Examination of Age Variations in the Predictive Validity of Self-Rated Health.

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ABSTRACT

Objectives

The high predictive validity of self-rated health (SRH) is a major strength of this widely used population health measure. Recent studies, however, noted the predictive validity varies across population subgroups. The aim of this Brief Report is to examine respondents' age as a moderator of SRH predictive validity with respect to subsequent mortality risk.

Methods

Using data from the National Health Interview Survey-Linked Mortality Files (NHIS-LMF) 1986-2006, we estimate Cox proportional hazard models of all-cause and cause-specific mortality for adults 45-84 years old as a function of their health ratings (N=574,008).

Results

The data show significant age moderation of the predictive validity of SRH across all levels of the ratings: the odds ratios for mortality decline by about one half between ages 50 and 80. This attenuation appears primarily among earlier birth cohorts; there is no significant age attenuation in more recent cohorts – however, this may be in part attributed to the earlier ages when the respondents are observed.

Discussion

The findings of declining predictive validity of SRH across age suggest that individuals may evaluate their health differently as they age. The results also imply caution in using SRH to capture age-related health changes in the older population.

Key terms: Self-rated health, age, predictive validity, mortality, US adults, birth cohorts.

Examination of Age Variations in the Predictive Validity of Self-Rated Health.

How does age moderate the predictive validity of self-rated health (SRH)? SRH has been widely used for over half a century to measure population health status, trends, and disparities (Jylhä, 2009). Numerous studies have established the high predictive validity of SRH for mortality (Idler & Benyamini, 1997). More recently, however, researchers noted systematic group differences in the SRH-mortality association. SRH predicts mortality better among men, non-Hispanic whites, and adults with higher socioeconomic status (SES) compared to women, minorities, and respondents with lower SES respectively (Benyamini & Idler, 1999; Dowd & Zajacova, 2007; Lee et al., 2007).

Another important potential moderator of the SRH-mortality relationship is age. Age is a key determinant of health status, as well as mortality. Older respondents, moreover are known to evaluate their health differently --more positively-- than their younger counterparts (Idler, 1993). Such age-related health judgment differences may be due to downward peer comparisons at older ages and/or the fact that the elderly may weigh their mental/social well-being more heavily relative to their physical health (Schnittker, 2005). The predictive validity depends, however, on the relative position of thresholds respondents use to delineate the categories. If respondents change their ratings more at some levels of health than at other levels, then SRH may become better or worse at distinguishing the underlying health status and the SRH-mortality link may become stronger or weaker with age.

The question of validity of the SRH measure is critical: given its extensive use in aging research and clinical practice, lower predictive validity among older adults would mean that health reports by these subjects may not be as useful for capturing their actual health status and future health needs as would health assessments of younger patients. In addition, SRH is often used in longitudinal research to measure health changes. If respondents rate their health differently as they age, then the observed changes in SRH may be biased. More broadly, understanding how

age moderates the SRH validity contributes to the important task of learning what the health ratings capture. Systematic age differences suggest that respondents alter the evaluation process as they age, and we can glean insight into whether their evaluation process becomes more finely tuned to their physical health or less so. This in turn can be used in further work to drill down into what exactly the SRH captures – a key question in our aging society where the health status of older adults is of immense public interest.

Surprisingly little work examined age as a moderator of the predictive validity of SRH. Two analyses of European adults found SRH a weaker predictor of mortality in older respondents (Helweg-Larsen, Kjøller, & Thoning, 2003; van Doorslaer & Gerdtham, 2003). In contrast, Korean respondents aged 65 and older evidenced a slightly stronger SRH-mortality association than adults 35-64 (Khang & Kim, 2010). In the US, SRH collected in the early 1970s predicted mortality among middle-aged men but not among older men or women of any age, net of detailed information on diagnosed conditions (Idler & Angel, 1990). We believe that a comprehensive examination of the moderating impact of age is overdue, especially given substantially improved health conditions and longevity of older adults over the last few decades.

When examining age patterns in the SRH-mortality associations, other time dimensions – especially birth cohorts-- need to be considered as potential confounders. Older respondents come from earlier birth cohorts, and cohorts could also drive systematic differences in the SRH evaluation process. Health literacy, for instance, is higher in more recent cohorts, which could contribute to a better understanding of one's health and more precise SRH judgments. The overall health levels have increased across birth cohorts, changing the peer reference group health and thus possibly the respondents' own health evaluation as well (Idler, 1993).

In this Brief Report, we use a large, nationally representative data with up to 20 years of follow-up to present a comprehensive analysis of age variation in the predictive power of SRH on mortality. To the best of our knowledge, this is the first such analysis for the U.S. population

since 1990. SRH is used in aging research and clinical work alike as a holistic indicator of general health. It is therefore imperative to know whether SRH predicts longevity the same way at different ages.

METHODS

Data

We used data from the National Health Interview Survey-Linked Mortality Files (NHIS-LMF) 1986-2006. The NHIS is a large, annual cross-sectional survey of the non-institutionalized U.S. population. The NHIS-LMF links adult respondents interviewed in 1986–2004 to mortality records in the National Death Index (NDI) through 2006.

The analytic sample includes respondents age 45 to 84 at the time of the interview. The upper age limit was selected because the NHIS top-coded age at 85 since the 1997 survey. The lower limit captures adults in middle adulthood and excludes fewer than 5% of deaths that occur at younger ages (Arias, 2010). We excluded 2,094 respondents (0.4%) who were missing self-rated health information. The final sample comprised 574,008 respondents.

Measures

Self-rated health (SRH) and *age* were the key predictors. SRH was measured on a 5-point scale from excellent (reference) to poor. Age was measured in single years. For age-stratified analysis, age was categorized in decades (45-54, 55-64, 65-74, and 75-84). Models with age by SRH interaction terms had age centered on 65 and measured in decades in order to obtain more easily interpretable hazard ratios.

All-cause mortality and *cause-specific mortality* comprised the outcomes. For *cause-specific mortality* we included leading causes of death: heart disease, cancer, respiratory disease, cerebrovascular disease, diabetes, and accidents.

Covariates included *gender*, *race/ethnicity*, categorized as non-Hispanic white (reference), non-Hispanic black, Hispanic, and other, *Census region of residence,* coded as Northeast (reference), Midwest, South, and West, the *year* of interview, *marital status*, categorized as married (reference), divorced, widowed, and never married, and *educational attainment,* coded as less than high school, high school and some college, and bachelor's degree or higher. Finally, *birth cohort*-stratified analyses grouped birth years into 15-year intervals.

Analysis

We estimated a series of Cox proportional hazard (PH) models of all-cause and cause-specific mortality as a function of SRH. Duration of follow-up was in 3-month increments. The Cox PH model is the most widely used approach to survival analysis and optimal for our research questions. First we stratified the sample by 10-year age groups to evaluate the association between SRH and mortality across age categories. Second, all-sample models that included SRH by age interaction terms tested whether age was a significant moderator of the SRH-mortality association. Further Cox PH models were estimated for cause-specific mortality and with additional covariates. Next we considered the role of birth cohorts, estimating Cox PH models stratified by three birth cohort groups. Finally, to get a more complete picture of the age-period-cohort patterns, we estimated Cox PH models of all-cause mortality on dichotomized SRH (poor/fair vs. excellent to good) separately for each combination of interview year and 2-year age groups (340 models for each gender, from a model for respondents interviewed in 1986 at ages 45-46 to a model for respondents interviewed in 2002 at ages 83-84), captured the hazard ratios from these models, and smoothed them to a 3D surface using generalized additive models (Wood, 2006). The resulting figures display the age-period-cohort pattern in the predictive validity of SRH on mortality. The Online Supplement also shows all analyses conducted separately by sex because of previous research that showed large sex differences in

the SRH-mortality links (Benyamini, Blumstein, Lusky, & Modan, 2003). All Cox PH models were adjusted for the NHIS-LMF complex sampling design and estimated using Stata 13.0.

RESULTS

Table 1 shows sample characteristics at the interview and mortality follow-up information. The distribution of SRH varied by age: about 30% of respondents aged 45-64 reported excellent health and 31% reported very good health, compared to 13% and 22% among respondents 75-84, respectively. During the follow-up, 7% of the adults aged 45-54 died, compared to 57% of the oldest group. Online Supplement Table S1 shows all covariates and follow-up information, including the distribution of causes of death.

Table 2 summarized results from age- and gender-adjusted Cox PH models stratified by 10-year age groups. The results corroborate the strong link between health ratings and mortality: the SRH hazard ratios are significant in all age groups, meaning that any health rating worse than excellent predicts significantly higher mortality hazard than the 'excellent' reference. There is a clear stepwise pattern across the models, however, whereby the hazard ratios are smaller for older respondents at each level of SRH relative to excellent. For instance, at ages 45-54, respondents who evaluated their health as 'good' had 2.5 times the odds of dying compared to those in excellent health; the odds were 1.6 times higher among respondents age 75-84. Across all SRH levels from 'very good' to 'poor,' the predictive power declined by over one half between the ages 50 and 80.

Table 3 tests whether these age patterns are statistically significant and whether they can be explained by key demographic and socioeconomic characteristics of the respondents. Results from Model 1 answer the first question: the moderating impact of age is statistically significant (all age by SRH interaction terms are significant). Models 2 and 3 show that the influence of age is not due to sociodemographic differences in respondent characteristics: the interaction

terms (and the main SRH terms) remain largely unchanged when controlling for race/ethnicity, region, interview year, marital status, and education.

Table 4 shows results from six cause-specific PH models. All but three of the 24 SRH by age interaction terms are statistically significant and all are in the same direction: older respondents have a lower predictive validity of SRH compared to their younger counterparts for all major causes of death.

Finally Table 5 disaggregates by birth cohort and shows that the diminishing predictive validity of SRH with age occurs primarily (or only) in the older birth cohort; the moderating impact of age on more recent birth cohorts is largely not significant, with hazard ratios of the interaction terms close to 1 in absolute size.

Figure 1 shows the age by period patterns in the predictive validity of dichotomized SRH on all-cause mortality for men and women. The predominant pattern in both genders is the diminishing predictive power of SRH across age at all time periods.

DISCUSSION

The findings reveal a strong moderating impact of age on the predictive validity of SRH among US adults age 45-84: SRH predicts mortality significantly better at younger ages than among older adults. The age effect is substantively large: SRH, at all levels from very good to poor, has as least twice as large hazard ratios for adults assessing their health at ages 45-54 than at ages 75-84. For instance, respondents age 45-54 who rate their health as poor have about 5 times the odds of dying compared to respondents with 'excellent' health; the odds decline to 2.2 among respondents interviewed around age 80.

The moderating influence of age was not explained by race/ethnic composition, region of residence, marital status, or educational attainment. The age effect was also not driven by only some causes of death but occurred across all leading causes of death. Additional analyses

shown in the Online Supplement showed that period (year of interview) also did not have a pronounced influence on the age moderation although later time periods were associated with stronger overall SRH hazard ratios as others found (Schnittker & Bacak, 2014).

The moderating impact of age may be occurring primarily among older birth cohorts. In models of younger cohorts (born after about 1940), age does not seem to change the predictive validity of SRH. If this finding is confirmed in futures studies, it would have welcome implications for population-health research, making SRH a particularly useful measure for capturing age-related health changes in the population by implying that the validity of SRH remains stable as people age. However, we urge caution in this interpretation because this findings may be simply a function of the relatively early ages –and correspondingly few deaths-- when the more recent birth cohorts are observed and analyzing them at a later time point (and thus at older ages) will be necessary.

We note several limitations of the study. With respect to data, only non-institutionalized U.S. adults are included, resulting in positively health-selected older respondents. This selection could influence the SRH values of the oldest respondents (Idler, 1993) but given the low institutionalization rate of adults prior to age 85, we do not believe this phenomenon is likely to substantially bias the findings. With respect to the interpretation of findings, we note two limitations. First, the predictive validity of SRH for mortality was captured by examining *relative* risks. This perspective is well-suited for the question. However, the absolute (average) mortality hazard increases sharply in old age, and this presents a methodological quandary. When baseline hazard is low, then even relatively small absolute difference in hazards translates into sizeable relative hazard ratios. In contrast, when the absolute baseline hazard is high, then even large absolute hazard differences may not translate into large relative coefficients. A part of the age-moderation effects may thus be attributable to this methodological consideration. Second, we were not able to fully resolve the discrepant findings

from the cohort-stratified models that suggested no moderating impact of age in younger cohorts versus the results from the age-and-period stratified models (Figure 1) that seemed to show a clear impact of age even in more recent time periods and cohorts. Additional years of follow-up will help clarify the age patterns among the more recent birth cohorts in the future.

This Brief Report contributes to the literature on the predictive validity of self-rated health by providing new evidence that adults from mid-adulthood to old age, especially those born in older cohorts, may form their health evaluation in a systematically different way as they age. The results suggest that we need to be cautious when comparing health ratings of adults across different ages because their ratings may fully comparable.

Table 1. Characteristics of the NHIS-LMF analysis sample, by age group (*N*=574,008)

	45-54	55-64	65-74	75-84
Proportion of the sample (%)	37.7	27.5	22.0	12.8
Self-rated health (%)				
Excellent	30.3	22.9	16.8	12.5
Very good	30.8	27.0	24.8	22.5
Good	26.2	29.8	33.7	34.1
Fair	9.2	13.7	17.6	21.4
Poor	3.6	6.5	7.3	9.6
Follow-up information				
Died during follow-up (%)	7.3	18.4	37.4	56.7
Duration of follow-up (s.e.)	10.4 (.04)	10.3 (.04)	9.3 (.04)	7.1 (.03)
N	215,279	158,385	128,066	72,278

Source: NHIS-LMF 1986-2006. Descriptive statistics adjusted for complex sample design.

Note: Descriptive statistics for all covariates and followup information are in Supplementary Table 1.

Table 2. Hazard ratios of age-adjusted all-cause mortality on SRH, by age group.

SRH (ref.=excellent)	45-54	55-64	65-74	75-84
Very good	1.46***	1.22***	1.27***	1.20***
Good	2.49***	1.94***	1.97***	1.60***
Fair	5.61***	4.23***	3.44***	2.51***
Poor	14.52***	10.11***	7.84***	4.69***
Covariates				
Age	1.07***	1.08***	1.08***	1.09***
Female	0.60***	0.62***	0.58***	0.59***

* p<.05, ** p<.01, *** p<.001

Hazard ratios from age-adjusted Cox proportional hazard models shown. All estimates are adjusted for the complex sampling design of the NHIS.

Table 3. Hazard ratios of all-cause mortality on SRH by age with covariates, by gender (*N*=574,008).

SRH (excellent)	Model 1	Model 2	Model 3
Very good	1.28***	1.28***	1.27***
Good	1.97***	1.97***	1.96***
Fair	3.75***	3.76***	3.67***
Poor	8.58***	8.59***	8.25***
SRH by age[1]			
Very good * age	0.95*	0.95*	0.96*
Good * age	0.87***	0.87***	0.88***
Fair * age	0.76***	0.76***	0.78***
Poor * age	0.67***	0.67***	0.69***
Covariates			
Age[1]	2.66***	2.65***	2.58***
Female	0.60***	0.60***	0.55***
Race/ethnicity (NH white)			
Non-Hispanic black		1.09***	1.02
Hispanic		0.74***	0.72***
Other		0.73***	0.72***
Region (Northeast)			
Midwest		0.99	1.00
South		0.96**	0.97
West		0.96*	0.97
Survey year		0.99***	0.99***
Marital status (married)			
Divorced/separated			1.38***
Widowed			1.25***
Never married			1.44***
Education (high school)			
Less than high school			1.00
Some college or more			0.92***

* p<.05, ** p<.01, *** p<.001

[1] Age is centered on 65 and incremented in decades in order to obtain easier-to-interpret sizes of the main and interaction terms.

Hazard ratios from Cox proportional hazard models shown. All estimates are adjusted for the complex sampling design of the NHIS.

Table 4. Cox PH models of cause-specific mortality on SRH by age.

	CVD	Respiratory	Cancer	Cerebro-vascular	Diabetes	Accidents
SRH (excellent)						
Very good	1.27***	1.40***	1.09***	1.30***	1.76***	1.04
Good	1.82***	2.14***	1.35***	1.80***	2.97***	1.26***
Fair	3.17***	4.15***	1.81***	2.64***	7.05***	1.77***
Poor	5.60***	9.34***	2.99***	4.30***	14.93***	2.75***
SRH by age[1]						
Very good * age	0.93***	0.86***	0.94***	0.93	0.84*	0.93
Good * age	0.85***	0.76***	0.88***	0.85***	0.75***	0.93
Fair * age	0.73***	0.65***	0.80***	0.74***	0.63***	0.80***
Poor * age	0.63***	0.58***	0.76***	0.68***	0.58***	0.70***
Covariates						
Age[1]	3.33***	3.69***	2.03***	3.78***	2.64***	1.86***
Female	0.58***	0.59***	0.61***	0.84***	0.80***	0.47***

* p<.05, ** p<.01, *** p<.001

[1] Age is centered on 65 and incremented in decades in order to obtain easier-to-interpret sizes of the main and interaction terms.

Hazard ratios from age-adjusted Cox proportional hazard models shown. All estimates are adjusted for the complex sampling design of the NHIS.

Table 5. Cox PH models of all-cause mortality SRH by age, stratified by 15-year birth cohorts.

	1910-24	1925-39	1940-55
SRH (excellent)			
Very good	1.33***	1.30***	1.36
Good	2.12***	2.03***	2.07***
Fair	3.39***	4.06***	5.22***
Poor	8.90***	9.23***	12.20***
SRH by age[1]			
Very good * age	0.91	1.08	0.96
Good * age	0.81***	1.04	0.89
Fair * age	0.80***	0.93	0.97
Poor * age	0.63***	0.88*	0.89
Covariates			
Age[1]	2.69***	2.13***	2.06***
Female	0.59***	0.61***	0.60***

* p<.05, ** p<.01, *** p<.001

[1] Age is centered on 65 and incremented in decades in order to obtain easier-to-interpret sizes of the main and interaction terms.

Hazard ratios from Cox proportional hazard models shown. All estimates are adjusted for the complex sampling design of the NHIS.

Note: the mortality hazards by SRH converge with duration. The maximum and average duration was necessarily shorter in the more recent interview waves and thus, to some degree, among younger birth cohorts, than in the older interview waves and thus older cohorts. This effect obviously affects cohort-stratified results more than all-sample results. To equalize duration across cohorts and eliminate its confounding, we estimated cohort-stratified models for 5-year follow-up. Results from unrestricted follow-up, available in the Online Supplement, also show no significant moderating effect of age in younger cohorts.

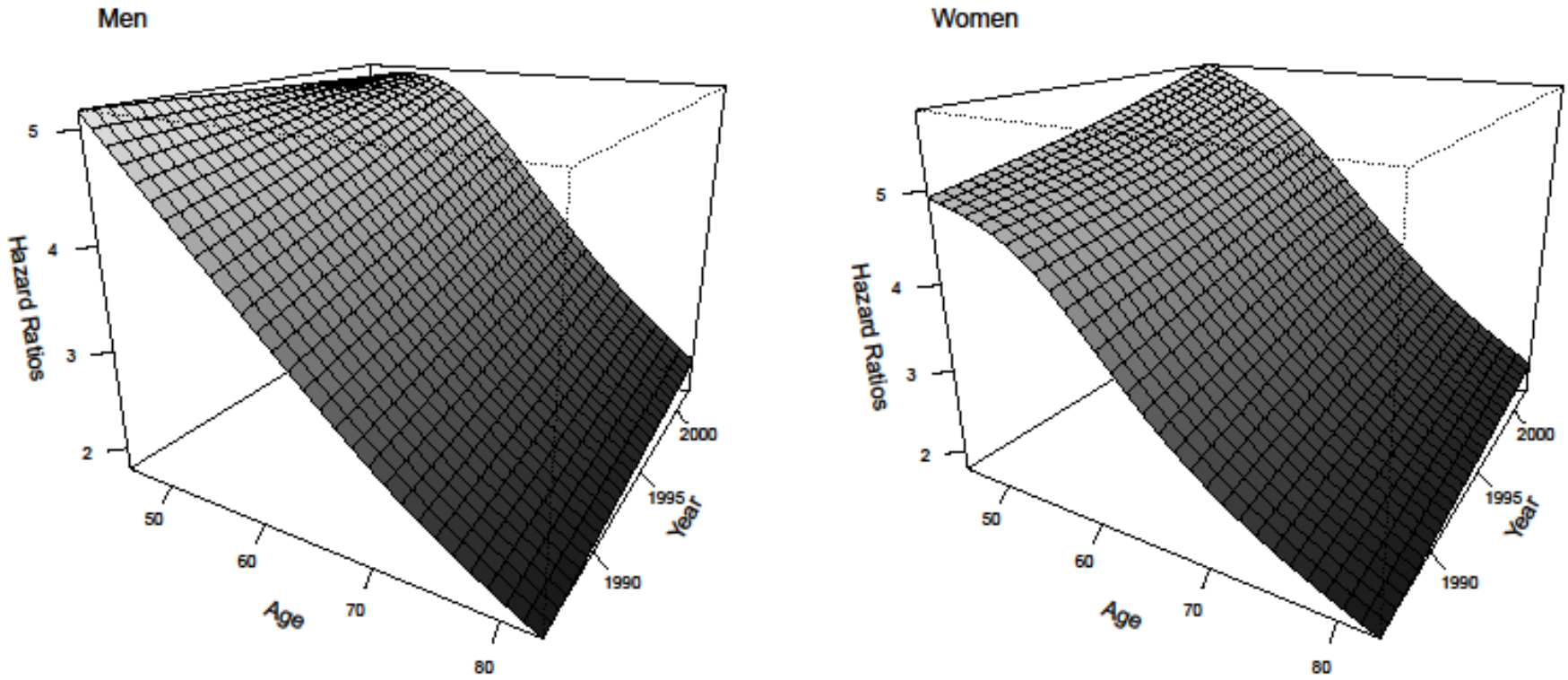

Figure 1. Hazard Ratios of Mortality for Poor/Fair SRH by Age and Period.
Note: The plots show the hazard ratios for poor/fair SRH relative to excellent to good SRH. The hazard ratios are captured from Cox PH models estimated separately for each age/time period combination and the surface is smoothed using generalized additive models.

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