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"Sibling Models of the Role of Job Characteristics in Mediating SES-Health Relationships"*

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Sibling Models of the Role of Job Characteristics in Mediating SES-Health Relationships

ABSTRACT

We focus on physical and psychosocial job characteristics as mediators in the link between education, earnings, and occupational standing and self-assessed overall health, cardiovascular and musculoskeletal health problems, and depression. From sociological research on the stratification of employment outcomes, we expect that people with less education also have lower earnings and lower levels of occupational standing, and have more physically and psychosocially demanding jobs. From the occupational stress, ergonomics, and job design literatures, we expect that physically and cognitively demanding jobs and jobs with varying amounts of control are associated with health outcomes. Consequently, we expect to find that job characteristics play an important mediating role in associations between SES and health. To address these hypotheses, we use data on sibling pairs from the Wisconsin Longitudinal Study. We find support for our hypotheses, although the extent to which job characteristics mediate SES-health relationships varies across health outcomes and by gender.

Keywords: SES; Education; Job Characteristics; Work; Health Disparities; Sibling Resemblance Models;

Inverse relationships between socioeconomic status (SES) and health outcomes are well documented (Alder and Ostrove 1999; House 2002; Marmot, Ryff., Bumpass, Shipley, and Marks 1997b; Mulatu and Schooler 2002; Wilson 2001). Evidence from a variety of academic disciplines makes clear that the incidence and prevalence of disease and health problems are higher for people with fewer socioeconomic resources. Despite this widespread consensus of empirical findings, the explanation for these SES-health relationships remains less well understood. In this paper we examine the extent to which the physical and psychosocial characteristics of jobs mediate relationships between SES and self-assessed overall health, cardiovascular and musculoskeletal health problems, and depression. We also examine the extent to which relationships between SES, job characteristics, and health differ for men and for women.

There is continuing debate about the direction of causality in SES-health relationships. In this paper we take an agnostic view on this issue. We recognize that adult SES and health are empirically associated in our cross-sectional data, and we attempt to understand the sources of that association. One obvious source has to do with health-risk factors --- such as exercise, body mass, and smoking --- that are stratified by education, earnings, and other SES factors and that are consequential for health. Another obvious source has to do with family socioeconomic origins --- children from less advantaged backgrounds experience more health problems later in life and are disproportionately low SES in adulthood. However, it is clear that these factors do not entirely account for observed SES-health relationships (Kaplan and Keil 1993; Mulatu and Schooler 2002). In this paper we demonstrate that job characteristics are another important source of observed SES-health associations, albeit to differing degrees across health outcomes.

This paper is preceded by a recent related paper (Warren, Hoonakker, Carayon, and Brand 2004) in which we find that job characteristics play an important mediating role in relationships between SES and self-assessed overall health, cardiovascular health problems, and musculoskeletal health problems. Our current work improves upon this previous paper in several important ways. Most importantly, we attempt to account for omitted variable bias with respect to family socioeconomic background. We recognize that observed relationships between adult SES, job characteristics, and health may be severely biased by characteristics of respondents' social origins. If children's social origins influence their adult SES, their subsequent job characteristics, and their health as adults, then it is crucial to account for all aspects of social origins in estimating the extent to which job characteristics mediate associations between SES and health outcomes. A key feature of our data is that one randomly selected sibling of each respondent was interviewed concurrently with the respondent. Using these data we estimate sibling resemblance models that account for all aspects --- observed and unobserved --- of respondents' social origins. The goal of these analyses is to obtain estimates of the extent to which job characteristics mediate associations between adult SES factors and self-assessed overall health, cardiovascular and musculoskeletal health problems, and depression that are not biased by family background.

THE STRATIFICATION OF HEALTH OUTCOMES

We start by briefly reviewing recent research on the relationships between SES and self-assessed overall health, cardiovascular and musculoskeletal problems, and depression. In each case, we note that although the associations between SES and health outcomes are well established, the mechanisms involved are less clear and warrant further investigation.

Self-assessed overall health is typically measured using a survey question that asks something like, “Would you say your health is excellent, very good, good, fair, or poor?" Such measures are highly correlated with a variety of more objective, concrete measures of morbidity and mortality (Idler and Benyamini 1997). Self-assessments of overall health are also highly correlated with SES. For example, Wilson (2001) found very strong associations between self-assessed overall health and education and income: men and women in the lowest income quintile were about six times as likely as their counterparts in the highest income quintile to report that their health was generally fair or poor. Likewise, Marmot et al. (1997b) and Miech and Hauser (2001) found strong relationships between education and self-assessed overall health, and Power et al. (1998) found strong associations between social class and self-rated health at age 33. Others also find gender differences in self-assessed overall health; some have hypothesized that such differences are the result of different stresses, preventive health practices, illness experiences and behaviors, biological factors, and reporting biases (Lane and Cibula 2000; Macintyre, Hunt, and Sweeting 1996). Reporting differences are particularly salient in the context of self-reported overall health; women are more likely than men to rate their health as poor (Waldron 1983; Verbrugge and Wingard 1987). Still, McDonough and Walters (2001) suggest negligible gender differences in self-assessed health. The direction and magnitude of gender differences in overall health also vary according to the phase of the life cycle (Arber and Cooper 1999; Macintyre, Hunt, and Sweeting 1996); Marks (1996), using Wisconsin Longitudinal Study data, found better self-assessed overall health for women than men at age 53.

SES is also strongly related to the prevalence, incidence, severity, and mortality of cardiovascular diseases (Chang, Shipley, Marmot, and Poulter 2002; Shishehbor, Baker, Blackstone, and Lauer 2002). Part of these associations is due to the fact that there are strong

relationships between SES and various recognized risk factors for cardiovascular disease, including the prevalence of cigarette smoking, obesity, excessive alcohol consumption, elevated serum cholesterol, and others (Kaplan and Keil 1993; Shishehbor, Baker, Blackstone, and Lauer 2002). However, even after controlling for these confounding variables there are still strong and significant relationships between SES and cardiovascular disease (Chang, Shipley, Marmot, and Poulter 2002; Pitsavos, Panagiotakas, Chrysohoou, Skoumas, Stefanadis, and Toutouzas 2002). The inability of these risk factors to entirely explain the association between SES and cardiovascular health has led some to suggest that job-related factors account for the remaining association. For example, Marmot et al. (1997a) concluded that job control in the workplace accounts for much of the occupational grade difference in coronary heart disease.

The incidence and severity of musculoskeletal diseases are also stratified by SES (Brekke, Hjortdahl, and Kvien 2002; Heistaro, Vartiainen, Heliovaara, and Puska 1998). Dionne et al. (2001), for example, reviewed sixty four articles published between 1966 and 2000 and concluded that there is good evidence that less well educated people are more likely to be affected by back pain. They noted that differences in occupational factors may be one mechanism responsible for this association. Vahatera et al. (1999) asked whether workplace factors play a role in generating socioeconomic gradients in sickness absence from work due to musculoskeletal disorders, and concluded that, particularly for men, workplace factors do partly account for socioeconomic gradients in health.

There is a strong association between SES and depression, perhaps especially among women (Marmot, Shipley, Brunner, and Hemingway 2001; Marmot et al. 1997b; Miech, Caspi, Moffitt, Wright, and Silva 1999). There is growing interest in the mechanisms that link SES and depression. Link et al. (1993) considered characteristics of occupations, i.e. the extent to which

they involve direction, control, and planning (DCP), as mediators in the SES-depression relationship, and concluded that DCP partially explains this relationship. Using data from Whitehall II, Marmot et al. (1997b) incorporated Karasek's (1979) Job Strain model and measures of social support and perceived control in the workplace. They concluded that job control in the workplace, as measured by control over work, variety and use of skills, support at work, work pace, and job satisfaction, entirely accounts for the social gradient in rates of depression. However, we wonder whether these findings can be generalized beyond the sample of middle-aged, mostly male, London-based civil servants studied by Marmot et al. (1997a; 1997b).

SES is associated with a variety of health outcomes via mechanisms that are not entirely understood. In the next sections we offer evidence that (1) the characteristics of men's and women's jobs typically differ and are stratified by SES and that (2) the characteristics of men's and women's jobs affect health outcomes. Together, this evidence makes a strong case that job characteristics should be important mediators in SES-health relationships.

THE STRATIFICATION OF JOB CHARACTERISTICS

There is a large and well developed literature on the role of education in the stratification of employment outcomes. Education has a pronounced effect on earnings, occupational prestige, and occupational status (Blau and Duncan 1967; Featherman and Hauser 1978), even net of social origins, intelligence, and other potentially confounding factors. There is also evidence that the characteristics of individuals' jobs are related to education and to the socioeconomic properties of those jobs. Jencks, Perman, and Rainwater (1988) found that better educated respondents were less likely to get dirty at work ($r = -.31$) and had less repetitive jobs ($r = -.41$).

Likewise, they found that better paid respondents were more likely to decide their own hours (r = .34), and that respondents in higher status occupations were more likely to decide their own hours (r = .29) and less likely to get dirty at work (r = –.41).

Several scholars have found stratification of SES and job characteristics by gender (Biebly and Baron 1986; Kilbourne, Stanek, England, Farkas, Beron, and Weir 1994; Petersen and Morgan 1995; Polachek 1981; Tam 1997; Reskin 1993; Sewell, Hauser, and Wolf 1980; Warren, Hoonakker, Carayon, and Brand 2004). Women tend to be overrepresented in low-paying and underrepresented in high-paying occupations. In addition, even in the same occupations women earn substantially less earnings than men. Moreover, women average fewer hours per week and typically have less (and sometimes interrupted) work histories. Men are more likely to have jobs in which they get dirty and are exposed to dangerous conditions than women. Men are also more likely to supervise others, control their own work schedule, and learn new things on their jobs than women.

HEALTH CONSEQUENCES OF JOB CHARACTERISTICS

While it is clear that job characteristics are stratified by SES, it is also clear that job characteristics have health consequences. In the literatures on job design, occupational stress and ergonomics, various aspects of work have been shown to influence workers' health and well-being in positive or negative ways (Carayon and Smith 2000; Smith and Carayon-Sainfort 1989). Balance Theory, a macro-ergonomic model of work proposed by Smith and Carayon-Sainfort (1989), is a systems approach based on the job design, occupational stress and ergonomics literatures. According to this theory, a work system is comprised of: (1) the individual, (2) tasks, (3) technologies and tools, (4) the environment, and (5) organizational conditions. Balance

Theory emphasizes the multiple positive and negative characteristics in each element of the work system that interact and collectively influence worker health and well being. Consequently, it is important for us to examine a range of physical and psychosocial job characteristics in our analyses. To briefly summarize three broad literatures, the work factors of importance in the job design, occupational stress and ergonomics literatures are: (1) psychosocial job characteristics: job control, job security, cognitive job demands and job content (e.g. variety, challenge), and social and organizational aspects (e.g., social support); and (2) physical job characteristics: ergonomics and safety.

Relationships between job characteristics and subjective measures of general or overall health have been examined in several studies (Martikainen, Stansfeld, Hemingway, and Marmot 1999; Power, Matthews, and Manor 1998). For example, Borg and colleagues (e.g., Borg and Kristensen 2000) interviewed 5,001 Danish employees in 1990 and 1995, focusing on the impact of both psychosocial and physical job characteristics on self-rated health. They hypothesized that job characteristics measured in 1990 would predict changes in self-rated health over the 5-year period. In fact, repetitive work, high job demands, low social support, high job insecurity, and high ergonomic exposures were all found to predict worsening of self-rated health over time. Likewise, Power et al. (1998) found that psychosocial work factors partially account for social class gradients in self-rated health at age 33.

Cardiovascular health is related to job stress and other job characteristics (Hemingway and Marmot 1999; Kivimäki, Leino-Arjas, Luukkonen, Riihimäki, Vahtera, and Kirjonen 2002). Different mechanisms for the relationship between job characteristics, job stress and cardiovascular health have been proposed (Kristensen 1996; Schnall, Landsbergis, and Baker 1994; Schwartz and Pickering 1996); much of the empirical research examining these

relationships has used Karasek's (1979) Job Strain model (Kivimäki et al. 2002; Kuper and Marmot 2003; Rau, Georgiades, Fredrikson, Lemne, and deFaire 2001) or some variant of that model (e.g., Steenland, Johnson, and Nowlin 1997). The Job Strain model assumes that strain results from the combination of high job demands and a lack of autonomy in decision making.

Musculoskeletal disorders are more common in physically demanding jobs, but they are also more common in jobs with negative psychosocial characteristics such as high cognitive demands and pressure, job future ambiguity, low job control, and low social support (Cooper and Cox 1985; Linton 2000; Smith 1987). Carayon et al. (1999) proposed several pathways for the relationship between job stress and musculoskeletal disorders that highlight the physiological, psychological, and behavioral reactions to stress that can affect such disorders directly and indirectly. Jensen et al. (2002) recently evaluated the associations between psychosocial, physical, and individual factors and musculoskeletal symptoms in the neck, shoulder, and hand/wrist regions of computer users. They concluded that long hours of computer use may be associated with musculoskeletal symptoms because of physical factors such as repetitive movements, whereas psychosocial factors appeared to be associated with the symptoms independently of the duration of computer use.

Job characteristics are also associated with psychological distress. Karasek (1979) revealed a strong relationship between job strain, i.e. job demands in relation to decision latitude, and depressive symptomatology; similar results have been found in several more recent U.S-based studies (Kohn and Schooler 1983; Link, Lennon, and Dohrenwood 1993; Link, Lennon, and Dohrenwood 1998; Mausner-Dorsch and Eaton 2000; Phelan et al. 1991). Using data from Whitehall II, Marmot and others have found that social support and control at work protect mental health while high job demands and effort-reward imbalance were risk factors for future

mental health problems (Marmot et al. 1997a; Stansfeld, Fuhrer, Shipley, and Marmot 1999; Stansfeld, Head, and Marmot 1998). Job characteristics are also significantly associated with depression in Japan (see Kawakami and Haratani 1999 for a review) and in Canada (Turner, Wheaton, and Loyd 1995; Wang and Pattern 2001).

DATA AND MEASURES

Data

To more carefully investigate the broad hypothesis that physical and psychosocial job characteristics mediate relationships between SES and self-assessed overall health, cardiovascular and musculoskeletal health problems, and depression we use data from the Wisconsin Longitudinal Study (WLS). The WLS began as a study of a random sample of 10,317 men and women who graduated from Wisconsin high schools in 1957. Survey data were collected from the graduates or their parents in 1957, 1964, 1975, and 1992/93 and from a randomly selected sibling in 1977 and 1993/94.[1] These data provide a full record of social background, schooling, and labor market experiences of the original respondents. In 1992/93 the content of the WLS was expanded to include detailed occupational histories, job characteristic measures, and extensive information about mental and physical health and well-being. The 1994 surveys of siblings also included extensive (and parallel) information about schooling, job characteristics, and health outcomes. Our health outcome measures were obtained from a mail questionnaire that was completed by respondents a month or two after they completed the

[1] WLS project leaders conducted a new round of surveys in 2003-2005 of the surviving original cohort members and their randomly selected siblings; members of the original graduate sample were 64-66 years old when they were surveyed.

telephone survey on which they answered questions about the explanatory variables. The WLS has enjoyed remarkably high rates of response and sample retention; more than 80% of the graduate sample responded to the 1992/93 telephone survey.[2]

The WLS data have obvious limitations. Some strata of American society are not represented: Everyone in the primary sample graduated from high school; there are only a handful of racial/ethnic minorities in the sample (mostly because of the demographic composition of the state in the 1950s); about 19% of the WLS sample is of farm origin; and about 70% of the sample still lived in Wisconsin in 1992. Unfortunately, we have a smaller proportion of low-SES individuals than if we had a sample that was not restricted in this manner. With all of that said, the WLS also has unique strengths. Among them is the combination of a wide array of measures of health outcomes and job characteristics for a large sample of respondents and their siblings that have been followed for decades (and is being contacted again in 2003-2005).

We restrict our analyses to the 2,862 sibling pairs in which original cohort members and their respective siblings responded to the 1992/93/94 telephone surveys and the 1992/93/94 mail questionnaires. We then further restrict our analysis sample to the 2,320 cases with no missing data on measures that we use in our analyses. Table 1 provides descriptive statistics for all measures in the full sample and in our final analysis sample for WLS graduates and siblings. We find only small differences in our measures across these samples. This suggests that the attributes of our analyses sample differ in only trivial ways from the full sample. Table 2 provides descriptive statistics for all measures in the samples of male graduates, male siblings,

[2] Partial interviews are included in calculation of this response rate; only 2%, however, of those responding in 1992/3 completed partial interviews.

female graduates, and female siblings.

Measures

Health Outcomes. The first panel of Tables 1 and 2 describe variables pertaining to respondents' self-reported health problems and medical conditions. We measure overall health using a question that asked "How would you rate your health at the present time?" Response options ranged from "excellent" (5) to "very poor" (1). About 31% of graduates and 44% of siblings reported that their health was excellent. We measure psychological distress using the 20-item Center for Epidemiological Studies Depression Scale (CES-D) from the 1992/93/94 WLS mail questionnaires. The scoring of individual CES-D index items is based on a count of the number of days (0-7) in the last week that the respondent felt as indicated in each of the twenty questions; items are summed for a total range of scores from 0 (least) to 140 (most depressed), and the natural logarithm of the index is used to normalize the distribution.

Cardiovascular and musculoskeletal health outcomes were measured using self-reports of health problems (i.e., symptoms that respondents have experienced) and medical conditions (i.e., diagnoses made by medical professionals). On the 1992/93 WLS graduate and 1993/94 sibling mail surveys, respondents were presented with a list of 17 health symptoms and asked whether they had experienced the symptom in the past six months. They were then asked to report the frequency with which they experienced each and how much discomfort each had caused them in the past six months. For each self-reported health problem, we coded a respondent as having that problem only if they reported experiencing it at least weekly in the past six months and only if they indicated that it caused them at least a little discomfort. Respondents were also presented with a list of 22 medical conditions and asked whether a medical professional has said they have

that condition. For each medical condition, respondents were coded as having that medical condition only if they reported that it interfered at least sometimes with what they "like to do."

To measure cardiovascular health conditions we use items that refer to the health symptoms "had chest pain" and "felt shortness of breath" and the medical conditions "heart trouble" and "high blood pressure." To measure musculoskeletal health conditions we use items that refer to the health symptoms "had aching muscles," "had stiff/swollen joints," and "had back pain or strain" and the medical condition "serious back trouble." We then construct separate scales of cardiovascular and musculoskeletal health problems. The α coefficients for the cardiovascular scale for graduates and siblings are 0.74 and 0.79, respectively. The α coefficients for the musculoskeletal scale for graduates and siblings are 0.80 and 0.86, respectively.

Socioeconomic Status Measures. We have opted to express educational attainment as a continuous variable which ranges from 12, indicating high school completion, to 21, indicating post-doctorate education for graduates and from 0, indicating no schooling completed, to 21 for siblings. All respondents are high school graduates and about one in four WLS primary respondents and siblings completed at least four years of college.[3] Table 2 suggests that on average, men obtained more education than women. We also employ measures of two socioeconomic characteristics of jobs. Earnings in 1992/93/94 are expressed as the natural log of wage rates on current or most recent jobs in 1992/93/94. Following Hauser and Warren (1997),

[3] Educational attainment is strongly related to each of our health outcomes regardless of how we express the concept. We estimated all of our models using both a categorical and a continuous measure of educational attainment in a related paper and the results are virtually identical (Warren, Carayon, Hoonaker, and Brand 2004).

we do not operationalize occupational standing in terms of occupational prestige or Duncan's Socioeconomic Index (1961). Instead we characterize the relative standing of occupations using a measure of occupational education. This measure ranks occupations with respect to all occupational incumbents' educational credentials, and is not the same as the respondent's own education.

Health Risk Factors. As described above, prior work suggests that health-related factors like exercise, weight, and smoking all partially mediate SES-health relationships. In order to account for these health risk factors, we include in our analyses measures of the number of times that respondents exercised vigorously in the month preceding the 1992/93/94 mail survey, their Body Mass Index (BMI), and an indicator of whether they currently smoked in 1992/93/94. In other samples we would include an indicator of whether respondents were covered by any health insurance; we do not do so here because 98% of WLS respondents were covered by some health insurance. BMI is calculated on the basis of self-reports of height and weight; higher scores indicate greater obesity. Respondents are classified as smokers if they report that they smoked regularly as of the time of their 1992/93/94 survey (regardless of how long they have been smokers or how many cigarettes they smoke per day). We construct an index of these 3 measures of health risk factors.[4]

Job Characteristics. In our analyses we do not enter each job characteristic individually; instead, we construct indices of job characteristics, separately for graduates and siblings. For graduates' and siblings' current or most recent jobs in 1992/93/94, our physical job characteristic index includes measures of whether that job always or frequently involved physical effort;

[4] Since we construct an index, rather than a scale, of the health risk factors, we do not report an alpha coefficient.

whether the job involved getting dirty; how many hours per week they spent doing the same things over and over; how many hours per week they worked with their hands; and whether they were ever exposed to dangerous conditions. Dangerous exposures most frequently involved hazardous chemicals and the use of heavy machinery. As indicated in Table 1, in 1992/93 about one in three WLS graduates had current or last jobs that always or frequently involved physical effort, about half had jobs that involved getting dirty, and one in five were ever exposed to dangerous conditions. Respondents tended to spend about 20 hours per week doing the same things over and over and working with their hands.

We divide the psychosocial characteristics of graduates' and siblings' current or most recent jobs in 1992/93/94 into two separate indices. First, we construct an index of the amount of job control respondents have. This construct includes whether the respondent supervised other employees' work; whether they were themselves supervised by someone else; and whether they control their own work schedule. We construct a second index of cognitive job demands. This construct includes whether respondents learn new things on their job; whether their job always or frequently involved working under the pressure of time; and whether their job always or frequently required intense concentration. Although the 1992/93/94 WLS surveys were not designed to test the tenets of Balance Theory (Smith and Carayon-Sainfort 1989), they do provide most of the measures of importance to that theory; our psychosocial measures also include several variables of importance in the Job Strain model (Karasek 1979).[5]

SIBLING RESEMBLANCE MODELS

[5] Again, since the job characteristics measures are indices rather than scales, we do not report alpha coefficients.

Although sibling resemblance models have been estimated using WLS data on a number of occasions, previous research has primarily focused on the impact of family socioeconomic background, educational attainment, and cognitive ability on educational and occupational attainment (e.g., Warren, Hauser, and Sheridan 2002). Sibling resemblance models conceptually account for observed and unobserved aspects of respondents' shared social origins. The goal of the present analyses is to obtain estimates of the extent to which job characteristics mediate associations between SES factors and a variety of health outcomes in the absence of spuriousness induced by family background factors.

Figure 1 represents a typical sibling model, in this case the effect of educational attainment on self-assessed overall health. We will use this simplified example to describe sibling resemblance models in general, and then we describe our actual models in more detail. The model in Figure 1 contains four observed variables: the graduate's education (x_1) and self-assessed overall health (y_1) and the sibling's education (x_2) and self-assessed overall health (y_2). Each of the observed variables is a function of a "true" latent characteristic and an error term. The four unobserved, latent characteristics are each a function of a common family factor (either ξ_2 or η_5) and a within-family factor. That is, each unobserved, latent attribute is wholly determined by two factors: one that affects each member of the sibling pair (the common family factor) and another that only affects one of the siblings (the within-family factor).

How does the model in Figure 1 express the effect of education on health? In the model, the common family factor for self-assessed overall health (η_5) is a function of the common family factor for educational attainment (ξ_2) and a disturbance term (ζ_5). Likewise, the within-family factors for graduates' and siblings' self-assessed overall health (η_3 for graduates and η_7 for siblings) are functions of the within-family factors for graduates' and siblings' education (ξ_1

for graduates and ξ_3 for siblings) and disturbance terms (ζ_3 for graduates and ζ_7 for siblings). Thus there are three coefficients ($\gamma_{3,1}$, $\gamma_{5,2}$, and $\gamma_{7,3}$) that represent the effect of education on self-assessed overall health. The between-family effect is expressed by $\gamma_{5,2}$. This coefficient expresses the effect of the common family factor for education on the common family factor for self-assessed overall health. The within-family effects for graduates and siblings are represented by $\gamma_{3,1}$ and $\gamma_{7,3}$, respectively. Whether $\gamma_{3,1}$, $\gamma_{5,2}$ and $\gamma_{7,3}$ are equivalent is an interesting empirical issue. If the between-family regression of self-assessed overall health on education differs substantially from the within-family regressions, then we would conclude that social origins bias the simple regression of observed self-assessed overall health outcomes on observed educational attainment. Otherwise stated, if social origins do not bias observed relationships between these variables, then the within-family and between-family regression should be equivalent.

The model as drawn in Figure 1 is not identified unless we impose restrictions on certain parameters. One reasonable restriction would be to impose the constraint that $\gamma_{1,2} = \beta_{4,5} = 1$. For each common family factor, this implies that both within-family measures are in the same metric as the latent family factor. This also allows comparisons of between-family regressions with their corresponding within-family regressions (Bielby 1982; Hauser and Mossel 1985).

The models that we actually estimate are a good deal more complicated than the model depicted in Figure 1, mostly because Figure 1 only represents the relationship between one endogenous and one exogenous variable. The models we estimate include education, a health risk factors index, a physical job characteristics' index, a job control index, a cognitive job demands index, earnings, occupational socioeconomic standing, and health outcomes. By "health outcomes," we mean to say that we estimate separate models for self-reported overall health, a cardiovascular health scale, a musculoskeletal health scale, and depression.

Figure 2 is a conceptual model of the relationship between educational attainment, socioeconomic characteristics of jobs, health risk factors, physical and psychosocial job characteristics, and health outcomes. It is purely a heuristic diagram intended for elucidating the logic of our analyses, and is not accurate with respect to technical detail. To be technically accurate, each of the lines connecting two concepts in Figure 2 would need to be replaced with the full specification of relationships between latent and observed measures depicted in Figure 1. The model in Figure 2 specifies that education affects health both directly and indirectly by way of health risk factors, job characteristics, earnings, and occupational standing. Health risk factors, job characteristics, earnings, and occupational standing are mutually correlated, and each has a direct effect on health. Note that education, health-risk factors, physical job characteristics, job control, cognitive job characteristics, earnings, and occupational standing are each measured using single indicator indices, and that health outcomes are measured using single indicator scales.

Each of our models is estimated using LISREL 8.50. Model fit was assessed using the Bayesian Information Criterion, BIC = L^2 - $df \times \ln(N)$, where L^2 is the likelihood-ratio χ^2 statistic, *df* is the number of degrees of freedom in the model, and N is the sample size. BIC is useful in making judgments about model fit when a model would be rejected by conventional statistical tests. That is, in analyses based on large samples, BIC may suggest accepting a model that is rejected by usual criteria of statistical significance (Raftery 1995).

RESULTS

Table 3 presents selected results from five models for self-reported overall health, cardiovascular health problems, musculoskeletal health problems, and depression. Model 1 for each outcome

includes only education as an independent variable. Model 2 includes education and health risk factors as independent variables, and Model 3 includes education, health risk factors, physical job characteristics, cognitive job characteristics, and job control. Model 4 includes education and health risk factors, but does not include the job characteristics included in Model 3; rather, Model 4 includes socioeconomic aspects of jobs, i.e. earnings and occupational standing. Model 5 includes education, health risk factors, and both socioeconomic (earnings and occupational standing) and "non-socioeconomic" (physical and psychosocial) properties of jobs.[6]

By comparing the estimated effects of education across Models 1 and 2 we observe the extent to which the estimated effect of education on health is mediated by health risk factors; by making a similar comparison across Models 2 and 3 we observe the extent to which the estimated effect of education on health that persists after adjusting for health risk factors can be attributed to job characteristics. By comparing the estimated effect of education on health across Models 2 and 4 we observe the extent to which the estimated effect of education on health that persists after adjusting for health risk factors can be attributed to earnings and occupational standing. Finally, we can compare effects across Models 2 and 5 and across Models 4 and 5, in order to disentangle the effects of socioeconomic characteristics of jobs and other properties of jobs that indicate quality, namely physical demands, cognitive demands, and job control.

We tested a series of specifications of Models 1 through 5; these specifications differ with respect to assumptions about the equality of within-family effects across siblings and with

[6] Although physical and psychosocial characteristics of jobs are in effect socioeconomic, we use the term "non-socioeconomic" merely to differentiate between these characteristics and more traditionally conceived socioeconomic characteristics of jobs, i.e. earnings and occupational standing.

respect to the equality of the between- and within-family effects. The best fitting specifications of Models 1 through 5 stipulate that all within- and between-family effects are equivalent (such that $\gamma_{3,1} = \gamma_{5,2} = \gamma_{7,3}$ in Figure 1 in the part of the model that expresses the effect of education on health).[7] Substantively speaking, Models 1 through 5 specify that family background factors do not bias observed associations between education, health risk factors, earnings, occupational standing, physical and psychosocial job characteristics, and health outcomes. It is therefore unlikely that "indirect selection" poses a threat in our data.

The results of Model 1 show that education is significantly related to each of the four health outcomes, such that more educated respondents enjoy better overall health, experience fewer cardiovascular and musculoskeletal health problems, and are less likely to report symptoms of depression, before adjusting for health risk factors or job characteristics. As expected, the results of Model 2 suggest that health risk factors explain a portion of the observed associations between education and health outcomes. However, even after adjusting for health risk factors there are significant associations between education and each health outcome.

The results from Model 3 suggest that job characteristics, particularly physical job characteristics, are significantly related to health, and in expected directions. People with more physically demanding jobs enjoy less optimal health outcomes. Moreover, people with more job control are less likely to be depressed. Although the associations between job characteristics and health are substantively interesting, our real concern is in the extent to which the estimated associations between education and health change between Models 2 and 3. Although education was significantly associated with musculoskeletal health and depression even after adjusting for health-risk factors, these associations are no longer statistically significant once we account for

[7] Details of model specification and model fit are located in Appendix A.

physical and psychosocial job characteristics. Education is significantly associated with overall health and cardiovascular health problems even after adjusting for health risk factors and job characteristics, but this association is reduced in magnitude from Model 2 to Model 3 by more than 30% for overall health and by more than 40% for cardiovascular health problems. Hence, we find evidence that job characteristics play an important mediating role in associations between education and health.

Model 4 is like Model 3 except that instead of including physical and psychosocial characteristics of jobs, we examine socioeconomic properties of jobs, namely earnings and occupational standing. Results from Model 4 suggest that earnings and occupational standing are significantly related to overall health, musculoskeletal health, and depression, but not to cardiovascular health. People with higher earnings and people with higher occupational standing enjoy better health. Again, although these associations are substantively interesting, our main concern is in the extent to which the estimated associations between education and health change between Models 2 and 4. As was true for Model 3, the association between education and musculoskeletal health and the association between education and depression are no longer statistically significant in Model 4. Also analogous to Model 3, while education is significantly associated with overall health and cardiovascular health problems even after adjusting for health risk factors, earnings, and occupational standing, this association is reduced in magnitude from Model 2 to Model 4.

The models above were designed to answer two questions: (1) In Model 3, we questioned whether *non-socioeconomic* job characteristics, i.e. physical and cognitive job characteristics and job control, mediate the relationship between education and health; and (2) In Model 4, we questioned whether *socioeconomic* job characteristics, i.e. earnings and occupational standing,

mediate the relationship between education and health. The answer is that both non-socioeconomic and socioeconomic properties of jobs have a similar ability to mediate the education-health relationship. Model 5 includes health related risk factors, non-socioeconomic job characteristics (physical job characteristics, cognitive job characteristics, and job control) *and* socioeconomic job characteristics (earnings and occupational standing). The comparisons we make using Model 5 allow us to disentangle the roles of non-socioeconomic and socioeconomic job characteristics. First we compare results from Model 5 to Model 2. The association between education and overall health is still statistically significant, but it is reduced in magnitude from Model 2 to Model 5 by more than 50%. The inclusion of non-socioeconomic and socioeconomic characteristics of jobs eliminates the significant associations observed in Model 2 between education and cardiovascular health, between education and musculoskeletal health, and between education and depression.

We are also interested in comparing Model 4 which includes education, health-related behaviors, earnings, and occupational standing, with Model 5 which further controls for physical and psychosocial job characteristics. The inclusion of physical and psychosocial job characteristics reduces the magnitude of the association between education and overall health, eliminates the association between earnings and overall health, and reduces the magnitude of the association between occupational standing and overall health. Moreover, the significant association between education and cardiovascular health observed in Model 4 is no longer statistically significant in Model 5. There was not a statically significant association between education and musculoskeletal health problems or between education and depression in Model 4, but there were significant associations between earnings and musculoskeletal health and depression, and between occupational standing and musculoskeletal health and depression. The

association between occupational standing and musculoskeletal health problems and depression is eliminated in Model 5, and the association between earnings and musculoskeletal health is slightly reduced in magnitude. We take this as evidence that job characteristics do mediate associations between SES, as measured by education, earnings, and occupational standing, and health. Controlling for job characteristics either reduces in magnitude or eliminates the association between multiple SES indicators and multiple health outcomes.

In summary, we observe that less educated respondents enjoy less optimal health outcomes. Health related risk factors, including exercise, smoking, and body weight, explain a portion of, but do not entirely account for, the association between education and health. We find that less educated respondents enjoy less optimal health outcomes not only because of health behaviors, but because they have lower earnings and occupational status, have more physically demanding jobs, and less control over their jobs. In fact, by including both socioeconomic *and* non-socioeconomic job characteristics in our models, we completely explain the association between education and cardiovascular health, musculoskeletal health, and depression.

Results by Gender

The results presented above were estimated without respect to gender. However, as we have noted, there is considerable stratification of job characteristics by gender (Biebly and Baron 1986; Kilbourne, Stanek, England, Farkas, Beron, and Weir 1994; Petersen and Morgan 1995; Polachek 1981; Tam 1997; Reskin 1993; Sewell, Hauser, and Wolf 1980). There is also evidence of stratification of heath outcomes by gender (Arber 2001; Lane and Cibula 2000; Macintyre, Hunt, and Sweeting 1996; Walsh, Sorensen, and Leonard 1995). Women tend to report higher levels of depression and a variety of chronic illnesses than men (Baum and

Grunberg 1991; McDonough and Walters 2001; Verbrugge 1985). Despite gender differences in health being more modest in recent analyses that was hitherto found, it has become commonplace to include separate analyses for men and for women (Arber 2001; Macintyre, Hunt, and Sweeting 1996). Table 4 presents selected results from five models for self-reported overall health, cardiovascular and musculoskeletal health problems, and depression for male sibling pairs and Table 5 presents results for female sibling pairs. Models 1 through 5 in Tables 4 and 5 parallel the specification of Models 1 through 5 in Table 3; the best fitting specifications stipulate that all within- and between-family effects are equivalent.[8]

Male Pairs. We first examine results for male pairs. Results from Model 1 suggest that education is significantly related to each of three health outcomes, overall health, cardiovascular and musculoskeletal health, but in contrast to results reported without respect to gender, education is not significantly associated with depression for men. Again, as expected, the results of Model 2 suggest that health risk factors explain a portion of the observed associations between education and health. However, even after adjusting for health risk factors there are significant associations between education and overall health, cardiovascular and musculoskeletal health.

Results from Model 3 suggest that physical job characteristics and the degree of job control men have are significantly related to overall health. Men with more physically demanding jobs enjoy less optimal overall health and men with more control over their jobs have better overall health. Physical job characteristics are also strongly related to musculoskeletal health for men. While education was significantly associated with musculoskeletal health even

[8] Again, details of model specification and model fit can be found in Appendix A. Additionally, Appendix B provides results from t-tests testing whether there are significantly different effects for men and for women.

after adjusting for health-risk factors, this association is no longer statistically significant once we account for physical job characteristics. Education is significantly associated with overall health and cardiovascular health problems even after adjusting for health risk factors and job characteristics, but this association is reduced in magnitude from Model 2 to Model 3 by about 45% for overall health and by 25% for cardiovascular health problems. In other words, job characteristics completely explain the association between men's educational attainment and their musculoskeletal health that remains after adjusting for health-risk factors and explains a substantial share of the association between men's educational attainment and their overall and cardiovascular health.

Results from Model 4 for men are similar to results for the full sample, such that earnings and occupational standing are significantly related to overall health, musculoskeletal health, and depression, but not cardiovascular health. The associations between education and health are completely explained from Model 2 to Model 4. These results for men differ than the results for the full sample, in which education is significantly associated with overall health and cardiovascular health problems even after adjusting for health risk factors, earnings and occupational standing. Comparing results from Model 5 to Model 2, the inclusion of various properties of jobs eliminates the significant associations observed in Model 2 between education and overall health, between education and cardiovascular health, and between education and musculoskeletal health. Comparing Model 4 which controls for education, earnings, and occupational standing, with Model 5 that further controls for physical and psychosocial job characteristics, the association between earnings and occupational standing and musculoskeletal health problems is eliminated with the inclusion of job characteristics in Model 5, and the association between earnings and occupational standing and overall health is reduced in

magnitude. The inclusion of physical and psychosocial job characteristics also eliminates the association between earnings and depression.

In summary, we observe that less educated men enjoy less optimal overall health and have more cardiovascular and musculoskeletal health problems. In contrast to results that pertain to the full sample, less educated men do not have higher levels of depression than more educated men. As was true for the full sample, men's health related risk factors explain a portion of, but do not entirely account for, the association between education and health. The inclusion of earnings and occupational standing completely explains the association we observe between men's educational attainment and health. Our results further suggest that the association between earnings and occupational standing and musculoskeletal health is explained by the fact that less educated men have more physically demanding jobs.

Female Pairs. Table 5 presents results for female pairs. In contrast to men, education is only significantly related to overall health and depression for women and not to cardiovascular or musculoskeletal health; these gender differences are statically significant. Appendix B reports t-tests for the pairwise differences by gender reported in Tables 4 and 5. Health risk factors explain a portion of the observed associations between education and overall health and depression; however, significant associations remain. There are significant differences between men and women for the effects of education on musculoskeletal health and depression in Model 2. Results from Model 3 suggest that physical job characteristics are significantly associated with overall health, cardiovascular health problems, musculoskeletal health problems, and depression; women with more physically demanding jobs enjoy less optimal health. Cognitive job characteristics are also associated with overall health. Education is significantly associated with overall health and depression even after adjusting for health risk factors and job

characteristics, but this association is reduced in magnitude from Model 2 to Model 3 by about 25% for overall health and 25% for depression. In Model 3, only the effect of education on depression significantly differs by gender.

Results from Model 4 suggest that the associations between education and overall health and depression are no longer statistically significant from Model 2 to Model 4. These results are generally true for men as well. Comparing results from Model 5 to Model 2 for women, the inclusion of various properties of jobs also eliminates the significant associations observed in Model 2 between education and overall health and between education and depression. Comparing Model 4 with Model 5, there were not statically significant associations between education and health, but there were significant associations between occupational standing and overall health and between earnings and cardiovascular health. The association between occupational standing and overall health is eliminated for women as a result of the inclusion of characteristics of jobs women hold, while the association between earnings and cardiovascular health remains unchanged. In both Models 4 and 5, the effects of education and of earnings on depression significantly differ for men and for women.

In summary, we observe that less educated women enjoy less optimal overall health and have higher levels of depression. In contrast to results that pertain to the full sample, and results that pertain just to men, less educated women do not have more cardiovascular or musculoskeletal health problems. Women's health related risk factors explain a portion of, but do not entirely account for, the association between education and health and depression. While non-socioeconomic characteristics of jobs explain some portion of this association, the inclusion of earnings and occupational standing completely explains the association we observe between women's educational attainment and health. Our results also suggest that the association

between occupational standing and overall health is explained by the fact that less educated women have more physically demanding jobs.

DISCUSSION

Our paper is an effort to understand the mechanisms that link SES and health. We observed, as others have, that socioeconomic status is associated with a variety of health outcomes. Some portion of this association is explained by the facts that less educated individuals exercise less frequently, have higher body mass indexes, and are more likely to smoke. However, even after controlling for health-related behaviors there are still strong associations between SES and health outcomes. In general, we find that physical and psychosocial job characteristics account for some or all of these remaining associations. That is, job characteristics play an important role in mediating the relationships between SES and these health outcomes.

As there exists stratification of job characteristics and of heath outcomes by gender, suggesting that there may be important differences between men and women in associations between SES, job characteristics, and health outcomes, we also estimate separate models for men and for women. We find that there are indeed significant gender differences, particularly for relationships between SES and musculoskeletal health and depression. While SES is significantly associated with musculoskeletal health problems among men, it is not associated with such health problems among women. In contrast, while SES is significantly associated with depression among women, it is not associated with depression among men. An additional insight we achieve from estimating results separately by gender is that while the association between education and self-assessed overall health persists throughout the models estimated in the full sample, results by gender show that education is not significantly associated with overall health

when we control for earnings and occupational education. There are also significant differences between men and women for the association between job control and overall health.

Our analyses are obviously limited by the cross-sectional nature of the data that we use in these analyses. Earnings, occupational standing, job characteristics, and health are measured at the same point in time, and so we are in no position to make conclusions about the nature or direction of causality in these associations. It may be that socioeconomic status and job characteristics have direct effects on health, but it may also be that people who are in poor health are limited with respect to the kinds of jobs they can hold and the socioeconomic well-being they can enjoy. SES and health are certainly related to one another, and job characteristics certainly play an important role in this association. We make no claim about causal ordering. Statements about causality will have to await data from the 2003-2005 round of WLS graduate and sibling surveys, which will allow us to observe changes between 1992/93/94 and 2003-2005 in health outcomes and job characteristics.

Our central hypothesis is that some portion of observed education-health associations and observed SES-health associations can be attributed to job characteristics. People with more education (and higher wages, etc.) enjoy more favorable health outcomes. Why? We hypothesize that one reason is that people with more education tend to have jobs that are less conducive to ill health. Although a cross-sectional analysis like ours has real shortcomings, a simple longitudinal analysis (regress health at time *t* on explanatory variables at time *t-1*, where *t* and *t-1* are separated by 17 years on our data) has shortcomings as well. To really sort out the direction and nature of causality in the relationships between SES, health, and job characteristics we need more extensive data. Respondents' health changes over time, but so do their job characteristics and socioeconomic position. What is more, jobs change in response to health at

the same time that health changes in response to jobs. In the context of the WLS, it is not simply a matter of inserting pre-1992 SES and job characteristics measures in the place of 1992 measures. What we really need are cumulative measures of job characteristics over time, measures that capture the complete job histories of respondents in the period between which SES and health are measured. However, despite this being well beyond the scope of this paper, we do not have cumulative trajectories available for WLS siblings.

In this paper we expand and improve upon our previous effort (Warren, Hoonakker, Carayon, and Brand 2004) to understand how job characteristics mediate relationships between SES and health in several ways. First, we use sibling resemblance models and therefore address issues of omitted variable bias with respect to family socioeconomic background. Second, by including siblings, we do not exclusively focus on high school graduates. Third, we include an expanded set of model specifications; we examine relationships between education and job characteristics and relationships between education and job characteristics net of earnings and occupational status, rather than focusing exclusively on the latter. Fourth, we include an additional health outcome, depression, which yields further interesting findings.

Despite the aforementioned limitations, our results provide important suggestive evidence that in order to understand the social processes that stratify health outcomes we need to consider the processes that stratify the characteristics and conditions of paid employment. As researchers from a variety of disciplines continue to explore the mechanisms that link SES and health, it would be worth keeping in mind sociological evidence about inequalities in the conditions of paid employment and evidence from job design, occupational stress, and ergonomics fields that the conditions of paid employment matter for health.

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Table 1. Descriptions of Variables, WLS Graduate and Sibling Samples

	WLS Graduates					WLS Selected Siblings				
	Full Sample of Graduates			Analysis Sample[1] (N = 1,875)		Full Sample of Siblings			Analysis Sample[1] (N = 1,875)	
	% or Avg.	(sd)	n	% or Avg.	(sd)	% or Avg.	(sd)	n	% or Avg.	(sd)
Health Outcomes in 1992/1994										
Self-reported Overall Health [1(very poor) - 5(excellent	1.8	(0.7)	6,862	1.8	(0.7)	1.9	(0.7)	4,039	1.9	(0.7)
Cardiovascular Health Scale	0.00	(0.7)	6,875	0.01	(0.7)	0.01	(0.7)	4,043	0.04	(0.7)
Self-reported Chest Pain (Yes=1)	0.5%		6,849	0.4%		0.6%		3,983	0.8%	
Self-reported Shortness of Breath (Yes=1)	2.0%		6,837	1.8%		2.4%		3,963	2.4%	
Medically-diagnosed Heart Trouble (Yes=1)	3.7%		6,873	3.8%		5.3%		3,962	5.9%	
Medically-diagnosed High Blood Pressure (Yes=1)	8.8%		6,866	7.7%		10.7%		3,954	10.4%	
Musculoskeletal Health Scale	0.00	(0.7)	6,875	0.01	(0.7)	0.01	(0.7)	4,043	0.01	(0.7)
Self-reported Aching Muscles (Yes=1)	8.4%		6,708	7.7%		9.6%		3,849	9.5%	
Self-reported Stiff/Swollen Joints (Yes=1)	9.2%		6,775	8.4%		9.4%		3,921	9.4%	
Self-reported Back Pain/Strain (Yes=1)	8.4%		6,714	7.9%		9.6%		3,883	8.9%	
Medically-diagnosed Back Trouble (Yes=1)	8.4%		6,872	7.3%		13.1%		3,943	12.1%	
Depression CES-D [(0(least)-140(most depressed)]	16.6	(15.6)	6,807	15.9	(14.6)	17.3	(16.2)	3,974	16.4	(15.2)
Education										
Number of years of schooling completed	13.6	(2.3)	8,492	13.7	(2.3)	13.6	(2.5)	5,334	13.7	(2.5)
Socioeconomic Job Characteristics, Current or Last Job, 1992/1994										
Log Wage Rate on Current or Last Job in 1992/1994	2.4	(1.0)	7,719	2.5	(1.0)	2.2	(1.4)	4,468	2.3	(1.3)
Occupational Education, Current or Last Job, 1992/199	0.6	(1.4)	8,002	0.7	(1.4)	0.6	(1.4)	5,012	0.6	(1.4)
Health Behaviors in 1992/1994										
# Times Exercised Vigorously in Past Month	3.6	(3.9)	6,697	3.7	(4.0)	3.8	(4.0)	3,964	3.6	(3.8)
Body Mass Index	22.0	(3.8)	6,710	21.9	(3.8)	22.1	(3.9)	3,942	22.1	(4.0)
Current Smoker? (Yes=1)	17.7%		6,766	18.4%		17.1%		3,993	16.8%	
Physical Job Characteristics, Current or Last Job, 1992/1994										
Job Freq./Always Involves Phys. Effort (Yes=1)	36.5%		8,101	32.4%		38.7%		4,729	36.5%	
Job Ever Involves Getting Dirty (Yes=1)	51.3%		8,084	48.1%		53.1%		4,716	51.8%	
Hrs/Wk Spent Doing Same Things Over & Over	21.5	(17.4)	7,664	20.1	(16.9)	22.2	(17.6)	4,409	21.3	(17.0)
Hrs/Wk Spent Working with Hands	22.9	(17.0)	8,012	21.6	(15.7)	23.7	(17.5)	4,661	22.4	(16.9)
Exposure to Dangerous Conditions (Yes=1)	20.2%		8,099	17.7%		20.2%		4,723	20.2%	
Job Control Characteristics, Current or Last Job, 1992/1994										
Supervises Others (Yes=1)	53.6%		7,764	56.0%		52.2%		4,516	51.5%	
Supervised by Others (Yes=1)	74.6%		7,765	76.2%		76.4%		4,518	77.6%	
Controls Own Work Schedule (Yes=1)	50.9%		7,768	53.0%		49.4%		4,508	49.5%	
Cognitive Job Characteristics, Current or Last Job, 1992/1994										
Learns New Things on Job (Yes=1)	68.6%		8,023	69.5%		70.3%		4,665	69.9%	
Job Freq./Always Involves Concentration (Yes=1)	89.7%		8,104	90.3%		88.4%		4,726	88.5%	
Job Freq./Always Involves Time Pressure (Yes=1)	72.3%		8,090	73.5%		71.1%		4,717	71.7%	

[1] Sample restricted to cases in which graduates responded to the 1992 telephone and mail surveys and the sibling responded to the 1993 telephone and mail surveys

Table 2. Descriptions of Variables, WLS Male and Female Sibling Pairs

	WLS Male Sibling Pairs n=424				WLS Female Sibling Pairs n=561			
	Male Graduates		Male Siblings		Female Graduates		Female Siblings	
	% or Avg.	(sd)	% or Avg.	(sd)	% or Avg.	(sd)	% or Avg.	(sd)
Health Outcomes in 1992/1994								
Self-reported Overall Health [1(very poor) - 5(excellent	1.9	(0.6)	2.0	(0.7)	1.8	(0.7)	1.9	(0.7)
Cardiovascular Health Scale	0.08	(0.8)	0.10	(0.8)	0.00	(0.7)	0.00	(0.7)
Self-reported Chest Pain (Yes=1)	0.6%		1.4%		0.7%		0.3%	
Self-reported Shortness of Breath (Yes=1)	2.6%		3.7%		1.6%		1.8%	
Medically-diagnosed Heart Trouble (Yes=1)	6.0%		8.9%		3.7%		3.8%	
Medically-diagnosed High Blood Pressure (Yes=1)	8.0%		11.2%		7.3%		10.5%	
Musculoskeletal Health Scale	0.08	(0.7)	-0.02	(0.7)	0.08	(0.7)	0.01	(0.7)
Self-reported Aching Muscles (Yes=1)	5.6%		7.4%		10.7%		9.6%	
Self-reported Stiff/Swollen Joints (Yes=1)	6.2%		6.0%		11.8%		9.9%	
Self-reported Back Pain/Strain (Yes=1)	7.9%		9.1%		10.6%		8.8%	
Medically-diagnosed Back Trouble (Yes=1)	9.2%		11.5%		6.0%		10.8%	
Depression CES-D [(0(least)-140(most depressed)]	14.9	(14.4)	15.0	(15.2)	16.6	(15.0)	17.0	(14.7)
Education								
Number of years of schooling completed	14.1	(2.6)	14.2	(2.7)	13.4	(2.0)	13.4	(2.3)
Socioeconomic Job Characteristics, Current or Last Job, 1992/1994								
Log Wage Rate on Current or Last Job in 1992/1994	2.9	(0.6)	2.8	(1.0)	2.1	(1.1)	1.9	(1.3)
Occupational Education, Current or Last Job, 1992/199	0.7	(1.4)	0.6	(1.5)	0.6	(1.3)	0.7	(1.3)
Health Behaviors in 1992/1994								
# Times Exercised Vigorously in Past Month	4.1	(4.2)	4.1	(3.9)	3.3	(3.7)	3.0	(3.6)
Body Mass Index	22.4	(3.2)	22.7	(3.6)	21.3	(3.8)	21.9	(4.6)
Current Smoker? (Yes=1)	18.8%		20.0%		19.5%		15.4%	
Physical Job Characteristics, Current or Last Job, 1992/1994								
Job Freq./Always Involves Phys. Effort (Yes=1)	28.9%		36.8%		36.3%		37.8%	
Job Ever Involves Getting Dirty (Yes=1)	50.3%		56.2%		44.8%		47.7%	
Hrs/Wk Spent Doing Same Things Over & Over	19.7	(17.9)	19.6	(17.8)	20.9	(15.4)	21.2	(15.1)
Hrs/Wk Spent Working with Hands	20.5	(17.4)	20.9	(18.3)	22.8	(15.4)	23.2	(15.4)
Exposure to Dangerous Conditions (Yes=1)	21.1%		24.3%		12.0%		15.0%	
Job Control Characteristics, Current or Last Job, 1992/1994								
Supervises Others (Yes=1)	65.0%		59.8%		45.9%		44.0%	
Supervised by Others (Yes=1)	72.2%		74.0%		76.8%		80.5%	
Controls Own Work Schedule (Yes=1)	60.4%		58.7%		45.5%		44.9%	
Cognitive Job Characteristics, Current or Last Job, 1992/1994								
Learns New Things on Job (Yes=1)	72.8%		72.8%		65.0%		68.5%	
Job Freq./Always Involves Concentration (Yes=1)	90.7%		88.7%		90.9%		88.6%	
Job Freq./Always Involves Time Pressure (Yes=1)	76.9%		70.1%		73.7%		72.6%	

Table 3. Within-Family Effects of Education, Health-Related Behaviors, and Job Characteristics on Health: Full Sample

	Overall Health		Cardiocascular		Musculoskeletal		Depression	
	Coef.	Coef./se	Coef.	Coef./se	Coef.	Coef./se	Coef.	Coef./se
Model 1								
Education	**-0.17**	**(-10.22)**	**-0.09**	**(-5.58)**	**-0.09**	**(-5.72)**	**-0.05**	**(-2.90)**
Model 2								
Education	**-0.13**	**(-8.01)**	**-0.07**	**(-4.34)**	**-0.08**	**(-4.60)**	**-0.03**	**(-1.96)**
Health-Related Behaviors	**0.21**	**(12.97)**	**0.11**	**(6.68)**	**0.10**	**(5.89)**	**0.08**	**(5.13)**
Model 3								
Education	**-0.09**	**(-5.03)**	**-0.04**	**(-2.37)**	-0.02	(-1.30)	0.01	(-0.40)
Health-Related Behaviors	**0.21**	**(12.90)**	**0.11**	**(6.72)**	**0.10**	**(5.87)**	**0.08**	**(5.00)**
Physical Job Characteristics	**0.09**	**(5.36)**	**0.07**	**(4.19)**	**0.13**	**(7.13)**	**0.08**	**(4.56)**
Cognitive Job Characteristics	-0.03	(-1.66)	0.03	(1.65)	0.00	(0.05)	0.00	(-0.26)
Job Control	-0.01	(-0.92)	-0.01	(-0.35)	-0.01	(-0.73)	**-0.05**	**(-2.77)**
Model 4								
Education	**-0.07**	**(-3.22)**	**-0.05**	**(-2.17)**	-0.02	(-0.92)	0.01	(-0.59)
Health-Related Behaviors	**0.21**	**(12.93)**	**0.11**	**(6.65)**	**0.09**	**(5.79)**	**0.08**	**(5.06)**
Earnings	**-0.04**	**(-2.23)**	-0.02	(-1.04)	**-0.07**	**(-4.03)**	**-0.04**	**(-2.41)**
Occupational Education	**-0.09**	**(-4.27)**	-0.03	(-1.65)	**-0.06**	**(-2.95)**	**-0.05**	**(-2.63)**
Model 5								
Education	**-0.06**	**(-2.68)**	-0.03	(-1.57)	0.00	(-0.03)	0.03	(-1.25)
Health-Related Behaviors	**0.20**	**(12.88)**	**0.11**	**(6.70)**	**0.09**	**(5.81)**	**0.08**	**(4.96)**
Earnings	-0.03	(-1.87)	-0.02	(-1.08)	**-0.06**	**(-3.80)**	**-0.04**	**(-2.08)**
Occupational Education	**-0.05**	**(-2.47)**	-0.01	(-0.46)	-0.02	(-0.69)	-0.02	(1.01)
Physical Job Characteristics	**0.08**	**(4.14)**	**0.07**	**(3.76)**	**0.12**	**(6.31)**	**0.07**	**(3.86)**
Cognitive Job Characteristics	-0.02	(-1.13)	0.03	(1.82)	0.01	(0.60)	0.00	(0.12)
Job Control	-0.01	(-0.79)	0.00	(-0.29)	-0.01	(-0.54)	**-0.04**	**(-2.65)**
Percentage change in coefficient for SES variables								
Model 2 vs. Model 1								
Education		-22.2%		-21.3%		-18.5%		-31.5%
Model 3 vs. Model 2								
Education		-31.8%		-40.7%	No longer significant		No longer significant	
Model 4 vs. Model 2								
Education		-48.8%		-36.1%	No longer significant		No longer significant	
Model 5 vs. Model 4								
Education		-16.5%	No longer significant			---		---
Earnings	No longer significant			---		-5.4%		-13.0%
Occupational Education		-39.0%		---	No longer significant		No longer significant	

Table 4. Within-Family Effects of Education, Health-Related Behaviors, and Job Characteristics on Health: Male Pairs

	Overall Health		Cardiocascular		Musculoskeletal		Depression	
	Coef.	Coef./se	Coef.	Coef./se	Coef.	Coef./se	Coef.	Coef./se
Model 1								
Education	**-0.23**	**(-6.80)**	**-0.15**	**(-4.23)**	**-0.15**	**(-4.41)**	-0.01	(-0.15)
Model 2								
Education	**-0.18**	**(-5.26)**	**-0.12**	**(-3.44)**	**-0.14**	**(-3.98)**	0.00	(0.12)
Health-Related Behaviors	**0.22**	**(6.54)**	**0.11**	**(3.14)**	0.05	(1.32)	0.04	(1.18)
Model 3								
Education	**-0.10**	**(-2.82)**	**-0.09**	**(-2.15)**	-0.04	(-1.11)	0.06	(1.53)
Health-Related Behaviors	**0.22**	**(6.59)**	**0.11**	**(3.14)**	0.05	(-1.49)	0.04	(1.21)
Physical Job Characteristics	**0.08**	**(2.11)**	0.05	(1.33)	**0.20**	**(4.98)**	**0.10**	**(2.46)**
Cognitive Job Characteristics	0.01	(0.35)	-0.01	(-0.18)	0.01	(0.25)	-0.01	(-0.22)
Job Control	**-0.10**	**(-2.82)**	-0.04	(-1.15)	-0.01	(-0.41)	-0.04	(-1.03)
Model 4								
Education	-0.06	(-1.31)	-0.08	(-1.82)	-0.01	(-0.24)	**0.10**	**(2.11)**
Health-Related Behaviors	**0.22**	**(6.66)**	**0.11**	**(3.14)**	0.05	(1.40)	0.04	(1.15)
Earnings	**-0.12**	**(-3.48)**	-0.06	(-1.80)	**-0.08**	**(-2.11)**	**-0.13**	**(-3.45)**
Occupational Education	**-0.13**	**(-3.01)**	-0.03	(-0.60)	**-0.16**	**(-3.57)**	-0.08	(-1.77)
Model 5								
Education	-0.05	(-1.07)	-0.07	(1.58)	0.01	(0.27)	**0.11**	**(2.35)**
Health-Related Behaviors	**0.22**	**(6.64)**	**0.11**	**(3.12)**	0.05	(-1.51)	0.04	(1.16)
Earnings	**-0.11**	**(-3.20)**	-0.06	(-1.59)	-0.06	(-1.67)	**-0.12**	**(-3.18)**
Occupational Education	**-0.10**	**(-2.24)**	0.00	(0.02)	-0.09	(-1.87)	-0.05	(-0.93)
Physical Job Characteristics	0.02	(0.59)	0.04	(1.01)	**0.15**	**(3.64)**	0.06	(1.47)
Cognitive Job Characteristics	0.02	(0.63)	0.00	(-0.13)	0.02	(0.45)	0.00	(-0.04)
Job Control	**-0.09**	**(-2.52)**	-0.04	(-1.07)	-0.01	(-0.19)	-0.03	(-0.77)
Percentage change in coefficient for SES variables								
Model 2 vs. Model 1								
Education		-22.3%		-16.9%		-7.2%		---
Model 3 vs. Model 2								
Education		-45.2%		-29.7%		No longer significant		---
Model 4 vs. Model 2								
Education	No longer significant		No longer significant		No longer significant		Becomes significant	
Model 5 vs. Model 4								
Education		---		---		---		11.9%
Earnings		-7.2%		---		No longer significant		-6.9%
Occupational Education		-19.9%		---		No longer significant		---

Table 5. Within-Family Effects of Education, Health-Related Behaviors, and Job Characteristics on Health: Female Pairs

	Overall Health		Cardiocascular		Musculoskeletal		Depression	
	Coef.	Coef./se	Coef.	Coef./se	Coef.	Coef./se	Coef.	Coef./se
Model 1								
Education	**-0.13**	**(-4.42)**	-0.05	(-1.80)	0.00	(-0.05)	**-0.11**	**(-3.63)**
Model 2								
Education	**-0.11**	**(-3.62)**	-0.04	(-1.32)	0.02	(0.56)	**-0.09**	**(-3.10)**
Health-Related Behaviors	**0.23**	**(7.80)**	**0.12**	**(4.14)**	**0.16**	**(5.32)**	**0.14**	**(4.77)**
Model 3								
Education	**-0.08**	**(-2.56)**	-0.02	(-0.59)	0.05	(1.61)	**-0.07**	**(-2.19)**
Health-Related Behaviors	**0.22**	**(7.80)**	**0.12**	**(4.10)**	**0.16**	**(5.30)**	**0.14**	**(4.69)**
Physical Job Characteristics	**0.09**	**(2.91)**	**0.08**	**(2.49)**	**0.12**	**(3.79)**	**0.08**	**(2.65)**
Cognitive Job Characteristics	**-0.06**	**(-2.03)**	0.00	(-0.03)	-0.02	(-0.64)	-0.01	(-0.40)
Job Control	0.00	(0.07)	0.00	(0.01)	0.00	(0.14)	-0.04	(-1.25)
Model 4								
Education	-0.04	(-1.12)	0.02	(0.43)	0.06	(1.59)	-0.05	(-1.40)
Health-Related Behaviors	**0.23**	**(7.83)**	**0.13**	**(4.22)**	**0.16**	**(5.37)**	**0.14**	**(4.77)**
Earnings	-0.04	(-1.49)	**-0.09**	**(-2.82)**	-0.05	(-1.78)	-0.02	(-0.76)
Occupational Education	**-0.09**	**(-2.54)**	-0.06	(-1.54)	-0.05	(-1.29)	-0.06	(-1.60)
Model 5								
Education	-0.04	(-0.97)	0.02	(0.60)	0.07	(1.86)	-0.04	(-1.17)
Health-Related Behaviors	**0.22**	**(7.83)**	**0.12**	**(4.19)**	**0.16**	**(5.34)**	**0.14**	**(4.69)**
Earnings	-0.03	(-1.16)	**-0.09**	**(-2.81)**	-0.05	(-1.58)	-0.02	(-0.70)
Occupational Education	-0.07	(-1.80)	-0.04	(-1.12)	-0.02	(-0.44)	-0.04	(-1.00)
Physical Job Characteristics	**0.07**	**(2.26)**	0.06	(1.87)	**0.11**	**(3.41)**	**0.07**	**(2.25)**
Cognitive Job Characteristics	-0.05	(-1.54)	0.02	(0.60)	-0.01	(-0.30)	0.00	(-0.13)
Job Control	0.00	(-0.03)	-0.01	(-0.19)	0.00	(0.04)	-0.04	(-1.32)
Percentage change in coefficient for SES variables								
Model 2 vs. Model 1								
Education		-19.2%		---		---		-15.0%
Model 3 vs. Model 2								
Education		-26.9%		---		---		-26.6%
Model 4 vs. Model 2								
Education	No longer significant			---		---	No longer significant	
Model 5 vs. Model 4								
Education		---		---		---		---
Earnings		---		0.5%		---		---
Occupational Education	No longer significant			---		---		---

Figure 1. Sibling Resemblance Model of the
Effect of Education on Overall Health

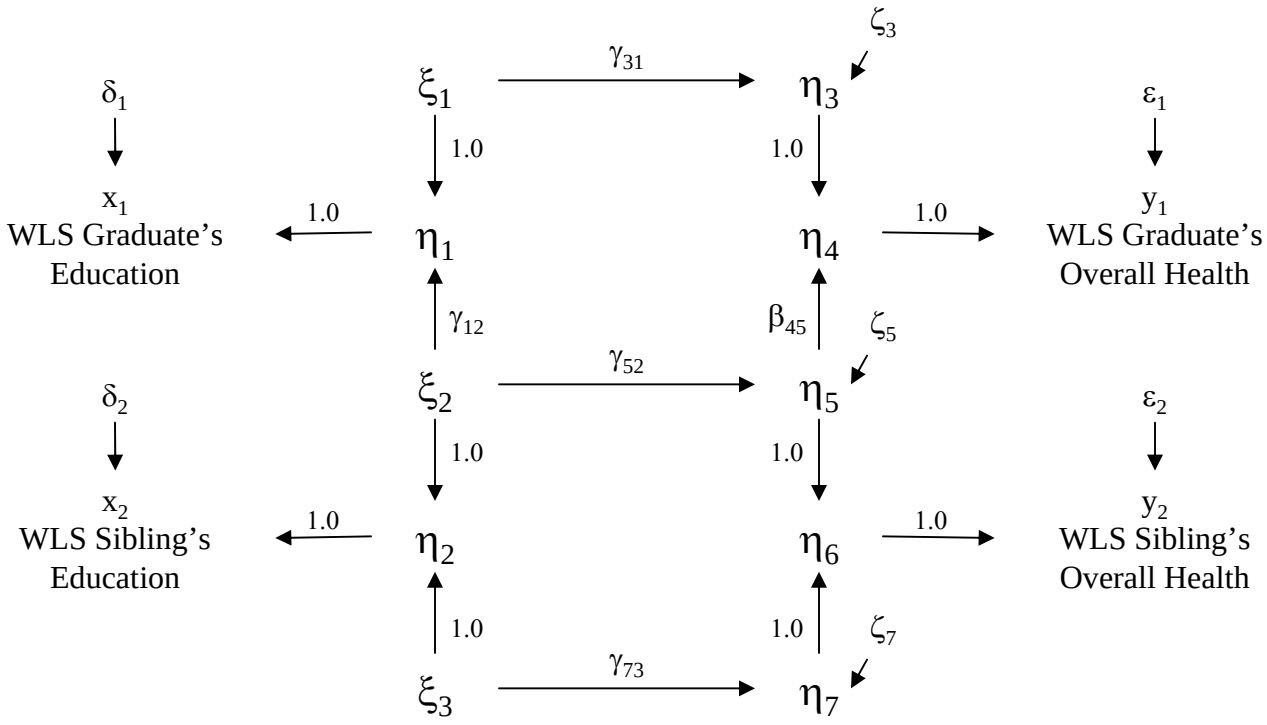
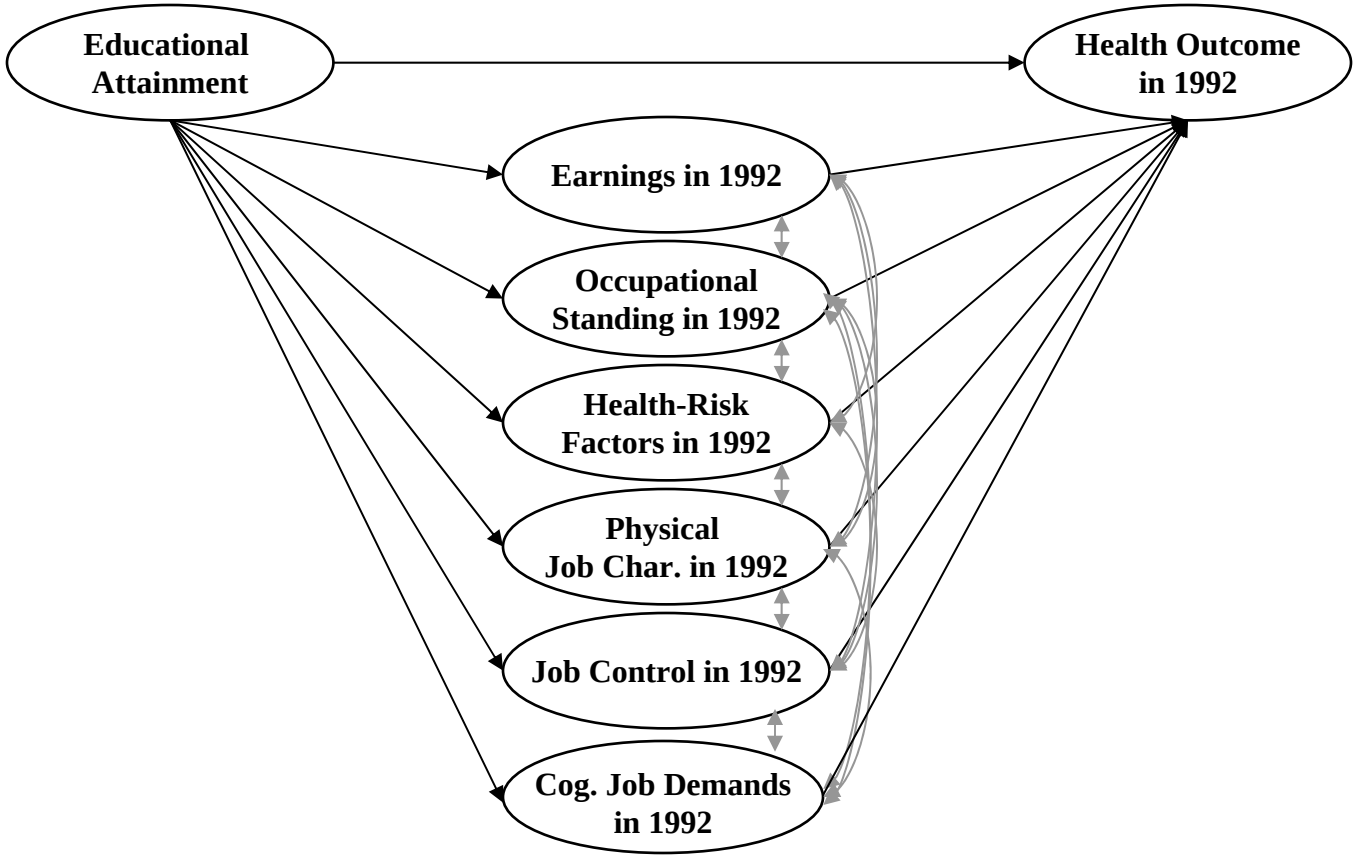


Figure 2. Conceptual Model of the Relationship between Educational Attainment, Earnings, Occupational Standing, Health-Risk Factors, Job Characteristics, and Health Outcomes



Appendix A. Model Specification and Model Fit

Model	Equality Constraints	*Full Sample n=1875* L2	d.f.	BIC	*Male-Male n=424* L2	d.f.	BIC	*Female-Female n=561* L2	d.f.	BIC
Model 1. Health Outcomes on Education										
Model 1A	**Baseline Model**									
	Outcome: Overall Health	0.02	1	-7.52	0.12	1	-5.93	0.07	1	-6.26
	Outcome: Depression	0.20	1	-7.33	0.20	1	-5.85	0.00	1	-6.33
	Outcome: Cardiovascular Health	0.49	1	-7.05	3.39	1	-2.66	0.13	1	-6.20
	Outcome: Musculoskeletal Health	0.62	1	-6.92	0.02	1	-6.03	1.53	1	-4.80
Model 1B	**1A + Education-Health Constraints**									
	Outcome: Overall Health	4.39	5	-33.30	0.55	5	-29.70	2.69	5	-28.96
	Outcome: Depression	1.75	5	-35.94	2.33	5	-27.92	0.10	5	-31.55
	Outcome: Cardiovascular Health	2.28	5	-35.41	8.58	5	-21.67	0.23	5	-31.42
	Outcome: Musculoskeletal Health	2.22	5	-35.46	1.17	5	-29.08	3.63	5	-28.02
Model 2. Health Outcomes on Education and Health Beahaviors										
Model 2A	**1B + Added Variables**									
	Outcome: Overall Health	3.62	7	-49.13	1.61	7	-40.74	2.48	7	-41.83
	Outcome: Depression	1.55	7	-51.21	2.39	7	-39.96	0.34	7	-43.97
	Outcome: Cardiovascular Health	2.89	7	-49.87	6.21	7	-36.14	1.04	7	-43.27
	Outcome: Musculoskeletal Health	3.81	7	-48.94	2.82	7	-39.53	4.08	7	-40.23
Model 2B	**2A + Edu-Health Beh, Health Beh-Health**									
	Outcome: Overall Health	12.00	12	-78.44	5.71	12	-66.89	8.93	12	-67.03
	Outcome: Depression	5.41	12	-85.03	10.69	12	-61.91	4.21	12	-71.75
	Outcome: Cardiovascular Health	7.86	12	-82.57	14.00	12	-58.60	5.83	12	-70.13
	Outcome: Musculoskeletal Health	6.80	12	-83.64	9.91	12	-62.68	9.85	12	-66.11
Model 3. Health Outcomes on Education, Health Beahaviors, and Job Characteristics										
Model 3A	**2B + Added Variables**									
	Outcome: Overall Health	25.97	24	-154.90	11.97	24	-133.22	19.79	24	-132.13
	Outcome: Depression	21.78	24	-159.10	13.52	24	-131.67	14.90	24	-137.01
	Outcome: Cardiovascular Health	20.97	24	-159.90	15.06	24	-130.13	17.60	24	-134.31
	Outcome: Musculoskeletal Health	22.94	24	-157.93	14.44	24	-130.75	18.16	24	-133.76
Model 3B	**3A + Edu-Job, Health Beh-Job, Job-Health**									
	Outcome: Overall Health	89.91	51	-294.44	49.28	51	-259.26	41.90	51	-280.91
	Outcome: Depression	82.03	51	-302.33	59.75	51	-248.79	36.67	51	-286.15
	Outcome: Cardiovascular Health	90.20	51	-294.15	64.35	51	-244.18	36.91	51	-285.91
	Outcome: Musculoskeletal Health	84.41	51	-299.95	57.60	51	-250.94	39.77	51	-283.04
Model 4. Health Outcomes on Education, Health Beahaviors, and SES Job Aspects										
Model 4A	**SES-Health Constraints**									
	Outcome: Overall Health	54.45	31	-179.18	24.71	31	-162.84	35.83	31	-160.39
	Outcome: Depression	50.02	31	-183.61	26.22	31	-161.32	22.56	31	-173.66
	Outcome: Cardiovascular Health	48.54	31	-185.09	34.96	31	-152.58	23.69	31	-172.53
	Outcome: Musculoskeletal Health	56.39	31	-177.24	31.58	31	-155.96	34.85	31	-161.37
Model 4B	**4A + SES-Health Beh, Health Beh-Health**									
	Outcome: Overall Health	58.25	35	-205.53	26.40	35	-185.34	38.02	35	-183.52
	Outcome: Depression	53.69	35	-210.08	35.78	35	-175.96	24.69	35	-196.85
	Outcome: Cardiovascular Health	52.67	35	-211.10	41.02	35	-170.72	27.45	35	-194.09
	Outcome: Musculoskeletal Health	59.01	35	-204.77	34.98	35	-176.76	36.95	35	-184.59
Molde 5. Health Outcomes on Education, Health Beahaviors, SES Job Aspects, and Job Characteristics										
Model 5A	**4B + Added Variables**									
	Outcome: Overall Health	112.64	74	-445.05	58.72	74	-388.96	76.78	74	-391.62
	Outcome: Depression	103.04	74	-454.65	64.25	74	-383.43	67.49	74	-400.91
	Outcome: Cardiovascular Health	107.91	74	-449.78	71.13	74	-376.55	70.38	74	-398.02
	Outcome: Musculoskeletal Health	110.39	74	-447.30	67.09	74	-380.59	78.25	74	-390.15
Model 5B	**5A + SES-Job, Health Beh-Job, Job-Health**									
	Outcome: Overall Health	223.95	92	-469.40	105.40	92	-451.18	109.21	92	-473.13
	Outcome: Depression	217.26	92	-476.08	123.43	92	-433.14	95.18	92	-487.15
	Outcome: Cardiovascular Health	222.55	92	-470.80	127.35	92	-429.22	96.59	92	-485.74
	Outcome: Musculoskeletal Health	221.87	92	-471.47	115.58	92	-440.99	105.54	92	-476.79

Appendix B. T-tests of Estimates of the Effects of SES, Health Behaviors, and Job Characteristics on Health by Gender

	Overall Health	Cardio-vascular	Musculo-skeletal	Depression
Model 1				
Education	-2.19	-2.01	-3.31	2.25
Model 2				
Education	-1.61	-1.77	-3.39	2.09
Health-Related Behaviors	-0.15	-0.33	-2.44	-2.16
Model 3				
Education	-0.44	-1.32	-1.87	2.55
Health-Related Behaviors	-0.13	-0.30	-2.32	-2.08
Physical Job Characteristics	-0.14	-0.49	1.59	0.35
Cognitive Job Characteristics	1.60	-0.11	0.61	0.09
Job Control	-2.21	-0.93	-0.41	-0.03
Model 4				
Education	-0.29	-1.68	-1.19	2.52
Health-Related Behaviors	-0.13	-0.38	-2.43	-2.20
Earnings	-1.66	0.47	-0.45	-2.16
Occupational Education	-0.66	0.52	-1.92	-0.36
Model 5				
Education	-0.21	-1.61	-0.97	2.57
Health-Related Behaviors	-0.14	-0.36	-2.34	-2.14
Earnings	-1.66	0.62	-0.24	-1.99
Occupational Education	-0.61	0.73	-1.19	-0.11
Physical Job Characteristics	-0.89	-0.31	0.87	-0.15
Cognitive Job Characteristics	1.50	-0.50	0.54	0.05
Job Control	-1.92	-0.71	-0.17	0.21