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Article

Subjective assessments of income and social class on health and survival: An enigma

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ABSTRACT

We examined the association between various measures of subjective social class identification (SSCI) and self-rated health as well as survival using the 2014 General Social Survey-National Death Index dataset (n = 21,108). We used multinomial logistic regression models to assess the association between SSCI and self-rated health and used Cox proportional hazards to assess the association between SSCI and survival. All analyses were adjusted for age, year at interview, race, gender, family income, and educational attainment level. The measures of SSCI that we had available were strongly correlated with self-rated health after controlling for objective measures of social status. For example, those who saw themselves as lower class were nine times as likely to self-report poor rather than excellent health status (odds ratio = 8.69; 95% confidence interval = 5.04–14.98) compared with those saw themselves as upper class. However, no such associations were observed for survival. While our alternative measures of SSCI were important predictors of self-rated health, they were not predictive of survival. This suggests that there may be potential confounding between two perceptions: SSCI and self-rated health.

Introduction

Income, education, and occupational grade—measures of socio-economic status (SES)—are correlated with higher mortality and greater morbidity in most nations (Marmot, Shipley & Rose, 1984; Muennig, Franks, Jia, Lubetkin & Gold, 2005). This relationship generally follows a "gradient." For example, as one's family income increases, so does one's average life expectancy and self-rated health (Marmot et al., 1984; Muennig et al., 2005). Researchers have speculated that this gradient in health and longevity by SES arises in part from perceptual factors, such as hierarchical social comparisons between members of a society. More specifically, the perception that one is on the "bottom" of a social hierarchy (e.g., with respect to income) is thought to produce more psychological stress and depression than being at the top (Hoebel, Muters, Kuntz, Lange & Lampert, 2015). This psychological stress induced by one's subjective social status is thought to damage biological systems, thereby reducing both health and longevity (Epel et al., 2004). This hypothesis has been tested using experimental studies in primates and in associational studies in humans (Adler, Epel, Castellazzo & Ickovics, 2000; Camelo, Giatti & Barreto, 2013; Cohen et al., 2008; Demakakos, Nazroo, Breeze & Marmot, 2008; Hu, Adler, Goldman, Weinstein & Seeman, 2005; Kopp, Skrabski, Rethelyi, Kawachi & Adler, 2004; Manuck, Phillips, Gianaros, Flory & Muldoon, 2010a; Miyakawa, Magnusson Hanson, Theorell & Westerlund, 2012; Ostrove, Adler, Kuppermann & Washington, 2000; Sapolsky, 2005; Singh-Manoux, Adler & Marmot, 2003; Singh-Manoux, Marmot & Adler, 2005; Thompson, Gaglani, Naleway, Thaker & Ball, 2014; Wolff, Acevedo-Garcia, Subramanian, Weber & Kawach, 2010; Wright and Steptoe, 2005). Human associational studies, however, are potentially confounded because it is highly plausible that those who perceive themselves to have poor social standing will also perceive themselves to be in poor health. These "perceptions" can occur irrespective of their actual social standing or actual health status. In this paper, we explore the association between various measures of subjective social status—primarily subjective social class identification (SSCI) and self-rated health as well as mortality to tease out these differences.

The SSCI hypothesis is most strongly supported by animal experiments in which the social position of non-human primates is experimentally manipulated (Sapolsky, 2005). When animals classified as dominant within stable hierarchies are removed, the biomarkers in non-dominant primates improve. However, primates at the top of colonies for which there is threats and competition for dominance follow the opposite pattern (Sapolsky, 2005). While these differences between

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stable hierarchies and unstable hierarchies could be explained by differences in psychological stress among dominant males, conflicting finding raises serious doubts about whether social position within a hierarchy matters.

While non-human primate colonies function very differently from human hierarchies, the association between SSCI and self-rated health has also been explored in human studies mostly using associations (Hamilton, van der Maas, Boak & Mann, 2014; Hu, Adler, Goldman, Weinstein & Seeman, 2005; Operario, Adler & Williams, 2004; Ostrove, Adler, Kuppermann & Washington, 2000). In fact, the majority of these studies rely on a single validated instrument that requires the participant to place themselves on a graphical ladder depicting their place within the social hierarchy of society or their own community (MacArthur, 2005). However, there are serious questions as to whether subjective perceptions of social status and subjective perceptions of health in humans are confounded by third variables, such as insecurity or negative mood (Kraus, Adler & TW, 2012; Muennig, 2008; Muennig & Bench, 2009). For instance, women's perceived body-mass index predicts self-rated health independent of their actual BMI, but has no impact on biomarkers.

Moreover, there is potential for reverse causality—participants who are in poor health plausibly have a lower SSCI as a result of their illness (Adler, Marmot, McEwen & Stewart, 1999; Adler and Ostrove, 1999; Adler et al., 1994; Chen & Paterson, 2006; Demakakos et al., 2008; Epel et al., 2004; Hamilton, van der Maas, Boak, & Mann, 2012; Hu et al., 2005; Manuck, Phillips, Gianaros, Flory & Muldoon, 2010b; Operario et al., 2004; Ostrove et al., 2000; Singh-Manoux et al., 2003, 2005). Specifically, those who see themselves as financially well off within their community, but who subsequently become sick, lose work time, and incur out of pocket medical expenses might be more likely to report a lower SSCI than those who have long enjoyed good health. While they may well remain wealthy relative to the average citizen in their country, they might see themselves as in financial duress simply because their wealthy peers serve as a reference group.

One way around this problem is to explore the relationship between SSCI and a concrete outcome, such as survival or biomarkers. While this is perhaps a good measure of one's SSCI, it is easy to imagine that this measure could reflect an overall sense of insecurity about one's health and financial situation. It is useful to look at alternative measures of SSCI to explore nationally-representative samples, to use a more concrete outcome measure, such as survival, and to control for perceptions of health within survival analyses.

Indeed, studies with more concrete outcome measures have shown more equivocal results. One study, conducted in Russia, for example, found that perceived wealth was significantly associated with survival, but no association between perceived respect or perceived power and survival was observed (Bessudnov, McKee & Stuckler, 2012). Others using intermediate biological markers have shown more consistent associations, however (Manuck et al., 2010a; Epel et al., 2004). We expand on this earlier work, exploring whether these associations are supported using survival time as a concrete outcome measure, use a nationally-representative sample in the US, employ tests for reverse causality, and explore unique mediating variables. We hypothesize that SSCI is associated with both self-rated health and survival time.

Materials and methods

Sample

In this study, we used the 2014 General Social Survey-National Death Index (2014 GSS-NDI) to explore whether one's SSCI is correlated with survival (Muennig, Johnson, Kim, Smith & Rosen, 2011). The 2014 GSS-NDI is based on a sample of the non-institutionalized US population. The 2014 GSS-NDI contains data from 22 waves of General Social Survey (1978 through 2010) that have been linked to prospective annual survival data. The General Social Survey was designed as a nationally representative, multi-year, cross sectional survey of the concerns, experiences, attitudes, and practices of residents of the United States. Death certificate data comes from the National Death Index (1979 through 2014). Each survey wave is linked to annual prospective mortality data, such that the vital status of the 1978 survey respondents is followed over nearly 36 years (1/1/1979–12/31/2014) but the vital status of the 2010 respondents is followed over nearly 5 years (2010–2014). This way, each unique respondent is assigned a vital status, and if dead, the time of death. The 2014 GSS-NDI dataset was approved by the Columbia University Medical Center Institutional Review Board.

Out of the original dataset (44,174 respondents), we removed 18,140 participants with missing values for relevant variables (income, age, gender, race, place of birth, education, self-rated health, survival status, subjective social class placement, satisfaction with one's financial situation, and subjective assessment of family income relative to average income). A total of 4567 (10%) participants were removed because they did not provide their income in the GSS. This percentage was similar to or smaller than that in other surveys, and the non-response bias on income was found to be fairly small (Smith, 1991). Thus, the missing values on income were unlikely to substantially impact our conclusions. All but a small percentage of other missing values were systematic and intentional on the part of the GSS survey design team. Because space limitations within the GSS preclude asking the same questions of all respondents in all years, the GSS uses a ballot design. The GSS randomly skips particular questions in some years and of some respondents within a given year. For instance, self-rated health information was not collected in 1978, 1983 and 1986 waves. In 1988, 1989, 1990, 1994 and 2002 self-rated health was asked of 70% of the participants. Because these exclusions are random and deliberate, they impact the sample size but do not introduce systematic bias into the analysis. Analyses of random missing values are described below.

We also removed 4257 foreign-born (whose associations between SSCI and survival tend to be different from native-born individuals) (Gong, Xu & Takeuchi, 2012). This *a priori* specification was made to ensure that interpretation of the analyses would be straightforward. In addition, because we are interested primarily in aggregated results, we removed 669 GSS oversampled participants from certain minority groups in some survey years in order to establish a nationally representative sample (see Appendix A of the GSS codebook). The final sample size was 21,108.

Measures

Exposures

The main exposures of interest were measured as subjective social class placement, satisfaction with one's financial situation, and subjective assessment of family income relative to average income. Subjective social class had four categories: lower class, working class, middle class, and upper class. Satisfaction with one's financial situation had three categories: not at all satisfied, more or less satisfied, and very satisfied. Satisfaction with one's job had four categories: very dissatisfied, a little dissatisfied, satisfied, and very dissatisfied. One's opinion of his or her family income had five categories: far below average, below average, average, above average, and far above average. Exposures were coded as dummy variables and the highest level of each variable was used as the reference group in the analysis. These measures were validated by ensuring that they predicted self-rated health.

Outcomes

The primary outcomes were survival time and self-rated health. Self-rated health had four categories: poor, fair, good, and excellent self-rated health status.

Confounders

SSCI and survival could plausibly be confounded by age, gender,

and race due to differences in socio-cultural perceptions surrounding one's SES (Adler et al., 2000). Likewise, perceptions might change over time within a given age group (Thompson et al., 2014), so we controlled for survey year. People's actual income and education level were parts of the objective measure of SES, which are likely associated with SSCI—factors that are correlated with survival.

Age was used as a categorical rather than a continuous variable because non-linear effects were observed in preliminary analyses. Race was categorized into three groups: white, black, and other, coded as dummy variables. Family income information was measured by the question, "in which of these 16 groups did your total family income, from all sources, fall last year before taxes?" The mid-point of each category was taken and then standardized to year 2000 dollars, using the Consumer Price Index adjustments. This variable was then categorized into five groups by quintiles. Education was categorized into four groups. The survey year ranged from 1978 to 2010 and was used as a continuous variable in the analysis.

Finally, in sensitivity analyses, we tested whether self-reported happiness or whether the respondent felt that his/her standard of living would improve. These indirect measures of negative emotional states and pessimism/optimism were tested as mediators both within the SSCI-self-rated health analysis and within the SSCI-survival time analyses.

Statistical analysis

Analyses were conducted using SAS 9.3 (SAS Institute, Cary NC). We used multinomial logistic regression models to assess the association between SSCI (subjective social class placement, satisfaction with one's financial situation, and subjective assessment of family income relative to average income) and self-rated health. These analyses were cross-sectional. Then we used Cox proportional hazards models to assess the association between SSCI and survival time. We tested these Cox models to ensure that the assumption of proportionality was met. All the analyses were conducted at $p < 0.05$.

We also tested interactions between SSCI and each covariate of interest. We conducted analyses to test the categorical break points of our variables and found that they had no impact on our outcomes. We also used Cox proportional hazards models to confirm the association between self-rated health and survival time in our data, to explore the extent to which self-rated health mediated survival, and to explore the impact of SSCI on survival among participants who reported that they were in excellent health at the time of the survey.

Missing values

Less than 5% of the SSCI measures were missing by random. The remainder were systematically excluded for an entire survey year. Participants with missing values did not differ substantively from those without missing values.

Results

Sample description

Demographic information about the sample is provided in Table 1. The total study population was 21,108. More than half (55%) of the respondents were female and 84% were white. About half of the respondents perceived their class, financial situation, and family income as "middle class." Only 5% of the respondents reported their health status as poor.

Table 2 shows the relationship between the SSCI measures of interest and actual household income. Those who have higher SSCI identification also tend to have higher income and vice versa.

Table 1
Demographic characteristics of the analytic sample (N = 21,108): 2014 General Social Survey-National Death Index.

Variable	Categories	Percentage % (N)
Age	< = 21	4.49 (991)
	22–45	54.37 (11,476)
	46–65	29.53 (6234)
	> 65	11.40 (2407)
Race	White	84.05 (17,741)
	Black	12.69 (2678)
	Other	3.26 (689)
Education	Less Than High School	16.44 (3471)
	High School Graduates	54.31 (11,464)
	College	21.93 (4630)
	Graduate School	7.31 (1543)
Gender	Male	45.46 (9595)
	Female	54.54 (11,513)
Income (Constant Yr. 2000 $)	1 (468–18,811)	19.88 (4197)
	2 (19,071–35,106)	20.55 (4338)
	3 (35,135–48,149)	20.92 (4416)
	4 (48,718–63,190)	18.81 (3971)
	5 (64,546–166,419)	19.83 (4186)
Subjective Class Identification	Upper Class	3.08 (650)
	Middle Class	45.07 (9514)
	Working Class	46.80 (9878)
	Lower Class	5.05 (1066)
Satisfaction with Financial Situation	Satisfied	27.43 (5790)
	More or Less	44.94 (9485)
	Not at All	27.63 (5833)
Opinion of Family Income	Far Above Average	2.10 (443)
	Above Average	19.77 (4174)
	Average	48.50 (10,238)
	Below Average	24.14 (5095)
	Far Below Average	5.49 (1158)
Self-Rated Health	Excellent	31.67 (6685)
	Good	46.58 (9833)
	Fair	16.97 (3583)
	Poor	4.77 (1007)
Survival status	Alive	72.94 (15,397)
	Dead	27.06 (5711)

Table 2
Relationship between subjective identification and actual income: 2014 General Social Survey-National Death Index.

	Categories	Mean income	Standard deviation
Subjective Class Identification	Upper Class	$80,096	51,067
	Middle Class	$54,624	35,558
	Working Class	$37,400	23,016
	Lower Class	$22,057	19,342
Satisfaction with Financial Situation	Satisfied	$57,985	37,706
	More or Less	$44,712	28,220
	Not at All	$32,790	23,684
Opinion of Family Income	Far Above Average	$82,074	52,678
	Above Average	$70,629	36,371
	Average	$43,336	24,110
	Below Average	$28,451	19,326
	Far Below Average	$26,775	29,794

SSCI and self-rated health

The results from analyses of the association between SSCI and self-rated health results are shown in Table 3. Our measures of SSCI showed strong and significant associations with self-rated health. All associations were in the hypothesized direction: the higher SSCI one had, the

Table 3
Multivariate analysis of perceived socioeconomic status and self-rated health. (OR and 95% Confidence Interval).

		Good vs excellent	Fair vs Excellent	Poor vs Excellent
Subjective Class Identification	Upper Class	1	1	1
	Middle Class	1.74 (1.45, 2.08)*	1.63 (1.24, 2.15)*	1.77 (1.07, 2.92)*
	Working Class	2.34 (1.95, 2.82)*	2.33 (1.76, 3.08)*	2.11 (1.27, 3.49)*
	Lower Class	2.65 (2.05, 3.43)*	4.10 (2.92, 5.74)*	8.69 (5.04, 14.98)*
Satisfaction With Financial Situation	Satisfied	1	1	1
	More or Less	1.49 (1.39, 1.61)*	1.83 (1.64, 2.05)*	2.18 (1.77, 2.68)*
	Not at All Sat	1.82 (1.66, 2.00)*	3.06 (2.70, 3.47)*	6.09 (4.92, 7.54)*
Opinion of Family Income	Far Above Average	1	1	1
	Above Average	1.47 (1.18, 1.83)*	0.98 (0.70, 1.36)	0.54 (0.30, 1.00)
	Average	1.84 (1.48, 2.29)*	1.44 (1.05, 2.00)*	0.85 (0.49, 1.48)
	Below Average	2.21 (1.76, 2.78)*	2.30 (1.65, 3.20)*	2.07 (1.19, 3.60)*
	Far Below Average	1.97 (1.51, 2.58)*	2.53 (1.76, 3.65)*	3.67 (2.05, 6.57)*

All models adjusted for sex, age group (categorical), race, survey year, education level (categorical) and actual income (quintile).
* $p < 0.05$.

higher was his or her self-rated health. After adjusting for sex, survey year, age group, educational attainment, and family income, most measures remained strong and statistically significant.

Compared with those who self-identify as upper class, people who identified as lower class were more likely to have a lower level of self-rated health status. For example, the odds ratio (OR) associated with having poor health vs. excellent health among people in lower class compared to upper class is 8.69 (95% confidence interval [95% CI] = 5.04–14.98). For working class relative to upper class subjective social class identification, the OR = 2.11 (95% CI = 1.27–3.49). With respect to perceived satisfaction with one's financial situation, the OR among people who were not at all satisfied compared with those who reported being satisfied is 6.09 (95% CI = 4.92–7.54). Compared with people who thought their family income is far above average, people who felt that their family income were far below average had four times the odds of being in poor health (OR = 3.67, 95% CI = 2.05–6.57).

To explore the impact of control variables on the coefficients, we examined crude models, models with covariates often found in earlier studies, and a more comprehensive set of covariates. These model outcomes were very similar.

SSCI and survival time

The results for the survival analysis are shown in Table 4. Unlike the results for SSCI on self-rated health, most of the SSCI measures (subjective social class placement, satisfaction with one's financial situation, and subjective assessment of family income relative to average income) were not associated with survival. The hazard ratios (HRs) for survival for the variables of SSCI were very close to 1 and were not statistically significant after Bonferonni corrections for multiple comparisons. Some SSCI variables had coefficients that trended in the opposite direction (< 1) before Bonferonni corrections. For instance, the adjusted HR among those who perceive themselves to be middle class compared to upper class is 0.75 (95% CI = 0.59–0.96). After Bonferonni correction, this association becomes non-significant.

Again, to explore the impact of control variables on the coefficients, we examined crude models, models with covariates often found in earlier studies, and a more comprehensive set of covariates. Finally, we explored the extent to which self-rated health mediated survival time. All models' outcomes were similar, as were those models that used different cut points. When we added a question that asked whether the respondent thought his or her standard of living would improve, this variable did not appear to mediate the relationship between SSCI and self-rated health.

Specially, the results for assessing the association between self-rated health and survival are presented in the last panel of Table 4. The results confirm self-rated health has strong and significant association with survival time. In addition, we consistently found females had

Table 4
Cox models examining the association between perceived socioeconomic status, self-rated health and mortality.

		Model 1(crude)	Model 2	Model 3
Subjective Class Identification	Upper Class	1	1	1
	Middle Class	0.75 (0.59, 0.95)*	0.76 (0.59, 0.97)*	0.75 (0.59, 0.96)*
	Working Class	0.61 (0.48, 0.78)*	0.81 (0.63, 1.04)	0.79 (0.61, 1.02)
	Lower Class	0.80 (0.60, 1.07)	0.99 (0.74, 1.34)	0.93 (0.69, 1.26)
Satisfaction with Financial Situation	Satisfied	1	1	1
	More or Less	0.82 (0.74, 0.92)*	0.96 (0.86, 1.07)	0.94 (0.85, 1.05)
	Not at All	0.79 (0.70, 0.89)*	1.10 (0.97, 1.26)	1.06 (0.93, 1.21)
Opinion of Family Income	Far Above Average	1	1	1
	Above Average	0.71 (0.51,0.97)*	1.04 (0.76, 1.44)	1.06 (0.77, 1.46)
	Average	0.88 (0.65, 1.20)	1.02 (0.75, 1.39)	1.02 (0.74, 1.39)
	Below Average	0.93 (0.68, 1.26)	1.13 (0.82, 1.54)	1.08 (0.78, 1.49)
	Far Below Average	1.04 (0.74, 1.45)	1.39 (0.98, 1.96)	1.30 (0.91, 1.85)
Self-rated health	Excellent	1	1	1
	Good	1.28 (1.13, 1.45)*	1.18 (1.04, 1.34)*	1.18 (1.04, 1.34)*
	Fair	2.02 (1.76, 2.32)*	1.44 (1.25, 1.66)*	1.43 (1.24, 1.65)*
	Poor	3.78 (3.22, 4.45)*	1.96 (1.65, 2.33)*	1.92 (1.61, 2.28)*

Model 2: Adjusted for sex, year, race, age group (categorical), education level (categorical).
Model 3: Adjusted for sex, year, race, age group (categorical), education level (categorical) and actual income (quintile).
* $p < 0.05$.

lower HR compared with males ($p < 0.001$ in all models with sex as a covariate). Compared with age group below 21, age group 22 to 45 has no significantly different HR ($p > 0.1$in all models with age as a covariate), while age group 46 to 65 and age group over 66 consistent have significantly higher HR ($p < 0.001$ in all models with age as a covariate).

Finally, a sensitivity analysis was conducted only among people who rated their health status as excellent or good (N = 16,518) to assess the possible effect of reverse causation in the mortality gradients (that sickness leads to lower SES, or that poor self-rated health is linked to lower SSCI). The survival analysis were then conducted separately at different age cut-off points—e.g., people who are below 45 years old (N = 12,467) and above 45 years old (N = 8641)—to take into account that the association of SSCI with survival might be different among older or younger people. These analyses (not shown) were very similar to those of the baseline models that included these participants or that did not include age cutoffs.

Discussion

We hypothesized that SSCI is associated with both self-rated health and survival. We observed that SSCI is associated with self-rated health, which is consistent with virtually all of the earlier studies on this topic. In fact, our associations between SSCI and self-rated health were consistent across measures and tended to have large coefficients. However, we also found none of our measures of SSCI was associated with survival time. In fact, the coefficient ran in the opposite direction than that predicted by the self-rated health analyses.

There are a number of possible explanations for this.

First, it is possible that people who have a negative view of their self-rated health tend to also have a negative perception of their SSCI (or are just generally insecure). One earlier study exploring perceived weight versus measured body mass index suggested that similar confounding occurred between women's perceived weight and their self-rated health (Muennig & Bench, 2009). If the association between SSCI and self-rated health is cofounded, then SSCI should predict self-rated health but not survival after controlling for self-rated health. Previous studies have shown that, in the GSS-NDI dataset as well as others, self-rated health is strongly associated with mortality (Schnittker & Bacak, 2014). We also replicate these earlier findings in our study and further show that self-rated health does not mediate the relationship between SSCI and mortality. We explored these relationships both with controls for self-rated health and in stratified analyses looking only at participants who rated their health highly at the time of the interview. It was, however, surprising to see that SSCI was not associated with mortality even in un-stratified analyses in which self-rated health was excluded as a control variable.

Some of plausible confounders of the relationship between SSCI and health (e.g., pessimism about one's health status or general unhappiness) should lead one to expect that SSCI produces a higher mortality risk (Lawrence, Rogers & Wadsworth, 2015). If SSCI is correlated with harmful emotions, then it should spuriously predict mortality in our analyses (we do not control for negative emotional states). Insecurity and doubt are more plausible confounders in this relationship, as they have been linked to lower risk-taking (and therefore, possibly lower mortality) (Decharms & Dave, 1965).

Second, health could also influence SSCI rather than the other way around. Specifically, participants in the GSS-NDI who had a health shock prior to the date of the interview could perceive their financial situation as poor at the time of the interview because they lost income or incurred medical expenses. However, our observed correlation between SSCI and self-rated health but not survival time would serve to rule this hypothesis out. This is because poor health predicts lower survival time (Lawrence et al., 2015). Moreover, when our analyses were limited to those in excellent or good self-rated health, the association between SSCI and survival time was similar to the analyses in which no such restrictions were included. If one is in excellent health at the time of the interview, then his or her health status is unlikely to influence his or her SSCI at the time of the interview.

A final possibility is that SSCI is linked to conditions that cause morbidity (as measured by self-rated health) but not survival time. However, it should be kept in mind though that self-rated health is powerfully associated with survival time, and this association also exists within the dataset we use here (Schnittker & Bacak, 2014).

Our study had a number of important limitations. For one, we lack the MacArthur Scale of SSCI to cross validate our measures of perceived SSCI (Adler et al., 2000). However, as with studies using the MacArthur Scale, our measures did show a strong positive association with self-rated health and SSCI (Adler et al., 2000; Epel et al., 2004; Hamilton et al., 2014; Hu et al., 2005; Operario et al., 2004; Ostrove et al., 2000; Singh-Manoux et al., 2003). Second, our self-rated health measure was also on a 4-point scale rather than the more common five-point scale, but appears to perform as well as a 5-point scale as a predictor of survival (Schnittker & Bacak, 2014). Third, one may argue that the effect of SSCI on self-rated health and survival time might be different among different age groups. However, the results of our sensitivity analyses at different age groups or among only those who were healthy at the time of the interview were very similar to the analyses we present here. We conducted a broad array of sensitivity analyses on missing values, different cut points, and so on and all of our analyses proved to be robust. Finally, we were using all-causes mortality as we did not have the statistical power to evaluate specific causes of death.

Were it possible to reduce the socioeconomic gradient in health and mortality, significant increases in health and longevity would be realized. For instance, by reducing the income gradient in health and longevity, upwards of a few years of perfect health could be added to the average health adjusted life expectancy in the US (Muennig et al., 2005). However, it is difficult to conceive of a strong policy remedy for SSCI (Deaton, 2002; Mechanic, 2002). No matter how much one reduces income inequality in a society, people may both "feel" and "be" different from others in society in a hierarchical way. On the other hand, if material circumstances are a driver of this effect, then redistributive policies might improve health by also reducing disparities in material resources, such as access to healthy food or adequate housing. From a policy perspective, it may be best to invest in policies that have been tested using randomized-controlled trials: housing vouchers, income support, and early education (Ludwig et al., 2011; Muennig, 2015; Muennig, Mohit, Wu, Jia & Rosen, 2016; Muennig, Schweinhart, Montie & Neidell, 2009).

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SL, QZ and PM developed the model, analyzed the data, and wrote the draft of the manuscript. SL and QZ helped with data preparation. PM provided guidance for finding data. QZ provided technical support. All authors contributed to writing and approved the final version of the manuscript.

Conflicts of interest statement

The authors certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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Ethics approval

Not Applicable. No human subjects are involved.

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