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Do age and social relations moderate the relationship between self-rated health and mortality among adult Danes?

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Abstract

It is well established that self-rated health (SRH) predicts mortality even after controlling for a wide range of factors. We explored the extent to which age and social relations (structural and functional) influenced the relationship between SRH and mortality (after 13 years follow-up) in a representative sample of adult Danes ($N = 6693$). After controlling for socioeconomic status, illness, and lifestyle variables, we found that age moderated the SRH–mortality relationship such that it was present for respondents under 55 but absent for respondents over 56. In addition, weaker structural (but not functional) social relations increased mortality directly but neither structural nor functional social relations moderated the SRH–mortality relationship. We discuss the theoretical and practical implications of these findings.

Keywords: Self-rated health; Age; Social networks; Social relations; Mortality; Denmark

Introduction

In the last 30 years many studies have demonstrated that self-rated health (SRH) is a powerful predictor of subsequent illness and mortality (see reviews by Idler & Benyamini, 1997; Idler & Kasl, 1991). This relationship holds in different countries, using different populations, question formulations, and different outcome measures (most commonly all-cause mortality as well as specific causes such as heart disease and cancer). The relationship persists even after controlling for a long list of demographic, psychosocial, and life style variables as well as prior illness, physician's assessments, and physiological measures.

Although the relationship between SRH and mortality is well established, we have not uncovered the exact factors that contribute to this relationship. Idler and Kasl (1991) concluded that researchers have identified no medical, psychosocial, or behavioral variables to explain the association nor does the association reflect a methodological artifact. Even studies that failed to show the effect typically found the relationship for some participants (e.g., men but not women) and these studies offer no consistent pattern that identifies the process underlying the relationship (Bjorner et al., 1996).

Respondents likely draw on a number of different sources when they make their health self-assessment (Idler & Benyamini, 1997). This information might include family history, severity of current illness, possible symptoms of diseases not yet diagnosed, trajectory of health status over time, as well as availability of external resources (such as social support) and internal resources (such as perceived control). It is also possible that causality might be reversed. That is, poor perceptions of health might lead to a reduction in preventive behaviors or nonadherence to medication and treatment (Idler & Benyamini, 1997). Ferraro, Farmer and Wybraniec (1997) found that low SRH was both a reflection of past ill health and a predictor of future ill health.

Many researchers have suggested that research in this area needs to move away from merely establishing that this relationship exists and move in the direction of examining why this relationship exists (Idler &

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Benyamini, 1997). One approach is to study different outcome measures (e.g., hospitalizations), different populations (e.g., not only the elderly) or use qualitative methods (Idler & Benyamini, 1997). Another approach to understanding this relationship is to examine variables that might moderate the relationship. Obtaining a better understanding of the circumstances under which the relationship strengthens, weakens, or disappears might lead to a better understanding of what factors underlie the relationship. In addition, it might have important clinical implications to understand exactly when people's own estimation of their health predicts mortality. In this article we examined age and social relations as moderators of the relationship between SRH and mortality.

SRH and age

Many researchers have examined the relationship between age and SRH. For example, Idler (1993) found in a sample of elderly (65 and older) community residents in New Haven, Connecticut that at any given level of health status, older participants rated their health as better than younger participants. Idler concluded that this is due both to a cohort effect (the cohort in this study was before 1906 and may have different perceptions about what constitutes good health), an age effect (people evaluate their health differently as they age) and a survival effect (individuals who evaluate their health positively are more likely to survive). However, according to a review by Bjorner et al. (1996) the relationship between age and SRH is inconsistent. Roughly one-third of the studies reviewed showed that older people evaluated their health more positively, roughly one-third showed that older people evaluated their health more negatively, and one-third showed no relationship between SRH and age. However, it is difficult to compare across these studies because many include only samples of the elderly. Finding an age gradient among the elderly (e.g., Idler, 1993) is not necessarily inconsistent with finding no age gradient in a sample of all ages. In addition, the same variables must be controlled in order to compare across studies. Failing to include variables or measure variables appropriately may alter the resulting relationship between SRH and age. For example, functional ability is typically highly correlated with SRH and functional ability declines with age. If functional ability is not controlled, then SRH may appear to decline with age, when in fact this decline can be entirely accounted for by functional ability (Bjorner et al., 1996).

Such inconsistent results might also mean that the relationship between age and SRH is not linear. In fact, Moum (1992) found a curvilinear relationship between age and SRH, such that when controlling for level of medical health, the younger (25–54) and the elderly (75–86) groups showed a better SRH than the middle age group (55–64). These data are consistent with Idler's (1993) data showing that among the elderly, the older the respondents the better their SRH.

Thus, the relationship between age and SRH is not clear and can vary depending on what variables are controlled for statistically in the analyses. It is important to note that the focus in the present study is on age as a moderator of the relationship between SRH and mortality. Most studies examining SRH and mortality control for age rather than examine its effect. The few studies that specifically examined the effect of age show inconsistent results. For example, Wannamethee and Shaper (1991) found the SRH–mortality association to be the same in the three age groups (44–54, 55–59, and 60–64) of UK men. In contrast, Idler and Angel (1990) found in their US sample the typical SRH mortality relationship only among middle aged men but not among middle aged women or among elderly men and women.

There are several reasons why we might expect the SRH–mortality association to decline with age. These reasons all center on how health-related judgments might change with age. First, health appraisals are partly based on social comparison with one's peers. As one grows older there is a larger pool of peers who have poor health. Older adults may consider their health relatively good when comparing themselves to other older adults, despite having significant health problems (Idler, 1993). Thus, increasingly with age social comparison to less fortunate others might be used to make assessments about one's own health. Second, older adults may be more likely to rely on nonphysical aspects when they make health self-assessments. In a sample of elderly (73–98 year olds) Borawski, Kinney, and Kahana (1996) analyzed open-ended responses to attributions underlying health self-assessments. Attributions were categorized into five categories: physical health, attitudinal/behavioral, externally focused, health transcendence, and nonreflective. Results indicated that the older the respondents the less likely they were to focus on physical health when judging their health. In addition, the elderly who were pessimistic about their health were more likely to make physical health attribution and died sooner than elderly who were optimistic about their health. Thus, as people age self-assessments may grow increasingly unpredictive of mortality because the self-assessments are based on aspects other than actual physical health, such as social comparison as well as attitudinal or behavioral aspects of health.

SRH and social relations

The relationship between better social relations and lower mortality is well documented (e.g., Berkman, 1995; Schwarzer & Leppin, 1991; Seeman, 2000).

Nevertheless, inconsistencies exist across studies. Inconsistencies may occur for several reasons. First, measures of social relations vary dramatically across studies, both in the included subconcepts and their conceptualization and in the way they are measured (Berkman, Glass, Brissette, & Seeman, 2000; Orth-Gomer & Unden, 1987). Second, the impact of social relations may interact with age in predicting mortality. Specifically, the type of social support as well as the usefulness of various types of social support varies throughout the lifespan (Bowling, 1991; Due, Holstein, Lund, Modvig, & Avlund, 1999; Olsen, Iversen, & Sabroe, 1991). Third, social relations are not necessarily positive and therefore do not necessarily contribute to improved coping with illness (Avlund, Damsgaard, & Holstein, 1998; Schwarzer & Leppin, 1991; Seeman, 2000). In addition, physical as well as mental health problems can change in a negative direction the perceived social support from friends and family (Alloway & Bebbington, 1987). Fourth, if social support has already been provided when measurements are made, it may actually appear that more support is related to greater illness or death (Schwarzer & Leppin, 1991). Fifth, the association between social relations and health can work both ways. Most often the association is interpreted as an expression of the protective roles of social relations on physical and mental health. But the association might also work the other way round, i.e., healthy persons are selected into positive social relations (Ren, Skinner, Lee, & Kazis, 1999). Despite these potential problems and lack of consistency it is fair to say that the current state of the literature suggests that poor social relations predict increased mortality.

Researchers working in the field of social network, social support, social integration, or social participation often point to problems with definitions and conceptualization of terms. Due et al. (1999) propose a framework where social relations is used as the overall concept and the structure and function of social relations as subconcepts. Specifically, *structural social relations* are defined as "the individuals with whom one has an interpersonal relationship and the connections between these individuals" (p. 662). The structural relations cover both formal and informal relations and can be measured by type of relation, frequency, diversity, density, and reciprocity. *Functional social relations* are defined as "the interpersonal interactions within the structure of the social relations" (p. 662). It can be further divided into emotional support, instrumental support, informational support and appraisal. This framework appears to improve terminological clarity and we adopted this conceptual framework in the present article.

While social relations predict mortality and SRH predicts mortality, few studies have examined the interaction of these variables in predicting mortality (often one of these two variables is controlled as a confounding factor). In fact, we located only two studies that examined simultaneously social relations and SRH as predictors of mortality. First, in one study of elderly (ages 60 and up) Japanese men and women, Sugisawa, Liang, and Liu (1994) examined five different aspects of social relations (social participation, social support, social contacts, feeling of loneliness and marital status) and their effect on mortality. Results showed that both social participation (but not the other aspects of social relations) and SRH predicted mortality. However, because a single equation approach was used for data analysis, the interaction among predictor variables was not examined. Second, in a Swedish study of middle-aged men Orth-Gomer, Unden and Edwards (1988) found three factors (social isolation, poor SRH, and ventricular irritability) that equally predicted all-cause mortality as well as ischemic heart disease mortality. Of note, social isolation did not interact with SRH in predicting either outcome variable. Thus, the study found main effect contributions of these variables but not uniquely interacting effects.

In this study we wanted to examine the unique combination of social relations and SRH in predicting mortality. It is possible that social relations and SRH have an additive positive effect on mortality (that is, positive social relations and positive SRH both contribute to lower mortality). Idler and Benyamini (1997) suggest that social relations is one element that people consider when asked to evaluate their overall health. If social relations are conceptualized as one of many components of SRH one might expect that SRH and social relations contribute independently to predict mortality (that is, they do not interact). On the other hand, it is possible that social relations and SRH interact in predicting mortality; that is, good SRH might be associated with lower mortality rates regardless of the quality of social relations, whereas poor SRH might would be associated with higher mortality when social relations are poor as opposed to good. Social relations might have a buffering effect (cf. Cohen, 1988) in that strong social networks are only utilized when health is poor. In light of the paucity of research on this issue, we tentatively predicted that social relations and SRH would interact in predicting mortality.

In this article the goal was to examine the relationship between SRH and mortality and two moderating variables, namely, age and social relations (functional and structural). We controlled for socioeconomic factors as well as illness and life style variables. We predicted main effects of SRH, age, functional social relations, and structural social relations. More importantly, we predicted that age would moderate the SRH–mortality link such that older respondents would show a weaker effect than younger respondents. In addition, we predicted that structural and functional social relations

would moderate the SRH–mortality link such that good SRH would be associated with lower mortality rates regardless of the quality of social relations whereas poor SRH would be associated with higher mortality when social relations were poor as opposed to good.

Methods

Study population

The sample included 6693 respondents from a health interview survey conducted in 1987 by the National Institute of Public Health. The survey forms the basis of the Danish National Cohort Study (DANCOS). The survey was based on a nationally representative random sample of 5950 adults in Denmark aged 16 years and older and on representative random samples from two counties ($N = 2413$). Data were gathered through personal interviews and collected in three rounds, with approximately 2800 people in each round.

The personal interview assessed chronic illness, two-week prevalence of symptoms, complaints and injuries (acute illness), long- and short-term disability, SRH, use of health services, illness behavior, health promotion behavior (dietary habits, physical exercise, smoking behavior, alcohol consumption), health risk behavior, and demographic and socioeconomic characteristics.

The overall participation rate for the personal interviews was 80%. The overall participation rates were similar among men and women. Participation declined with age. Fewer widows, widowers and divorced and never married people participated than did currently married people. The correction required for the skewed participation rates in the total survey was calculated to be less than 1%. Thus, the interview sample was deemed representative of the population.

Outcome measure

In 1999 (13 years after the end of the survey) information about mortality was obtained based on personal identification numbers from the Danish Registers of Causes of Death (Juel & Helweg-Larsen, 1999). At the time of analysis, information was available only about time of death, not the cause of death. Eighty-five participants were lost to follow-up mainly due to emigration.

Primary measures

SRH was assessed by asking, "How do you rate your health in general?" The response categories were "very good," "good," "fair," "poor," and "very poor". Poor and very poor were combined into one category. Thus, this variable contained four levels.

Social relations were assessed with four different questions that were combined into two dichotomized measures: structural social relations and functional social relations (Due et al., 1999). The two questions that assessed structural social relations were how often the respondents meet with friends and family, respectively, with response categories "daily or almost daily," "once or twice a week," "once or twice a month," "not as often," and "never". If participants responded "not as often" or "never" on the question regarding friends or if participants responded "never" on the question regarding family they were categorized as having poor structural social relations. All other participants were categorized as having good structural social relations.

Two questions also assessed functional social relations. The first question asked if respondents could rely on help from other people if they became ill. Response options were "no one," "yes, from the people I live with," "yes, from neighbors, people in the neighborhood (incl. family)," and "yes, from friends, acquaintances or family." The second question asked, "Does it ever happen that you are alone even though you would prefer to be with other people?" with options "no," "yes, but rarely," "yes, once in a while," and "yes, often." If participants responded "no one" to the first question or answered "yes, often" to the second question they were categorized as having a poor functional social relations.

Control variables

Socioeconomic factors: Level of education was defined based on the International Standard Classification of Education (ISCED) by combining variables assessing the respondent's number of years of basic schooling and vocational training. Categories were less than 10 years, 10 years, 11–12 years, 13–14 years, 15 or more years, and unknown/missing. Employment status consisted of employed versus unemployed. Marital status consisted of married, cohabitating, divorced (not cohabitating), or single (not cohabitating) respondents.

Illness factors: Presence of a chronic disease was coded as "yes" or "no." Activity limitations were assessed by asking respondents if illness, injury, or complaints during the past 2 weeks had made it difficult or impossible for them to carry out ordinary daily activities. Responses were coded as "no," "short term" (if expected to last less than 6 months) or "long term" (if expected to last 6 months or more). Physical limitations was coded as "no limitations" or "some limitations." If respondents indicated that without difficulty or with minor difficulty they could walk up and down a flight of stairs without resting, carry 5 kg, and walk 400 m, respondents were categorized as having no physical limitations. If respondents indicated they had difficulty with or were not at all able to do any one of these three tasks they were categorized as having physical

limitations. Communication limitations were similarly coded as "none" or "some." If respondents indicated that without difficulty they could hear what is said in a normal conversation with 3 or 4 other people, could read a newspaper, could speak without difficulty (as judged by the interviewer), respondents were categorized as having no communication limitations. Respondents who had difficulty with or were not at all able to do any of these three tasks were categorized as having communication limitations. Life quality was assessed by asking, "do you feel well enough to do what you want to do," with response categories "yes, most of the time," "yes, sometimes" and "no, hardly ever".

Life style variables: Control over own health was assessed by asking "do you believe that you yourself can do something to stay healthy?" Respondents' were categorized as having high control ("my own effort is very important"), some control ("my own effort is fairly important"), or no control ("I do not think I can do something myself to stay healthy"). Smoking behavior was defined as never, previous smoker, or current smoker. Alcohol use on the last week day (Monday–Thursday) before the interview was categorized as none, 1–4 drinks, or five or more drinks. One drink was defined as being equal to one bottle of beer, one glass of red/white wine, or one drink of strong alcohol. Everyday level of physical activity in the respondents' spare time was categorized as sedentary, light exercise, regular exercise, or participation in competitive sports. Body mass index (BMI) was calculated as body weight (kg) divided by the square of height (m^2) and divided into 4 categories: less than 20, 20–24, 25–29 and 30 or more.

Statistical methods

We used a Cox regression model for the analysis. Relative to an ordinary probability model such as a logistic regression model, the advantage of this model is that it models the time period from the start of the study to the event (death) instead of the entire follow-up period. In the Cox model all independent variables were related to the conditional "instantaneous" risk (or hazard) of death in the following way:

$$h_i(t) = h_0(t)\exp(\beta_0 + \beta_1 Z_1 + \beta_2 Z_2 + \beta_3 Z_3 + \cdots + \beta_n Z_n),$$

where $h_i(t)$ is the hazard function for the ith person and $h_0(t)$ an unknown standard hazard function. The Zs denote the covariates whereas the βs denote the regression coefficients.

Results

Table 1 shows descriptive data on mortality, namely the percent of people in each category who were deceased after 13 years (the total follow-up period) as a function of participants' age, gender, SRH, and functional and structural social relations. These data show the expected effects. There were greater mortality rates among men than women, among the old compared

Table 1
Percent deceased as a function of age, gender, self-rated health, structural network and functional network

	Self-rated health				Structural social relations		Functional social relations	
	Very good	Good	Fair	Poor/very poor	Good	Poor	Good	Poor
Age								
16–44	2	3	7	9	2	2	2	7
	2438	*867*	*291*	*66*	*3474*	*183*	*3515*	*143*
45–55	8	4	19	29	9	21	10	15
	505	*271*	*177*	*85*	*910*	*125*	*971*	*59*
56–66	20	25	34	43	28	28	26	42
	315	*228*	*244*	*105*	*750*	*143*	*808*	*81*
67–77	54	46	65	77	55	73	57	64
	192	*177*	*194*	*116*	*534*	*143*	*547*	*121*
78+	78	90	92	95	86	92	87	88
	88	*98*	*85*	*63*	*226*	*104*	*235*	*76*
Gender								
Men	10	18	39	62	17	43	17	46
	1744	*841*	*447*	*189*	*2890*	*325*	*3023*	*183*
Women	7	15	31	44	13	35	12	38
	1794	*800*	*544*	*246*	*3004*	*373*	*3053*	*297*

Note: The first number in each cell indicate the percent people deceased in that category after 13 years.
The second number (in italics) indicates the total number of participants in that cell. Total $N = 6611$.
Number deceased after 13 years = 1141.

with the young, among people with poorer SRH compared to people with better SRH (within age groups), and among people with poor structural and functional social relations compared to people with good structural and functional social relations (within age groups).

In Tables 2 and 3 we display Cox Regression analyses predicting mortality. The purpose of the Cox Regression analyses was two-fold. First, we wanted to examine if our hypothesized interactions between SRH and age as well as SRH and social relations were significant. Second, we wanted to examine if these two primary interactions remained significant after controlling for a wide range of variables.

Our first model (Table 2) included gender, age, structural social relations, functional social relations, and SRH as well as all two-way interactions. As hypothesized the Age × SRH interaction was significant. Contrary to predictions, neither Functional Social Relations × SRH nor Structural Social Relations × SRH were significant. To remove the many nonsignificant interactions from the model (including our hypothesized interactions with social relations) we subjected Model 1 to backwards selection. The resulting Model 2 is displayed in Table 3. Model 3 added socioeconomic status variables including employment status, educational level, and marital status. Model 4 added variables describing illness, including the presence of chronic illness, physical, communication, and activity limitations, and whether the respondent feels able to do what he/she wishes. Model 5 added life style variables, including smoking, exercise, alcohol use, BMI, and perceived control over own health outcomes. The Final Model (Model 6) included the same variables as Model 5 but backwards selection was again used. This allowed us to remove the control variables that did not significantly contribute to mortality. Table 3 displays Model 2–6.

In the Final Model the SRH × Age interaction remained significant, as did the main effect of structural social relations. There was no main effect of functional social relations. Importantly, the Age × SRH interaction remained significant after controlling for socioeconomic variables, illness factors, and life style variables and the Social Relations × SRH interactions were not significant.

It is tempting to examine the remaining effects in the models. However, such interpretation should be done very cautiously because the model contains a great many control variables. For example, the effect of chronic illness is not related to mortality in the Final Model. This is likely because chronic illness and SRH are highly related, not because chronic illness is not related to mortality.

In Table 4 we examined in more detail the nature of the Age × SRH interaction. In all previous Cox regression analyses age was treated as a continuous variable. For ease of interpretation of this interaction Table 4 shows the beta-values for a number of age intervals. We adjusted for age within each of the age categories. It appears that the SRH–mortality relationship is present for the 16–44 age group, and the 45–55 group, but absent for the 56–66, 67–77, and 78 and older age groups. Examining the data within the first two age categories we note that the pattern of beta-values across the four SRH categories does not follow a linear pattern in which better SRH is clearly related with greater mortality (within that age category). This lack of linearity within age categories (that are otherwise significant) might be due to a very low number of deceased individuals in some of the age categories (for example, among 16–44 year olds with poor/very poor health only 6 were deceased after 13 years). Future research will have to examine in more detail the pattern of SRH within different age categories. The conclusion here is that the SRH and mortality relationship is stronger for younger individuals and appears to be absent for the age groups above 56 years old.

Discussion

To elucidate the relationship between SRH and mortality we examined in a representative sample of adult Danes the moderating influence of social relations and age controlling for a wide range of factors. The analyses revealed that structural (but not functional) social relations influenced mortality directly, but neither structural nor functional social relations moderated the SRH–mortality relationship. In addition, the analyses revealed that the strength of the relationship between SRH and mortality declined with increasing age. It is this last finding that is perhaps the most interesting because it deviates from the consistent finding that SRH predicts mortality.

Why does SRH not predict mortality among the elderly? There are both substantive factors and methodological factors that can address this question. First, as mentioned earlier the elderly are more likely (with increasing age) to consider nonphysical health aspects when they assess their own health (Borawski et al., 1996). In addition, making social comparisons to ailing peers might lead to the conclusion that health problems are not as bad as they could be. In fact, Idler (1993) found that with increasing age (among the elderly) self-assessed health was seen as better, regardless of actual health status.

Second, methodological considerations may play a role. Specifically, reliability of the SRH measure might be worse among the elderly. One study of adult (30 years old and above) Finish participants found that SRH generally showed good test-retest reliability, but the reliability was poor for respondents 75 and older

Table 2
Cox Regression Analyses of mortality after 13 years of follow-up. Model 1

		N	Beta	S.E.	*p*
Gender	Men	3240	0.000		
	Women	3377	−0.799	0.328	
Age		6617	0.095	0.004	
Self-rated health	Very good	3571	0.000		
	Good	1644	−0.044	0.417	
	Fair	978	1.690	0.413	
	Poor/very poor	424	2.263	0.505	
Structural social relations	Good	5938	0.000		
	Poor	679	−0.630	0.479	
Functional social relations	Good	6135	0.000		
	Poor	482	0.663	0.543	
Self-rated health × age	Very good × age		0.000		0.001
	Good × age		0.001	0.006	
	Fair × age		−0.018	0.006	
	Poor × age		−0.020	0.007	
Self-rated health × structural social relations	Very good × socal relations		0.000		0.081
	Good × social relations		−0.044	0.239	
	Fair × social relations		0.275	0.217	
	Poor × social relations		0.454	0.229	
Self-rated health × functional social relations	Very good × social relations		0.000		0.549
	Good × social relatoins		0.310	0.265	
	Fair × social relations		0.036	0.245	
	Poor × social relations		0.209	0.245	
Self-rated health × gender	Very good × gender		0.000		0.091
	Good × gender		0.033	0.177	
	Fair × gender		0.109	0.164	
	Poor × gender		−0.343	0.191	
Gender × age	Men × age		0.000		0.436
	Women × age		0.004	0.005	
Gender × structural social relations	Men × social realtions		0.000		0.791
	Women × social relations		0.040	0.153	
Gender × functional social relations	Men × social realtions		0.000		0.478
	Women × social relations		−0.119	0.168	
Age × structural social relations	Good social relations × age		0.000		0.172
	Poor social relations × age		0.009	0.006	
Age × functional social relations	Good social relations × age		0.000		0.260
	Poor social relations × age		−0.008	−0.007	
Structural social relations × functional social relations	Good structural × functional relations		0.000		0.732
	Poor structural × functional relations		0.059	0.174	

Table 3
Cox Regression Analyses of mortality after 13 years of follow-up. Model 2–5 and final Model

		Model 2				Model 3				Model 4				Model 5				Final model			
		N	Beta	S.E.	*p*	*N*	Beta	S.E.	*p*	*N*	Beta	S.E.	*p*	*N*	Beta	S.E.	*p*	*N*	Beta	S.E.	*p*
Gender	Men	3240	0.000	*p*	<0.001	3212	0.000		<0.001	3190	0.000		<0.001	3125	0.000		<0.001	3125	0.000		<0.001
	Women	3377	−0.575	0.062		3359	−0.664	0.067		3329	−0.700	0.069		3218	−0.667	0.077		3218	−0.661	0.075	
Age		6617	0.096	0.004		6571	0.089	0.004		6519	0.088	0.004		6343	0.089	0.005		6343	0.090	0.004	
Self-rated health	Very good	3571	0.000			3547	0.000			3534	0.000			3467	0.000			3467	0.000		
	Good	1644	−0.107	0.413		1633	−0.004	0.410		1620	0.269	0.404		1582	0.165	0.416		1582	0.221	0.413	
	Fair	978	1.642	0.403		969	1.549	0.403		954	1.595	0.410		909	1.504	0.426		909	1.609	0.417	
	Poor/very poor	424	2.165	0.480		422	1.642	0.503		411	1.389	0.526		385	0.850	0.559		385	1.019	0.541	
Structural social relations	Good	5938	0.000			5895	0.000		0.004	5850	0.000		0.011	5709	0.000		0.025	5709	0.000		0.020
	Poor	679	0.196	0.074	0.008	676	0.216	0.075		669	0.193	0.076		634	0.178	0.079		634	0.182	0.078	
Functional social relations	Good	6135	0.000		0.037	6093	0.000		0.501	6053	0.000		0.608	5904	0.000		0.370				
	Poor	482	0.171	0.082		478	0.058	0.086		466	0.045	0.088		439	0.082	0.091					
Self-rated health × age	Very good × age		0.000		0.001		0.000		0.017		0.000		0.010		0.000		0.024		0.000		0.013
	Good × age		0.003	0.006			0.001	0.006			−0.004	0.006			−0.003	0.006			−0.004	0.006	
	Fair × age		−0.016	0.006			−0.015	0.006			−0.018	0.006			−0.018	0.006			−0.020	0.006	
	Poor × age		−0.019	0.007			−0.013	0.007			−0.015	0.007			−0.008	0.008			−0.010	0.008	
Education	<10 years					2026	0.000		0.780	2006	0.000		0.737	1926	0.000		0.686				
	10 years					460	−0.190	0.188		459	−0.194	0.192		448	−0.143	0.193					
	11–12 years					1553	−0.056	0.075		1536	−0.055	0.076		1502	−0.082	0.079					
	13–14 years					1738	−0.055	0.105		1726	−0.077	0.107		1698	−0.099	0.112					
	15+ years					509	−0.162	0.167		507	−0.171	0.169		494	−0.215	0.175					
	Other-unknown					285	−0.190	0.272		285	−0.217	0.273		275	−0.227	0.284					
Marital status	Married					3590	0.000		<0.001	3562	0.000		<0.001	3493	0.000		<0.001	3493	0.000		<0.001
	Cohabitating					913	0.331	0.132		909	0.289	0.133		891	0.296	0.137		891	0.272	0.136	
	Single (divorced)					313	0.651	0.126		309	0.683	0.127		299	0.597	0.132		299	0.609	0.129	
	Single (widowed)					475	0.213	0.085		470	0.220	0.087		437	0.104	0.091		437	0.107	0.088	
	Single (unmarried)					1280	0.199	0.124		1269	0.166	0.125		1223	0.102	0.133		1223	0.109	0.132	

Employed	Yes	3956	0.000		<0.001	3929	0.000		0.001	3875	0.000		0.001	3875	0.000		<0.001
(economically active)	No	2615	0.348	0.099		2590	0.332	0.101		2468	0.351	0.102		2468	0.373	0.101	
Feel able to	Mostly					5192	0.000		0.587	5083	0.000		0.396				
do what one wish	Sometimes					803	−0.085	0.089		772	−0.117	0.093					
	Hardly ever					524	−0.010	0.106		488	−0.115	0.112					
Physical	None					5930	0.000		<0.001	5801	0.000		<0.001	5801	0.000		<0.001
limitations	Some					589	0.499	0.085		542	0.420	0.090		542	0.421	0.086	
Communication	None					6259	0.000		0.111	6115	0.000		0.295				
limitations	Some					260	0.149	0.094		228	0.106	0.101					
Activity	None					5876	0.000		0.278	5727	0.000		0.443				
limitations	Short term					371	0.106	0.152		359	0.074	0.160					
	Long term					272	0.175	0.116		257	0.151	0.123					
Chronic disease	No					4449	0.000		0.764	4338	0.000		0.233				
	Yes					2070	0.023	0.076		2005	0.096	0.080					
Control over	High									4945	0.000		0.020	4945	0.000		0.015
own health	Some									1221	0.125	0.073		1221	0.127	0.073	
outcome	None									177	0.312	0.121		177	0.324	0.120	
Physical	Sedentary									1616	0.000		0.003	1616	0.000		0.003
Activity	Light exercise									3554	−0.258	0.074		3554	−0.255	0.073	
	Regular exercise									920	−0.349	0.144		920	−0.347	0.143	
	Competitive									253	−0.004	0.422		253	0.001	0.421	
Smoking	Never smoked									2152	0.000		<0.001	2152	0.000		<0.001
	Previous smoker									1202	0.045	0.098		1202	0.057	0.097	
	Current smoker									2989	0.351	0.088		2989	0.361	0.087	
Alcohol use	None									3866	0.000		0.003	3866	0.000		0.009
	1–4 drinks									2057	0.023	0.072		2057	0.006	0.071	
	5 or more									420	0.448	0.135		420	0.398	0.133	
BMI	less than 20									900	0.000		0.006	900	0.000		0.009
	20–24									3504	−0.302	0.109		3504	−0.294	0.108	
	25–30									1615	−0.370	0.114		1615	−0.353	0.113	
	30+									324	−0.176	0.149		324	−0.145	0.147	

Table 4
Age stratified analysis showing the relation between self-rated health and mortality

Cox Regression Analysis		Beta	S.E.	p
Age 16–44	Very good	0.000		0.022
	Good	0.494	0.267	
	Fair	0.904	0.302	
	Poor/very poor	0.613	0.489	
Age 45–55	Very good	0.000		0.012
	Good	−0.818	0.340	
	Fair	0.353	0.276	
	Poor/very poor	0.147	0.357	
Age 56–66	Very good	0.000		0.236
	Good	0.146	0.191	
	Fair	0.359	0.185	
	Poor/very poor	0.125	0.275	
Age 67–77	Very good	0.000		0.096
	Good	−0.233	0.156	
	Fair	0.044	0.153	
	Poor/very poor	0.230	0.193	
Age 78 +	Very good	0.000		0.392
	Good	0.205	0.194	
	Fair	0.251	0.204	
	Poor/very poor	0.396	0.233	

perhaps due to poorer health (Martikainen et al., 1999). If reliability were low it would lead to a weaker predictive value of that measure. However, low reliability in the SRH measure among the elderly cannot entirely explain our results since the association declined steadily with increasing age. In fact, the association became non-significant among respondents 56 and older. Even if reliability cannot entirely explain these findings it is worth remembering that measures may change in reliability and validity with age.

Aside from possible theoretical contributions these results may have consequences for preventive medicine. Because SRH is remarkably consistent as a predictor of mortality researchers often suggest that physicians should carefully consider the patient's self-assessment of his or her health (e.g., Møller, Kristensen, & Hollnagel, 1996). Although this is certainly prudent advice, it suggests that the patient knows something about his or her own health that the physician does not. Although the literature is supportive of this general notion, our results suggest that this may not be the case for the elderly. In addition, these results may have consequences for intervention studies. Given the generally strong association between SRH and mortality it might make sense to encourage patients to interpret their problems, symptoms, or illnesses in a positive light. However, this only makes sense to the extent that there is a direct causal relationship between SRH and mortality (a fact that has not yet been established) and to the extent that this relationship exists for all groups. What advice should the elderly receive? Should they be told to be more accurate in their health assessments or should they be told nothing? Intervention studies would be one fruitful avenue for understanding the causal effect of SRH.

We also found that neither structural nor functional social relations moderated the relationship between SRH and mortality. Thus, it appears that there are no unique combined effects of SRH with social relations in predicting mortality. Furthermore, we found that structural (but not functional) social relations predicted mortality. Overall, social relations are associated with mortality (Berkman, 1995) making it somewhat surprising that functional social relations did not show a relationship with mortality. Functional social relations were assessed by asking if respondents could rely on help from other people if they became ill and asking if respondents ever felt alone when they preferred to be with other people. This second variable of loneliness might not in the best way capture the essence of functional social relations, although Bowling (1991) argues that the subjective experience of social relations is more important than objective measures. These measurement problems might in part contribute to the lack of predictive quality of functional social relations.

Several factors contribute to the strengths of this study. First, studies often examine the main effect contributions and not the interaction among variables. In addition, most studies control statistically for extraneous variables (that is, treat them as nuisance variables), which does not permit an examination of the dynamic contribution of these variables. In this study, we examined the moderating effects of two variables (social relations and age) on the relationship between SRH and mortality. Second, we have valid and reliable data on mortality because we were able to use a national register of death. Few participants were lost to follow up. In addition, the cohort was a representative sample of all adult Danes. Most studies have followed non-representative samples of elderly populations. Third, we have a long follow-up period lasting 13 years and we have data from the entire life span (ages 16 and on). This is particularly important when examining the effects of age.

Of course, there are also methodological weaknesses and other limitations in this study. First, mortality as an outcome measure does not allow us to examine at what point the variables influence factors leading to mortality. It is possible that individuals have increased incidence (onset), increased severity, faster progression, or reduced recovery from disease. Thus, these data do not allow us to examine the possible pathways that lead from

perceptions of one's own health to mortality (Cohen, 1988). Second, we did not have extensive measures of social relations. We only had four questions and combined these into measures of structural and functional social relations. Thus, we were not able to determine exactly what aspect of social support influenced mortality. In addition, the inclusion of loneliness as a measure of functional social relations might not have been optimal.

Generally SRH appears predictive of mortality, but our results indicate that age plays an important role in conceptualization of one's own health and subsequent relationship with mortality. Clearly, more research is needed to further specify the underlying variables that contribute to this finding.

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