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The Association Between Physical Functioning and Self-rated General Health in Later Life: The Implications of Social Comparison

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Abstract Self-rated general health has been used widely in health surveys as a single-item measurement of health-rated quality of life. Heterogeneity in self-evaluation of health has been well documented, yet the causes of this heterogeneity are poorly understood. This study evaluated the moderating effects of age, aging, gender, race, education and income on the relationship between physical functioning and self-rated general health using social comparison theory as a guiding framework. A longitudinal mixed-effects regression model was used to analyze a cohort enrolled into the Health and Retirement Study in 1993 that was interviewed at baseline and during four subsequent waves. The results revealed that the association between physical functioning and self-rated general health is weaker among subgroups that tend to have lower health status; i.e., older individuals, non-Caucasians and less educated individuals. These findings suggest

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the usefulness of social comparison theory in explaining self-rated general health and provide the basis for future research.

Keywords Physical functioning · Self-rated general health · Social comparison theory · Socio-demographic · Socio-economic

Self-rated general health (SRGH) has been found to be a significant and independent predictor of morbidity, mortality and health care utilization irrespective of a person's objective health condition and socioeconomic status (Baron-Epel and Kaplan 2001; Eriksson et al. 2001; Idler and Benyamini 1997; Nybo et al. 2003; Strawbridge and Wallhagen 1999). Researchers have defined SRGH as consisting of both subjective self-image (Benyamini et al. 2003; Friedsam and Martin 1963) and objective physical health status (Benyamini et al. 2003). Studies revealed that the determinants of SRGH include a variety of factors such as physical health status, the ability to do things that an individual wants or needs to do, level of energy and what a doctor says about an individual's health and activity level (Krause and Jay 1994; Benyamini and colleagues 2003). In addition to the wide range of factors considered by individuals, different individuals consider different factors when evaluating their own health (Krause and Jay 1994). The criteria people use to evaluate their own health can change over their life course (Idler 1993; Leinonen et al. 2001). Similarly, research on quality of life found that the relative contribution of functional and medical comorbidities, as well as health-promoting behaviors to health-related quality of life (HRQoL), was different among elders (Borowiak and Kostka 2004).

Different theories explain heterogeneity in individuals' evaluation of their own general health or health-related quality of life. These include social comparison theory, personal construct theory, response shift, models of illness behavior, health identity theory, survey literature and linguistics (Festinger 1954; Wiseman 1999). Of these, social comparison theory is the most important and widely discussed (Wiseman 1999). While social comparison has been cited as an important theory, and although Yngwe et al. (2003) showed that the mechanism has a significant effect on one's health, very little empirical research based on social comparison theory exists to explain the observed discrepancies between people's physical health and SRGH. By analyzing the moderating effects of some socio-demographic and socio-economic factors on the relationship between one's physical functioning (PF) and concurrent SRGH, the present study aims to reveal whether social comparison theory can explain discrepancies between PF and SRGH.

Background

Physical Functioning and Its Importance to Elderly Individuals

PF decline and disability are common among the elderly and have adverse consequences (Levy et al. 2002). Even relatively modest declines in PF are associated with a loss of independence, increased caregiver burdens, greater financial expenditures and lower quality of life (Reuben et al. 2004). The definition

of physical functioning is, "overall impact of medical conditions, lifestyle and age-related physiologic changes in the context of the environment and social support system" (Reuben et al. 2004), which reflects the built-in effect of PF changes on emotion and social life.

In the case of PF decline or disability, the socio-emotional effect on subjective well-being is manifested in two ways (Luborsky 1995). First, there is pressure to withdraw from social life due to physical incapability, impaired self-images and societal barriers. Second, physical disfigurement might lead to feelings of guilt and shame.

What Self-rated General Health Measures?

Previous researchers have identified self-rated general health as a significant measure of an individual's subjective well-being. It is associated with future morbidity, mortality and health care utilization (Baron-Epel and Kaplan 2001; Eriksson et al. 2001; Idler and Benyamini 1997; Nybo et al. 2003; Strawbridge and Wallhagen 1999). Some researchers used SRGH and HRQoL interchangeably, e.g., SRGH is used as a single-item quality of life measurement (Dasbach et al. 1994; Huang et al. 2004; Jonsson et al. 2001). However, other researchers argued that SRGH and HRQoL measured different constructs (Fries et al. 1996). Fries and colleagues (1996) proposed that SRGH measures life quality at a certain time point and HRQoL measures a cumulative series of health status measurements.

Generally, self-rated general health is a multi-domain concept consisting of sub-domains such as physical health, mental health, and social functioning (Bosworth et al. 1999; Vaez and Laflamme 2002). Idler and colleagues (Idler and Benyamini 1997; Idler and Kasl 1991) suggested that SRGH is a dynamic concept capturing the change in health and incorporating comparisons from the subjects. From a sociological perspective, individuals internalize social contextual effects when evaluating their own health (McMullen and Luborsky 2006); thus, social contextual factors are likely to moderate the relationship between an individual's SRGH and any changes in their physical health.

The Heterogeneous Relationship between Physical Functioning and Self-rated General Health

The relationship between PF and SRGH has been investigated in the literature. First, PF levels are positively related to SRGH (Jylha et al. 1986; Parkatti et al. 1998). Studies often show that PF can explain more than 10% of the variance in SRGH (Hoeymans et al. 1997a). The relationship between PF and SRGH is heterogeneous between individuals; i.e., when faced with the same change in PF level, some individuals might report less change of SRGH than others do (Hoeymans et al. 1997a, b).

Some studies suggest that age, gender, race, culture and education moderate the PF-SRGH relationship (Bobak et al. 1998; Franks et al. 2003; Jonsson et al. 2001; Kim et al. 1997; Liang et al. 1991; Mackenbach et al. 1994). When studying the age effects on self evaluation of health, some recommended differentiating the age cohort effect from the aging effect (Aldwin and Gilmer 2004). The age cohort effect

means that people born in the same period often share similar experiences and health perception systems, while those born at different periods tend to have different ones (Aldwin and Gilmer 2004). The aging or time effect (when time is long enough to account for non-transient effect) describes how, even for the same individual, one's definition and perception of health can change as one grows older. With few exceptions (Daltroy et al. 1999; Rakowski and Cryan 1990), most studies report that older people are more favorable than younger ones when rating their own health (Idler 1993). Previous literature on aging or time effects also is contradictory. Three studies (Hoeymans et al. 1997a, b; Leinonen et al. 2001) concluded that the decline in SRGH levels is slower than the decline in PF levels over time. Conversely, Heyman and Jeffers (1963) concluded that the relationship between PF and SRGH does not change over time. Some studies directly or indirectly support the moderating effects of gender, race and education on the PF-SRGH relationship. Two studies using physical health indicators other than PF found that men appeared to be more positive than women when rating their own health, given similar physical health (Fillenbaum 1979; Johnson and Wolinsky 1993), although Jylha and colleagues (1998) did not find such positive tendencies. A study by Krause and Jay (1994) suggested that a higher proportion of Caucasians linked SRGH to PF than did African-Americans or Hispanics. However, Ferraro et al. (1997) and Spencer et al. (2009) found that, among African Americans, declines in functional status related to greater declines in SRGH than they did for Caucasians. Krause and Jay (1994) reported that subjects with higher education were more likely to link SRGH to PF, which could suggest that PF has greater effects on SRGH in individuals with higher education. Studies on the moderating effects of socio-demographic factors provide an important ways to examine how social contextual factors affect people's self-evaluation of general health when facing functional decline. However, findings on how socio-demographic factors moderate the relationship between PF and SRGH mostly are contradictory.

Theoretical explanations of the heterogeneity in PF-SRGH relationships are unclear. Although various theories to explain the heterogeneous relationship between physical health and SRGH exist, few theories have undergone empirical testing. As a result, an understanding of SRGH and its relationship with other health measures is piecemeal.

Social Comparison and the PF-SRGH Relationship

Social comparison theory states that individuals evaluate their health by comparing themselves to their chosen reference group (Festinger 1954). As one of the major psychological processes employed by ill individuals in the reconstruction of self identity (Wiseman 1999), social comparison enhances coping capabilities, adjustment, self-esteem and psychological well-being (Langford et al. 1997; Stewart 1993; Swann and Brown 1990). Some studies suggested that people, when evaluating problems of self, tend to compare themselves with people they are familiar with (Heckhausen and Brim 1997; Wheeler and Miyake 1992; Mussweiler and Ruter 2003). According to Fillenbaum (1979), when conceptualizing social comparison theory as the basis of SRGH, gender, age or community-of-residence can influence the reference group one chooses. Empirically, Fillenbaum (1979) showed that

community elderly residents tend to choose people of the same sex as reference group.

We believe social comparison theory can provide guidance for the study of the moderating effects of socioeconomic factors on the PF-SRGH relationship. In other words, self-evaluations of general health are made relative to the health—e.g., PF level—of an individual's primary reference group. If that group has, on average, a lower PF level, then the individual's lower PF level might seem less severe in comparison. In contrast, if a reference group is healthy, then even mild declines in PF might lead to lower self-ratings of general health. A study by Baron-Epel and Kaplan (2001) showed that individuals of 65 years of age or older were more likely to rate their health more favorably when asked to compare themselves with people of the same age and sex than when the rating was made without comparison. We propose that people tend to make implicit comparisons to a reference group, even when they are not asked to do so. Since people tend to compare themselves with similar people, chosen references are likely to be people from a similar socio-economic group. If this is true, then self-evaluations of general health should relate to the average health status of one's reference group. In the U.S., less educated groups, ethnic minorities, and lower income groups are associated with poorer health (Goldberg et al. 2004). Specifically, non-Caucasian races, lower education and lower family income are associated with lower PF even after controlling for the level of chronic conditions (Mackenbach et al. 2001; Strawbridge et al. 1996; Amaducci et al. 1998; Lantz et al. 2005). In addition to social class indicators, gender and age are the other two major demographic variables that explain population health differences. Women tend to have lower PF levels in cross-sectional as well as in longitudinal comparisons (Beckett et al. 1996). The literature documents both health and functional status declines with age (Gill and Kurland 2003). Thus, we expect that declines in PF have less effect on SRGH for females, older individuals, non-Caucasians, elderly individuals with less education and elderly individuals with lower incomes.

The objectives of our study were two-fold: first, to examine the moderating effects of socio-demographic and economic factors on the PF-SRGH relationship; second, to test the applicability of social comparison theory in explaining the moderating effects. Among the many determinants of SRGH, we focused on PF for the following reasons: first, PF decline is common among the elderly population, including those without chronic disease; and second, PF is a primary indicator of one's ability to perform social roles, which are central in the definition of health in modern society (Parsons 1951).

Considering the above postulation, we hypothesized that: (1) the PF-SRGH association is weaker among those individuals belonging to lower-PF populations including females, older elderly individuals, non-Caucasians, those with less education and those with lower incomes; (2) the PF-SRGH association diminishes over time for an elderly individual (the aging effect) because his or her peers tend to experience declining PF over time as well. This study will help clarify the inconclusive role of socio-demographic and socio-economic factors in self-evaluation of general health. We believe that the confirmation of these hypotheses helps support the theory that social comparison is the dominant mechanism for the discrepancy between changes in PF and SRGH.

Data and Methods

Sample

The cohort of individuals born in 1923 or earlier from the Health and Retirement Study (HRS) was used. The HRS used a nationally representative sampling method that targeted community-dwelling elders in the contiguous United States, with oversampling of Blacks, Hispanics, Florida residents and those 80 years old or older (Myers et al. 1997). There were 7,443 subjects for the first interview in 1993. Follow-up interviews occurred in years 1995, 1998 and every 2 years after 1998. The present study used data collected in 1993, 1995, 1998, 2000 and 2002. Data came primarily from files produced by the RAND Center for the Study of Aging (RAND Center for the Study of Aging 2008) and the raw data from HRS.

There were 22,365 observations from 6,777 subjects retained for the present study. We excluded data from the interviews conducted with proxies to focus on the self-evaluation of general health. We excluded 2 subjects with inconsistent identifications across waves. The interviews with missing data were excluded list wise. Subjects were retained in the analysis as long as they had complete data in one or more of the other interviews.

Measures

SRGH, the dependent variable in the current study, was measured in the HRS study on an ordinal scale by asking the subjects "Would you say your health is excellent, very good, good, fair or poor?" In our study, answers are coded from 1 to 5 and the higher the score, the higher the self-reported general health level. The distribution of the variable was close to a normal distribution in each of the five waves.

Explanatory variables were concurrent PF, time, age, gender, race, education and income. In the HRS, items to measure PF vary across waves. However, 5 activities of daily living (ADL) and 5 instrumental activities of daily living (IADL) items were measured in all 5 waves. The ADL items included bathing, eating, dressing, walking across a room, and getting in or out of bed. The IADL items include using a telephone, taking medication, handling money, shopping and preparing meals. To measure PF limitations, we combined the ADL and IADL items to form a single scale of 0–10. By doing so, it is possible to measure a greater range of PF levels than by using only ADL or IADL items (Spector and Fleishman 1998). We consolidated those with limitations in 8 or more items into one group because few subjects demonstrated limitations in 8 or more items. The measure of PF limitation was coded reversely in later analysis, such that a higher score indicated better PF.

Regarding socio-demographic and economic variables, years of age at baseline (1993) was used for all waves in the longitudinal analysis to avoid collinearity between time and the aging of a subject during the study period. As a result, age reflected the effects of subjects' age at baseline and time reflected the aging effects over the 9-year study period. In the modeling analysis, the age variable was centered to facilitate model convergence and interpretation. Years of education were collapsed into 4 categories: middle school or lower, high school, college and post-graduate education. The race variable was coded into 4 categories: African

American (non-Hispanic), Caucasian (non-Hispanic), Hispanic and others. Annual household income was measured in 1993 dollars. To account for the highly skewed distribution of the income variable, income was logged except for $0. In case of $0, the original value was kept.

Concurrent marital status and chronic diseases were controlled for in the analysis. Marital status was classified as two categories: married or partnered, and never married, separated, widowed or divorced. Chronic diseases included cognitive functioning impairments, back problems, hypertension, diabetes, cancer, chronic lung disease, heart problems, a history of stroke, psychiatric problems and arthritis, which account for most of the morbidity among the elderly in western countries (Fisher et al. 2005). Information on back problems, hypertension, diabetes, cancer, chronic lung disease, heart problems, stroke history, psychiatric problems and arthritis was obtained by asking a respondent about each disease separately (RAND Center for the Study of Aging 2008). Depression was measured as an index score summing answers to the following statements: "you felt depressed", "you felt that everything you did was an effort", "your sleep was restless", "you were happy", "you felt lonely", "you enjoyed life", "you felt sad", "you could not get going", "you had a lot of energy", which is based on the Center for Epidemiologic Studies Depression Scale CES-D short version (see Wallace et al. 2002). In the HRS study, cognitive ability has been measured by the Telephone Interview for Cognitive Status (TICS) instrument, which was derived from the Mini-Mental State Examination (MMSE) (Brandt et al. 1988; Herzog and Wallace 1997). The TICS score was computed following the methods by Langa et al.(2001).

Analytic Strategy

A mixed-effects regression model was applied for the longitudinal data analyses. The model accounts for the autocorrelation from repeated measurements (Hedeker and Gibbons 2006) and allows for tests of interaction between PF and time. The mixed model also enabled us to account for age and aging effects (by including the time variable) simultaneously. In addition, the mixed model allowed for inclusion of a subject if the subject had missing data in different waves, but had at least one wave of complete data. A simpler model (Model I) with only time (time, $time^2$ and $time^3$) and PF was implemented first to examine random-effects of PF to examine the heterogeneity in the PF-SRGH relationship. Then a detailed model (Model II) that included time (time, $time^2$ and $time^3$), PF, socio-demographic and economic factors and interactions between PF and the other variables (time, age, gender, race, education and income) was analyzed to test the two hypotheses. Likelihood ratio (LR) tests were implemented to examine the significance of random effects of the time trends and PF for both Models. Although time trends are not the focus of the current study, random effects of time trends were included in the modeling to account for the possible linear and non-linear SRGH trajectories over time across individuals. Interaction terms were included to examine the moderating effects of time and the other variables on the effects of PF on SRGH. Chronic diseases were controlled for, so that the coefficient of PF would reflect the effects of PF on SRGH given the same disease burden. Response patterns were also controlled for in the analysis. Respondents' response patterns were categorized into three groups: those

who died during the study, those who were lost to follow up and the rest of the sample (i.e., those who were alive and responded to the survey as of 2002, including intermittent missing respondents).

Data were analyzed using SAS statistical software, version 9 (SAS Institute Inc. 2004). The SAS PROC MIXED procedure was used for fitting the longitudinal model. The alpha level selected for this study was 0.05.

Results

Description of Sample

Among the 6,777 subjects included in analysis, 3,306 (48.78%) had complete data for all waves or at least the first and last waves (i.e., intermittent missing); 548 (8.09%) were lost to follow up; and 2,923 (43.13%) died during the study period (1993–2002). Tables 1 and 2 show the socio-demographic characteristics and health levels of the subjects in the first and last waves. The subjects were predominantly

Table 1 Socio-demographic characteristics of the analyzed sample

Demographic characteristics	Year of interview	
	1993	2002
Sample size	6562[a]	2689
Male (%)	37.80	35.40
Race (%)		
Caucasian	80.63	83.26
African American	13.21	10.75
Hispanic	5.11	4.99
Other	1.05	1.00
Age (Baseline) (%)		
70–79	67.60	82.71
80–89	29.31	16.81
90 +	3.09	0.48
Household Income (1,000$)		
Mean (±SD)	25.78 (±52.80)	29.39 (±34.53)
Median (Min, Max)	16.45 (0; 3,024.88)	20.19 (0; 616.58)
Education (%)		
Middle school or lower	30.89	24.77
High school	41.83	43.96
College	21.41	24.28
Post-graduate or professional degree	5.87	6.98

[a] Although 6,777 subjects were analyzed, only 6,562 from 1993 were included due to the exclusion of proxy interviews and missing data. Those excluded in earlier waves were included in the longitudinal analysis, as long as they had complete data in later wave(s).

Table 2 Health conditions of the analyzed sample

Health measurements		Year of interview	
		1993	2002
Self-rated health[a]		2.99±1.16	2.90±1.09
Physical functioning[b]:	Mean±SD	7.31±1.36	6.97±1.84
	Mode (Min, Max)	8 (0, 8)	8 (0, 8)
Number of diseases:	Mean±SD	1.64±1.32	3.00±1.61
	Mode (Min, Max)	1 (0,9)	3 (0,9)
Cognitive level[c]		0.06±0.24	0.06±0.23
CES-D score[d]:	Mean±SD	1.62±2.07	1.73±2.06
	Mode (Min, Max)	0 (0,8)	0 (0,8)
Back problem	(%)	2.5	35.3
Hypertension	(%)	46.3	62.6
Diabetes	(%)	12.5	17.0
Cancer	(%)	12.6	20.1
Lung disease	(%)	8.6	10.7
Heart problem	(%)	28.4	40.6
Stroke	(%)	8.6	14.5
Psychiatric problem	(%)	7.0	12.8
Arthritis	(%)	25.0	72.4
Body Mass Index	Mean±SD	25.4±4.45	25.0±4.56

[a] Self-rated health was coded as: 1 "poor", 2 "fair", 3 "good" 4 "very good", 5 "excellent".

[b] Physical functioning ranged from 0 to 8. A higher score indicates a higher functioning level.

[c] Cognitive level was coded as: 1 "normal", 2 "mildly limited", 3 "moderately limited", 4 "severe limited".

[d] The Center for Epidemiologic Studies Depression Scale score ranged from 0 to 8. A higher score indicates more severe depression.

Caucasians with a mean age of 77.3 (range=70–103) at baseline (Table 1). There were a higher percentage of women and Caucasians remaining in the sample in later waves than in earlier waves. The percentage of subjects living with spouse or partner declined over the 9-year study period. At baseline, 86.04% reported family incomes under $40,000 and 72.72% had high school or lower education levels. Generally, mean levels of income and education were higher in later waves than in earlier waves.

There seemed to be a decline in mean SRGH and PF levels over time (Table 2). The magnitude of the decline in PF was relatively small. More than half of the subjects could perform all 10 of the ADL and IADL tasks in all the 5 waves of interviews. The mean number of chronic diseases (11 major chronic diseases were counted) reported by subjects increased from 1.64 to 3.00 over the study period, and the prevalence of all chronic diseases increased as well. Although changes in health status were not the major focus of the present study, it is important to note that respondents with worse health (SRGH or chronic diseases) were more likely to die during the study period, so the numbers in Table 2 should underestimate the health decline of the subjects.

Longitudinal Analysis

According to the likelihood ratio tests, the random subject effects of PF, time and time^2 were significant in both Model I with only time and PF (chi-square=30.1, df=4, $p<0.05$) and Model II with all of the independent variables (chi-square=30.6, df=4, $p<0.05$). This finding confirmed that the PF-SRGH association is heterogeneous across elderly individuals, even after controlling for the interactions between PF and the other variables.

Table 3 presents the fixed effects of Model II. Interactions between PF and gender, and PF and household income, which were not significant, were dropped from the modeling. The test of main effects showed that being a female, living with a spouse or partner, having a lower income, or having chronic diseases were associated with lower SRGH levels after controlling for other socio-demographic factors.

The significant interaction terms (Table 3) showed that the effect of PF on SRGH diminished over time. With regard to the socio-demographic variables, PF level had a greater and positive effect on SRGH level for subjects who were younger, who had higher education level or who were Caucasian (compared to African Americans or Hispanics). The interactions between PF and time (the aging effect), and PF and race were selected to illustrate the interactions (see Figs. 1 and 2 respectively). As shown in Fig. 1, PF had greater effects on SRGH in 1993 than in 1998 or 2002 although PF was positively associated with SRGH in all waves. Similarly, in Fig. 2, the PF-SRGH association had a steeper slope among Caucasians than among African Americans or Hispanics.

Discussion

The subjective process of the health evaluation of elderly individuals remains poorly understood. The present study expands on the existing literature in two ways. First, it examines the inconclusive role of socio-demographic and socio-economic factors in the relationship between PF and SRGH; second, it suggests the applicability of the theory in explaining discrepancies between changes in PF and changes in SRGH.

We assessed the effects of age and time simultaneously using longitudinal analysis, which allowed for the differentiation of the age cohort effect and the aging effect. Both the age and time variables had significant moderating effects on the PF-SRGH relationship and both moderating effects consistently showed that PF had less effect on SRGH in older elderly persons, which cannot be attributed only to a cohort effect. This provides strong evidence to clear the disagreement created by the contradictory findings in literature (Hoeymans et al. 1997a, b; Leinonen et al. 2001; Heyman and Jeffers 1963). PF was found to have less effect on SRGH for the elderly over time, which is consistent with the findings of Hoeymans and colleagues (1997a, b) and Leinonen et al (2001).

In the present study, PF had a greater influence on SRGH in Caucasian elders than on Hispanics or non-Hispanic Blacks. Spencer et al. (2009) also found that PF had more influence on the SRGH of Caucasians than Hispanics or African Americans. However, this stands in contrast to a previous study (Ferraro et al.

Table 3 Fixed effects of time, PF, socio-demographic factors and chronic diseases on SRGH

Variable	Estimate
Intercept	3.9097**
Time	0.1956**
PF	0.1815**
Gender (ref. Female)	0.0829*
Age	0.0221**
Race (ref. Caucasian)	
Hispanic	−0.0180
Non-Hispanic Black	−0.0766
Other Races	−0.2541
Education (ref. High school)	
Middle school or lower	−0.1069*
College	0.1026*
Post-graduate	−0.0250
Marital Status (ref. Married or Partnered)	0.1291**
Income (logged)	0.0306**
Depression	−0.0892**
Cognitive limitation	0.0902*
Back problem	−0.0929**
High blood pressure	−0.1058**
Diabetes	−0.1626**
Cancer	−0.2583**
Lung disease	−0.2610**
Heart disease	−0.2655**
Stroke	−0.1245**
Psychiatric	−0.1160**
Arthritis	−0.1644**
Died during the study	−0.2436**
Lost to follow-up during the study	−0.1440**
Interaction: PF by	
Time	−0.0629**
Age	−0.0058**
Hispanic	−0.0589**
Non-Hispanic Black	−0.0319*
Other Races	0.0539
Middle school or Lower	−0.0134
College	0.0122
Post-graduate	0.0868**

*$p \leq 0.05$; ** $p \leq 0.001$.

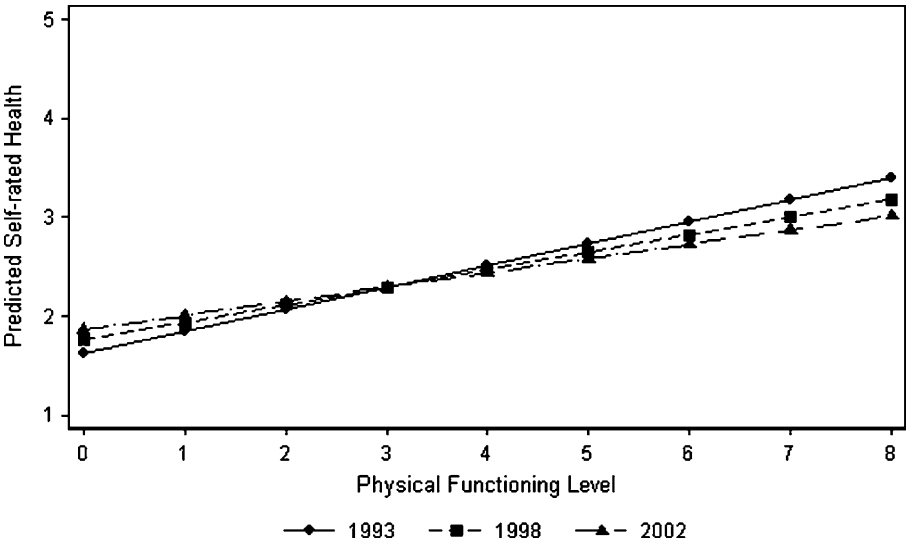

Fig. 1 The interaction between time and physical functioning. Note: Fig. 1 shows the SRGH levels of a married or partnered Caucasian female subject at the age of 77 (mean), with a high school education, with $0 household income and without major chronic diseases

1997), which indicated that, with similar changes in functional status, African American subjects reported a faster decline in SRGH than Caucasians. This might be due to the fact that our population is much older than the one in Ferraro et al's study, because younger populations have different health evaluation systems than the elderly (Krause and Jay 1994) and many younger individuals might encounter

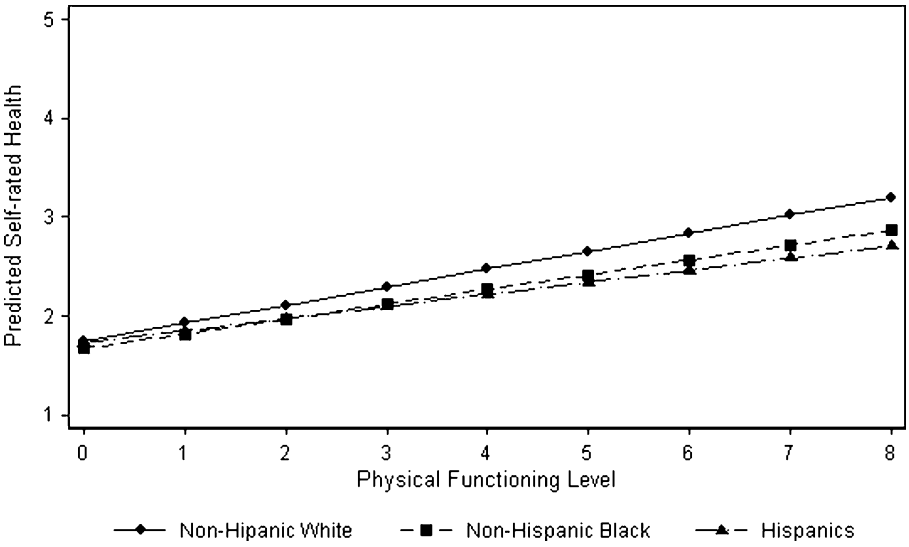

Fig. 2 The interaction between race and physical functioning. Note: Fig. 2 shows the SRGH levels of a married or partnered female subject at age 77 (mean), with a high school education, with $0 household income and without major chronic diseases at 1997

barriers to health care access than the elderly do when facing health decline. Specifically, access to health care among the elderly of different races can be more comparable than for younger populations because of Medicare coverage.

We also found that PF influences SRGH more in elders with post-graduate education than in those with less education. Similarly, Martinez-Sanchez and Regidor (2002) revealed that health problems had a greater influence on SRGH among people with more years of education. Those researchers suggested that individuals with more education are likely to work at jobs where they have higher levels of responsibility or greater autonomy. Thus, health problems have more influence on their SRGH levels than they do on less educated individuals. This explanation is plausible for working adults studied by the researchers, but it does not explain the results for the subjects in our study, who were older than 70.

The finding that the effect of PF on SRGH depends on socio-demographic factors as well as the significant random-effects of the coefficient of PF supports the idea that there is heterogeneity in health evaluations. As expected, the PF-SRGH association is heterogeneous across individuals given that individuals have various core values and beliefs and, externally, their health evaluation is affected by social context (McMullen and Luborsky 2006). It is worthwhile to note that the moderating effects we examined did not account for all heterogeneity seen in PF-SRGH relationship, as shown by the significant random effects of PF in the full model which already controlled for the moderating effects.

Income did not affect the PF-SRGH relationship in the present study. This might be due to the variance explained by the moderating effects of race and education, which tend to relate to income. To find out, we ran the model without interactions between education and race, in which the income-PF interaction became significant. This indicates attenuation of the moderating effects of income when we included the moderating effects of education and race. We also did not find significant interactions between gender and PF, which is in line with the findings by Jylha and colleagues (1998).

Viewed together, the findings that PF had less of an effect on SRGH for subjects who were older, had less education or were non-Caucasians confirmed our hypothesis that the PF-SRGH association is weaker among individuals belonging to lower-health populations. Thus, these findings support our theoretical proposition that if an individual from a health-disadvantaged population tends to compare his or her health with peers from the same disadvantaged population, the individual's SRGH is affected less by PF limitations. Social comparison theory, as well as other theories, have long been used to explain self evaluation of general health and discrepancies between physical health and SRGH (Wiseman 1999). However, few studies on SRGH are theory-driven or have a theoretical focus. Thus, there are prolific studies in the literature, yet a fragmented understanding of the self-evaluation of general health. Our findings suggest that social comparison theory can help explain how elderly individuals employ social contextual factors in their self-evaluations. When employing social comparison theory in self-evaluation of general health, the reference group people actually use might be complex and fall into a wide range due to the different characteristics he or she shares with others (Yngwe et al. 2003). However, some characteristics likely will be dominant when the selecting of reference groups. The current study suggests that the seniors might have used age,

race and education as the major factors to group themselves in choosing reference, although the process might be unconscious.

Previous studies show that social comparisons can be positive or negative (Yngwe et al. 2003). This study shows that social comparison is a positive process for self-evaluation of general health in elderly populations whose PF tends to be lower. Our findings on social comparison theory are different from what Heckhausen and Brim (1997) laid out. They stated that elderly individuals use social downgrading to mitigate the threat of health decline on their self-esteem by comparing "oneself to a negatively biased view of a group not generally identified as or known to be inferior to the self;" e.g., "most people your age." Particularly, our findings support the idea that elderly people do not necessarily use a reference "inferior to the self" but the reference can be a population having common background with them and, simultaneously, lower health. Our side analysis of the interaction between co-morbidities and PF also supports this. In that analysis, we found that PF had less effect on the SRGH of those with more co-morbidity.

It should be noted the social comparison theory was supported but not directly tested, which is the major limitation of our study. To directly test the role of social comparison theory, we suggest that future research can apply qualitative and/or quantitative approaches. Qualitatively, elderly individuals can be asked about the reference person(s) they use in evaluating SRGH. The characteristics of such references can then be analyzed to identify whether similarity in age, education or racial background between the subject and the reference dominates the conceptual process in selecting a reference. Quantitatively, the effect of social comparison theory can be examined using an experimental design by examining the effect of age, education and race one by one. For example, elderly individuals at the age of 80 can be randomly separated into two groups: one group is asked to report their SRGH by comparing their PF with individuals at similar age and the other group is asked to report their SRGH by comparing their PF with individuals at the age of 70. The difference between the reported SRGH of the two groups will measure the magnitude and significance of social comparison (age) effects.

Although we propose that the current study supports social comparison, we are not arguing for limiting one's view to a single theory. Other mechanisms could play a role in self-evaluation of general health to varying degrees. However, it seems that most theories cited in the literature, e.g., social capital (Szreter and Woolcock 2004), would not explain the significant moderating effects of age, time, race and education simultaneously. We recommend exploring alternative theories that might clarify whether PF has less influence on the SRGH of elderly individuals from disadvantaged socio-demographic groups. For example, Krause and Jay (1994) found that a higher percentage of Caucasians considered functioning capability than did African Americans or Hispanics when asked to evaluate own general health. Therefore, it is possible that individuals from health-disadvantaged populations would give greater weight to non-PF factors when evaluating their own health than younger, higher educated or Caucasians would.

The present study, together with previous studies, suggests that it is more appropriate to use or compare SRGH measurements within subgroups, e.g., people of similar ages, if the goal is to make an inference on people's physical health. This study also illustrates the complexity of what the SRGH measures. In addition,

findings from the present study have implications in the predictive power of SRGH on mortality. Many studies show that SRGH predicts future mortality even after controlling for other health condition measurements, but the predictive power differs among different populations (Deeg and Kriegsman 2003). Specifically, the association between SRGH and subsequent mortality is stronger for men (Idler 2003), younger persons, those with more education (Franks et al. 2003) and those who are Caucasian (Ferraro and Kelley-Moore 2001; Franks et al. 2003). By comparing their results with our findings that PF has a stronger association with SRGH among younger elderly individuals, those with post-graduate educations and Caucasians, it seems that SRGH has greater predictive power for mortality among those whose SRGH is a better reflection of PF (although we did not find significance on the moderating effects of gender). Researchers have been searching for an explanation of the differential predictive ability of SRGH on mortality and we believe the current study is groundbreaking and opens the door for more investigation following this logic. Moreover, our study could explain what McFadden and colleagues (2009) found. i.e., SRGH could explain the different mortality rates between social classes, but not substantially. This could be because physical health disparities between social classes are the major cause of differential mortality. However, changes in PF (and potentially other physical health indicators) did not go hand in hand with changes in SRGH.

Researchers have been interested in deriving response shift score (Schwartz and Sprangers 1999), which can be useful in quality of life computation and interpretation such as scale recalibration and/or concept redefinition. This study has demonstrated that longitudinal analysis approaches, by examining the growth curve of individuals, are very useful in quantifying response shift score (e.g., the change in the estimated coefficient of PF effect over time in the present study).

This study together with previous studies suggest that SRGH may not be able to capture the variance in specific health sub-domains due to the heterogeneity in individuals' health conceptual process and the change in their health conceptual process over time. In other words, SRGH is less reliable than sub-domain measurements if the purpose is to evaluate objective health condition. However, as proposed by some researchers (Cunny and Perri 1991; Idler and Benyamini 1997), SRGH can capture the preclinical or sub-clinical conditions not diagnosed routinely by physicians and thus reflects the unique health experience of each individual. An overall judgment of health also requires patients to evaluate different health sub-domains and to combine the weightings of these dimensions into a generic value. Therefore, such an overall judgment may better reflect individuals' overall well-being.

Conclusions

Building upon PF-SRGH relationship and social comparison theory literature, the present study found that PF had less effect on concurrent SRGH for older elderly, non-Caucasians or those with less education, who have lower physical health generally. This study has certain limitations. Although the HRS data is advantageous in representing the U.S. elderly population, had a large sample size and had long-term follow-up, it was not designed to examine the specific issues of interest here.

We used the self-reported PF measurements because objectively measured PF is not available in the data. Future studies could examine similar issues by incorporating objectively measured PF. Another limitation is the strength of our findings for supporting the social comparison theory. Our findings consistently provide support, but arguably not direct support. More studies that directly elicit the references used by individuals could help to confirm whether social comparison remains the major mechanism that moderates the effects of physical health on SRGH. Finally, this study was based on community-dwelling elderly in the United States. The results might not generalize to other countries, younger populations and institutionalized elderly populations.

Notwithstanding these limitations, this study presents evidence for the effects of socio-demographic factors on the relationship between PF and SRGH that have rarely been examined quantitatively using a nationally representative sample. This study suggests that social comparison theory can be the major explanation for the discrepancy between PF and SRGH.

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