wide range of chronic diseases associated with aging, including cardiovascular disease, diabetes, cancer, and Alzheimer's disease (Harvey et al., 2011; Kiecolt-Glaser et al., 2002). This study emphasizes the importance of obesity as a mechanism through which early-life SES contributes to socioeconomic disparities in later-life PA and, ultimately, chronic diseases of aging.

Depression in Adulthood

Whereas the mediating effects of adult SES, health problems, and obesity are similar for men and women, depressive symptoms in 1993 mediate 20% of the association between early-life SES and PA in 2004 among women only. Although higher levels of depression are associated with reduced PA regardless of gender, early-life SES is a significant predictor of depressive symptoms in midlife for women but not for men. Women from lower-SES families experience more depressive symptoms in later life than their peers with higher-SES family background. Research suggests that parents' low SES and poverty may affect children's exposure to stressors, which have long-term negative implications for psychological functioning (McLaughlin et al., 2010). The relationship between early-life disadvantage and later-life depression is stronger for women than men because

psychological manifestations of distress are gender-specific (Rosenfield, Phillips, & White 2006). Women suffer more from internalizing problems, including depression, whereas men exhibit more externalizing disorders, such as antisocial behavior (Rosenfield et al., 2006). Gender differences in psychological responses to stress are likely to explain this study's finding that low parental SES is stronger related to depression among daughters than sons and, thus, depression is a more important mediator of the effect of early-life SES on PA for women.

High School Sports Participation

Children of higher-SES parents participated in more sports in high school, and sports participation in adolescence is positively associated with PA at age 65. This finding is consistent with research showing that PA tracks from childhood to adulthood (Cleland et al., 2009; Kuh & Cooper, 1992). Our study suggests that tracking extends not only to adulthood but also to later life. The familial environment provides an important context for learning lifestyle habits and lays the groundwork for health-related behaviors over the life course (Umberson et al., 2010).

High school sports participation mediates 4.5% and 17% of the effect of early-life SES among women and men, respectively. There are two reasons for why the indirect effect of early-life SES via high school sports is significantly greater for men. First, early-life SES is more strongly related to high school sports among sons than daughters. The WLS cohort graduated from high school in 1957 before the implementation of Title IX of the Education Amendments of 1972 requiring schools to provide equal athletic opportunities for girls and boys. Therefore, women in the WLS cohort had limited participation in high school sports regardless of parents' SES. Moreover, higher-SES parents may have been less likely to encourage daughters than sons to participate in sports due to prevailing traditional ideals of masculinity and femininity in the 1950s. Because masculinity is more compatible with athletic prowess than femininity (Courtenay, 2000), boys in this cohort may have received more family support for exercise. Second, high school sports participation is a stronger predictor of PA in 2004 for men than women, which is consistent with research reporting a weaker correlation between childhood and adulthood PA among women (Telama et al., 2005). Women's family responsibilities may create discontinuity in PA over the life course and curtail women's opportunities for exercise (Bittman & Wajcman, 2000). The gendered nature of family labor is likely to explain why adolescent PA is a stronger mediator of the effect of parents' SES on late-life PA among men than women.

Limitations and Future Research

The measure of early-life PA in this study reflects the number of high school sports obtained from high school yearbooks. This measure is limited and may capture some aspects of adolescent PA while neglecting other aspects. Moreover, because PA was assessed differently in early life and old age, it was not possible to estimate life-course trajectories of PA. Ideally, future research should incorporate prospective measures of PA at each life stage beginning in childhood. Further, although our hypothesized mediators explain the effect of early-life SES and reduce it to nonsignificance, we do not argue that we fully established causal mechanisms and unraveled all life-course pathways. The association between parents'

SES and offspring's PA can reflect other processes that originate early in life but are not captured in our study, including genetic factors, physiology, cognition, personality, and meso-level influences of childhood residential context. Because these mechanisms cannot be evaluated with the WLS, an important direction for future research will be a more detailed exploration of the intergenerational transmission of life-course processes that may have important implications for later-life PA.

Another limitation of this study is that it is based on aggregate measures of light and vigorous exercise. The WLS does not provide enough information to explore different types of light and vigorous PA separately. Future research should explore whether early-life SES is related differently to walking, golfing, jogging, bicycling, and other specific types of exercise. Moreover, the measures of PA in this study are based on self-reports. Ideally, more objective measures, such as accelerometers, are needed. Yet, because only few participants reported the highest level of vigorous exercise, whereas the majority of self-reports of vigorous exercise were at a low level, it appears that the participants did not systematically over-report their PA levels. Researchers concur that, just like self-reports, accelerometers have limitations (Ham & Ainsworth, 2010). Therefore, studies should combine accelerometry and self-reported measures of PA to increase the accuracy of information about PA.

CONCLUSION

Despite these limitations, the present study is among the first to document how early-life SES affects PA almost 50 years later. The analysis identifies life-course pathways linking socioeconomic family background to PA at age 65. By adopting a life-course approach, this study suggests that socioeconomic inequalities in older adults' PA originate early in life. Socioeconomic disadvantage in adolescence decreases later-life PA by giving rise to unfavorable pathway processes: curtailed opportunities for educational and occupational achievement, increased risks of obesity and depression, and reduced sports participation in high school. From a preventive perspective, these findings identify chains of risks that need to be broken to improve PA in later life (Ben-Shlomo & Kuh, 2002). This study also suggests that interventions aimed at maintaining optimal physical functioning in old age should begin at least at midlife.

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Figure 1.

The Structural Part of the Estimating the Effect of Socioeconomic Status in 1957 on Physical Activity in 2004: The Wisconsin Longitudinal Study, 1957–2004, $N = 5,778$

Note: Only theoretically central paths are shown for parsimony. SES = socioeconomic status.

Table 1Summary Statistics for the Study Variables: The Wisconsin Longitudinal Study, 1957–2004, $N = 5,778$

Variables	Mean/ Proportion	Standard deviation	Minimum	Maximum
<i>Physical Activity in 2004:</i>				
Light exercise (hours)	38.141	45.132	0	600
Light exercise (logged hours)	3.278	.939	0	6.396
Vigorous exercise (hours)	8.055	17.567	0	200
Vigorous exercise (logged hours)	1.626	1.085	0	5.298
<i>Parents' SES in 1957:</i>				
			0	
Father's education	9.763	3.402	0	26
Mother's education	10.533	2.817	0	20
Family income (in \$100's)	59.294	31.613	1	150
Father's occupation	2.468	1.453	1	5
Father's occupational education (ln)	2.636	.853	-.223	4.601
Father's occupational income (ln)	3.089	.856	-1.204	4.474
<i>Mediators in 1957:</i>				
Number of high school sports	.849	1.140	0	4
<i>Mediators in 1993:</i>				
<i>SES:</i>				
Education	13.713	2.307	12	21
Occupation	2.203	.745	1	3
Occupational education (ln)	4.022	.472	2.116	4.604
Occupational income (ln)	3.237	.773	1.308	4.472
Wealth (ln)	11.855	1.686	0	18.421
<i>Health:</i>				
Self-rated health (poor = 5)	1.819	.646	1	5
Physical symptoms	4.046	2.945	0	11
Chronic illnesses	1.011	1.208	0	9
Depressive symptoms	16.043	14.565	0	80
Obesity (BMI ≥ 30)	.223	-----	0	1
<i>Controls in 2004:</i>				
Current smoker	.17	-----	0	1
Moderate drinking	.20	-----	0	1
Married	.791	-----	0	1
Number of children	3.017	1.682	0	10

Table 2

The Measurement Part of the Structural Equation Model Estimating the Effect of Socioeconomic Status in 1957 on Physical Activity in 2004: The Wisconsin Longitudinal Study, 1957–2004, $N = 5,778$

Indicators	Factors			
	SES 1957	SES 1993	Health 1993	PA 2004
Father's education	.643 (.598)			
Mother's education	.475 (.775)			
Family income	.399 (.841)			
Father's occupation	.725 (.474)			
Father's occupational education	.857 (.266)			
Father's occupational income	.602 (.638)			
Eigenvalue 2.335, χ^2 (df) 171 (9), CFI .980, RMSEA .056				
Education		.603 (.636)		
Occupation		.839 (.294)		
Occupational education (ln)		.832 (.307)		
Occupational income (ln)		.706 (.501)		
Wealth (ln)		.479 (.782)		
Eigenvalue 2.253, χ^2 (df) 60.634 (5), CFI .992, RMSEA .044				
Self-rated health			.529 (.719)	
Physical symptoms			.655 (.570)	
Chronic illnesses			.679 (.537)	
Eigenvalue 1.018, χ^2 (df) 42.951 (3), CFI .957, RMSEA .048				
Light exercise (ln)				.652 (.567)
Vigorous exercise (ln)				.677 (.535)
Eigenvalue 1.327, χ^2 (df) 14 (1), CFI .979, RMSEA .047				

Variables and Factors as Outcomes of Socioeconomic Status in 1957 and Predictors of Physical Activity in 2004: The Wisconsin Longitudinal Study, 1957–2004, $N = 5,778$

Variables	Effects of SES 1957 on variables/factors (β)		Effects of variables/factors on PA in 2004 (β)	
	Men	Women	Men	Women
	(1)		(2)	
<i>Mediators in 1993:</i>				
SES	.359***	.359***	1.320***	1.320***
Heath problems	-.127***	-.127***	-1.276***	-1.276***
Heath problems net of obesity	-.107***	-.107***	-1.206***	-1.206***
Obesity (BMI 30)	-.114***	-.114***	-2.088***	-2.088***
Obesity (BMI 30) net of health	-.109***	-.109***	-2.067***	-2.067***

Variables and Factors as Outcomes of Socioeconomic Status in 1957 and Predictors of Physical Activity in 2004: The Wisconsin Longitudinal Study, 1957–2004, *N* = 5,778

Variables	Effects of SES 1957 on variables/factors (β)		Effects of variables/factors on PA in 2004 (β)	
	Men	Women	Men	Women
	(1)		(2)	
Depressive symptoms	-.332	-1.588***	-.096***	-.096***
<i>Mediators in 1957:</i>				
High school sports in 1957	.239***	.077*	.806***	.675*
<i>Controls in 2004:</i>				
Marital status	.009	-.102*	-.089*	.130*
Number of children	-.066*	-.264***	-.042	.151*
Smoking	-.029	.057*	-.308***	-.013
Moderate drinking	.240**	.240**	.076*	.076*

Note: Each cell contains standardized factor loadings and residual variances (in parentheses). All factor loadings are significant at the .001 level.

SES = socioeconomic status; PA = physical activity; df = degrees of freedom; CFI = the comparative fit index; RMSEA = the root mean square error of approximation.

Note: Each cell contains standardized path coefficients. SES = socioeconomic status; PA = physical activity; BMI = body mass index.

*
p < .05.

**
p < .01.

p < .001.

Table 3

Decomposition of the Effect of Socioeconomic Status in 1957 on Physical Activity in 2004: The Wisconsin Longitudinal Study, 1957–2004, $N = 5,778$

Mediators	Total effect (β) of SES in 1957 = 1.117***				Model fit: χ ² (df), CFI, RMSEA
	Direct effect (β) of SES in 1957		Indirect effect (β) of SES in 1957		
	Men	Women	Men	Women	
1993:					
SES	.643***	.643***	.474***	.474***	1363 (107), .960, .045
Health	.955***	.955***	.162***	.162***	
			.129*** ^a	.129*** ^a	1058 (78), .929, .047
Obesity	.879***	.879***	.018 ^b	.018 ^b	
			.238***	.238***	
			.225*** ^c	.225*** ^c	789 (51), .922, .048
			.131 ^{ab}	.131 ^{ab}	
Depression	1.085***	.965***	.032	.152**	785 (52), .935 .050 ^d
				.143 ^{ab}	
All 1993 mediators	.211**	.091*	.906***	1.026***	2936 (242), .931, .044
1957:					
High school sports	.924**	1.065***	.193***	.052*	641 (53), .937, .044 ^e
All mediators	.018	.039	1.099***	1.078***	2358 (304), .944, .048

Note: All models adjust for marital status, the number of children, smoking, and alcohol use in 2004.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

SES = socioeconomic status; PA = physical activity; BMI = body mass index; df = degrees of freedom; CFI = the comparative fit index; RMSEA = the root mean square error of approximation.

^a after adjustment for obesity in 1993.

^b after adjustment for SES in 1993.

^c after adjustment for health problems in 1993.

^d χ^2 difference between this best-fitting model and the model in which the path SES in 1957 $\rightarrow$ depression in 1993 was constrained to be equal for men and women: $\chi^2 = 46$, $df = 1$, $p < .001$.

^e χ^2 difference between this best-fitting model and the model in which the paths SES in 1957 $\rightarrow$ sports in high school $\rightarrow$ physical activity in 2004 were constrained to be equal for men and women: $\chi^2 = 75.778$, $df = 1$, $p < .001$.