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Original Article

The Long-Term Associations of Objective and Subjective Health Status on Mortality

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Abstract

Background: The aim of this study was to reveal the longitudinal associations of health status (HS) and Self-rated Health (SRH) on mortality.

Methods: Data from the Korea Longitudinal Study of Ageing were used in this study. The baseline data (2006) included 10,239 participants. The Cox proportional hazard model was used to verify the hypothesis.

Results: The mortality was high when the health status was Bad and higher when the SRH was Bad. The HS-Bad–SRH-Bad group had the highest mortality. Middle-aged people with diseases had higher mortality than older people who perceived themselves as in Bad health. For older people, mortality was high for SRH-Bad people of all health statuses.

Conclusion: The results predict a high rate of mortality for middle-aged and older people with a combination of HS-Bad and SRH-Bad, with SRH being relatively more influential in mortality

Keywords: Health status; Long-term associations; Mortality; Older people; Self-rated health

Introduction

Modern society-especially improved health hygiene and decreased mortality is rapidly changing the elderly population worldwide. Koreans aged 65 or older are expected to increase from 7.37 million (14.3%) in 2018 and 7.68 million (14.9%) in 2019 to 8.13 million (15.7%) in 2020, with the proportion of senior citizens expected to reach 39.8% in 2050 (1). The increasing elderly population presents physical, economic, psychological, and social challenges (2). Along with the aging of the population, the mortality from geriatric diseases is increasing rapidly; cancer, heart disease, and pneumonia are the main causes of death for the elderly (3). As of 2018, 11.7% of Koreans aged 65 or older had some form of cancer (4).

Aging makes people increasingly vulnerable to developing cardiovascular diseases (5), including hypertension, cerebrovascular disease, and arrhythmia, due to reduced muscle mass and decreased physical activity (6). About 17.9 million people died from cardiovascular diseases in 2016, reporting 31% of all deaths worldwide (7). In Korea, 80.8% of all deaths are due to chronic

diseases such as liver disease, cerebrovascular disease, diabetes, and hypertension (8).

Self-rated health (SRH) reports are valuable tools for assessing people's health, since those tools consider individual and cultural beliefs and health behaviors as subjective indicators of health conditions (9). SRH is considered a highly reliable indicator of elderly persons' health judgment and a complement to medical diagnoses (10). SRH have been widely used in gerontology studies (11) to examine mortality predictions, health interventions, and long-term care plans (12). SRH significantly predict mortality (13,14), many report that the worse the SRH, the higher the mortality (12,15). However, most studies on SRH and mortality analyzing cross-sectional design data have failed to clarify causal relationships between the two.

HS and SRH are significant predictors of mortality. However, the longitudinal association of SRH on mortality has remained unclear, and little is known about the relative associations of objective HS and SRH. Thus, it is necessary to test the combined associations of SRH and HS in predicting mortality among the elderly. It remains unclear whether different combinations of HS and SRH have different associations on mortality. This study addressed those questions by analyzing the data collected by the Korea Longitudinal Study of Ageing (KLoSA) to verify the longitudinal association of health status and SRH on mortality and to test the combined associations of health status and SRH on mortality.

Materials and Methods

Study sample and design

The study data were obtained from the 2006, 2008, 2010, 2012, 2014, 2016, and 2018 waves of the Korean Longitudinal Study of Aging (KLoSA) conducted by the Korea Employment Information Service (KEIS) and the survey field agency TNS Korea. KLoSA is a multistage stratified cluster sampling (patients in facilities or hospitals were excluded from the investigation) based on 15 geographical areas and housing types across the nation to create nationally representative longitudinal data of Koreans aged 45 years or more (16). The baseline survey (2006) interviewed 10,254 individuals in 6,171 households (1.7 per household). There were 292 individuals with cancer. Wave 2 (2008) interviewed 8,875 subjects (86.6% of the original panel). Wave 3 (2010) interviewed 8,229 subjects (81.7% of the original panel). Wave 4 (2012) interviewed 7,813 subjects (80.1% of the original panel). Wave 5 (2014) interviewed 8,387 subjects (920 new participants and 80.4% of the original panel. Wave 6 (2016) interviewed 7,893 subjects (878 new participants and (79.6% of the original panel). Wave 7 (2018) interviewed 7,491 subjects (817 new participants and 78.8% of the original panel). Of all the public data available on Korea, KLoSA's data were considered the most suitable for this study's analyses. This study included 10,239 participants in the analysis, excluding those with missing data, followed up until death.

This study did not require the approval of the Institutional Review Board because it used free public data.

Dependent variables

All-cause mortality

All-cause mortality during the time interval from year 2006 to the end of follow-up was the main outcome of the study. Death over a maximum follow-up period of 12 years was determined by death certificates.

Independent variables

Health status (chronic disease)

The health status (HS) variable was based on comorbidities investigated in the KLoSA database. Self-reported data regarding the comorbidities of hypertension (1), diabetes (1), cancer (2), chronic obstructive pulmonary disease (1), liver disease (3), heart disease (1), cerebrovascular diseases (1), and arthritis or rheumatoid arthritis (1) was included and assigned weights for each condition based on the Charlson comorbidity index (17) and categorized into three group: 0(Good), 1(Moderate), and ≥2(Bad).

Self-rated health

Self-rated health (SRH) was assessed with the question: "How do you usually perceive your health?" The Bad responses were "insufficient" or "very insufficient" and the Moderate responses were "moderate" and the Good responses were "sufficient" or "very sufficient."

Scale of estimation

'Accurate' means self-assessment of their health and their doctors' assessment match. 'Underestimation' means self-assessment of their health is worse than their doctors' assessment. 'Overestimation' means self-assessment of their health is better than their doctors' assessment.

Combined association

The combined associations represent the difference between the health status and the self-rated health on all-cause mortality. We categorized into nine groups: 1) HS-Good–SRH-Good; 2) HS-Good–SRH (Moderate); 3) HS-Good–SRH-Bad; 4) HS-Moderate–SRH-Good; 5) HS-Moderate–SRH (Moderate); 6) HS-Moderate–SRH-Bad; 7) HS-Bad–SRH-Good; 8) HS-Bad–SRH (Moderate); and 9) HS-Bad–SRH-Bad.

Control variables

The following covariates were collected: age (45-54, 55-64, 65-74, and >74 yr), gender (male and female), education (elementary, middle, high school, and ≥college), residential region (urban and rural), marital status (married and single), income (last year's wage income yes and no), smoking status (never, former smoker, and smoker), alcohol use (never, former drinker, and drinker), and social engagement (high, high middle, middle, middle-low, and low).

Social engagement was measured using the most variables, point-weighted as follows: 1) *frequency of contacts of friends* (4=every day, 3=once a month to two or three per week, 2=once a year to five or six a year or almost never); 2) *frequency of attendance at leisure, culture, or sports activities* (4=every day, 3=once a month to two or three per week, 2=once a year to five or six a year or almost never); 3) *frequency of religious attendance* (4=every day, 3=once a month to two or three per week, 2=once a year to five or six a year or almost never); and 4) *frequency of contacts at an alumni-type meeting, hometown reunion, or clan gathering* (4 = every day, 3 = once a month to two or three per week, 2=once a year to five or six a year or almost never). The variables were summed, and the totals ranged from 4 to 20. We used the SAS Rank procedure to identify five groups based on levels of social engagement.

Analytical approach and statistics

The chi-square test, log-rank test, and Cox proportional hazards models were used to investigate the association between HS and all-cause mortality. To examine the impact of HS on mortality, we calculated the adjusted hazard ratio (HR) using the Cox proportional hazard model. The outcome variable was survival time, measured from the date of enrollment to death or censoring (up to 12 years). For all the analyses, the criterion for statistical significance was $P<0.05$, two-tailed. All analyses were conducted using the SAS statistical software package, ver. 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

Sample characteristics

Table 1 shows the characteristics of the participants in the baseline (2006). Of the 10,239 participants, 1,948 were found to have died. The worse the HS, the higher the mortality, and the better the SRH, the lower the mortality. Table 1 also shows the participants' general characteristics of age, gender, education, residential region, income, smoking status, alcohol status, marital status, and social engagement. Table 2 shows the hazard ratios (HRs) of all-cause mortality for each variable. The mortality for those with HS-Bad was higher than for those with HS-Good. Similarly, the mortality for those with SRH-Bad was higher than for those with SRH-Good. The worse the HS and SRH, the higher the mortality, and both variables had a positive association on mortality.

The older and lower the level of social engagement, the higher the mortality. In addition, male, rural, no income, experience of smoking and alcohol consumption , low level of education, and single showed higher mortality than opposite case.

Table 1: General characteristics of participants at baseline

Variable	*Total*		*Death*				*P-value*
			No		Yes		
	N	%	N	%	N	%	
Health status*							<.0001
0 (Good)	5,376	52.5	4,652	86.5	724	13.5	
1 (Moderate)	2,138	20.9	1,668	78.0	470	22.0	
≥2 (Bad)	2,725	26.6	1,971	72.3	754	27.7	
Self-rated health (SRH)							<.0001
Good	1,307	12.8	1,205	92.2	102	7.8	
Moderate	3,504	34.2	3,092	88.2	412	11.8	
Bad	5,428	53.0	3,994	73.6	1,434	26.4	
Health status-SRH							<.0001
Health(Good)-SRH(Good)	1,057	10.3	989	93.6	68	6.4	
Health(Good)-SRH(Moderate)	2,473	24.2	2,224	89.9	249	10.1	
Health(Good)-SRH(Bad)	1,846	18.0	1,439	78.0	407	22.1	
Health(Moderate)-SRH(Good)	172	1.7	149	86.6	23	13.4	
Health(Moderate)-SRH(Moderate)	644	6.3	540	83.9	104	16.2	
Health(Moderate)-SRH(Bad)	1,322	12.9	979	74.1	343	26.0	
Health(Bad)-SRH(Good)	78	0.8	67	85.9	11	14.1	
Health(Bad)-SRH(Moderate)	387	3.8	328	84.8	59	15.3	
Health(Bad)-SRH(Bad)	2,260	22.1	1,576	69.7	684	30.3	
Age							<.0001
45-54	1,786	17.4	1,704	95.4	82	4.6	
55-64	2,912	28.4	2,707	93.0	205	7.0	
65-74	2,890	28.2	2,412	83.5	478	16.5	
>74	2,651	25.9	1,468	55.4	1,183	44.6	
Gender							<.0001
Male	4,456	43.5	3,457	77.6	999	22.4	
Female	5,783	56.5	4,834	83.6	949	16.4	
Education							<.0001
≤Elementary	4,821	47.1	3,478	72.1	1,343	27.9	
Middle school	1,656	16.2	1,445	87.3	211	12.7	
High school	2,705	26.4	2,429	89.8	276	10.2	
≥College	1,057	10.3	939	88.8	118	11.2	
Residential region							<.0001
Urban	6,658	65.0	5,523	83.0	1,135	17.1	
Rural	3,581	35.0	2,768	77.3	813	22.7	
Income							<.0001
Yes	1,983	19.4	1,809	91.2	174	8.8	
No	8,256	80.6	6,482	78.5	1,774	21.5	
Smoking status							<.0001
Non-smoker	7,288	71.2	6,049	83.0	1,239	17.0	
Former smoker	978	9.6	710	72.6	268	27.4	
Smoker	1,973	19.3	1,532	77.7	441	22.4	

Alcohol consumption							<.0001
Nothing	3,883	37.9	3,257	83.9	626	16.1	
Former drinker	689	6.7	461	66.9	228	33.1	
Drinker	5,667	55.4	4,573	80.7	1,094	19.3	
Marital status							<.0001
Married	7,944	77.6	6,719	84.6	1,225	15.4	
Single (Including separated, divorced)	2,295	22.4	1,572	68.5	723	31.5	
Social engagement**							<.0001
Low	2,648	25.9	1,918	72.4	730	27.6	
Middle-low	1,162	11.4	905	77.9	257	22.1	
Middle	2,642	25.8	2,231	84.4	411	15.6	
Middle high	1,419	13.9	1,202	84.7	217	15.3	
High	2,368	23.1	2,035	85.9	333	14.1	
Total	10,239	100.0	8,291	81.0	1,948	19.0	

*Hypertension, diabetes, cancer, chronic obstructive pulmonary disease, liver disease, heart disease, cerebrovascular diseases, mental illness and arthritis or rheumatoid arthritis

**Social engagement was measured in five variables. (1) frequency of contacts in domains of friends (2) frequency of contacts in mutual benevolence group meeting (3) frequency of attendance in leisure, culture and sports activities (4) frequency of religious attendance (5) frequency of contacts in alumni meeting, hometown alumni and clan gathering

Table 2: Adjusted mortality hazard ratios associated with health status and self-rated health on death

	Death			
Variable	***HR***	***95% CI***		***P-value***
Health status*				
0 (Good)	1.000			
1 (Moderate)	1.078	0.957	1.216	0.216
≥2 (Bad)	1.138	1.018	1.273	0.024
Self-rated health (SRH)				
Good	1.000			
Moderate	1.080	0.868	1.345	0.489
Bad	1.584	1.280	1.960	<.0001
Age				
45-54	1.000			
55-64	1.319	1.017	1.709	0.037
65-74	2.527	1.973	3.236	<.0001
>74	6.657	5.197	8.528	<.0001
Gender				
Male	2.121	1.854	2.427	<.0001
Female	1.000			
Education				
≤Elementary	1.295	1.055	1.588	0.013
Middle school	0.990	0.788	1.245	0.934
High school	0.991	0.798	1.231	0.938
≥College	1.000			
Residential region				
Urban	1.000			
Rural	1.217	1.108	1.336	<.0001
Income				
Yes	1.000			

No	1.305	1.104	1.544	0.002
Smoking status				
Non-smoker	1.000			
Former smoker	1.265	1.082	1.478	0.003
Smoker	1.386	1.214	1.582	<.0001
Alcohol consumption				
Nothing	1.000			
Former drinker	1.246	1.066	1.456	0.006
Drinker	1.215	1.078	1.369	0.001
Marital status				
Married	1.000			
Single (Including separated, divorced)	1.574	1.411	1.755	<.0001
Social engagement**				
Low	1.570	1.376	1.793	<.0001
Middle-low	1.180	0.999	1.392	0.051
Middle	1.106	0.956	1.279	0.176
Middle high	1.102	0.928	1.309	0.269
High	1.000			

*Hypertension, diabetes, cancer, chronic obstructive pulmonary disease, liver disease, heart disease, cerebrovascular diseases, mental illness and arthritis or rheumatoid arthritis

**Social engagement was measured in five variables. (1) frequency of contacts in domains of friends (2) frequency of contacts in mutual benevolence group meeting (3) frequency of attendance in leisure, culture and sports activities (4) frequency of religious attendance (5) frequency of contacts in alumni meeting, hometown alumni and clan gathering

Table 3 shows the HRs of all-cause mortality following the scales of estimation of HS and SRH. The mortality among those whose self-assessment of their health (SRH) accurately matched their doctors' assessment (HS) was 1.306 times higher than for those who overestimated their health (95% CI: 1.053-1.620, *P*=0.015). Thus, the more the participants overestimated their health, the lower the mortality.

Table 3: Adjusted mortality hazard ratios associated with scale of estimation

	Death			
	HR	***95% CI***		***P-value***
Scale of estimation				
Accurate	1.306	1.053	1.620	0.015
Underestimation	1.208	0.975	1.497	0.083
Overestimation	1.000			

Table 4 shows the HRs of mortality with the combined association of HS and SRH on all-cause mortality. Compared with the HS-Good–SRH-Good group, the mortality for the HS-Bad–SRH-Bad group was 1.951 times higher (95% CI: 1.502-2.534, *P*<.0001). The highest mortality was found among those for whom both HS and SRH were Bad. Compared with the participants in the HS-Good–SRH-Good group, the mortality in the HS-Good–SRH-Bad group was 1.722 times higher (95% CI: 1.322-2.243, *P*<.0001), and the mortality in the HS-Moderate–SRH-Bad group was 1.798 times higher (95% CI: 1.373-2.354, *P*<.0001).

Table 4: Combined associations between health status and self-rated health on death

Variable	*Death*			
	HR	*95% CI*		*P-value*
Health status*-SRH				
Health(Good)-SRH(Good)	1.000			
Health(Good)-SRH(Moderate)	1.166	0.890	1.528	0.265
Health(Good)-SRH(Bad)	1.722	1.322	2.243	<.0001
Health(Moderate)-SRH(Good)	1.406	0.874	2.261	0.160
Health(Moderate)-SRH(Moderate)	1.300	0.953	1.774	0.098
Health(Moderate)-SRH(Bad)	1.798	1.373	2.354	<.0001
Health(Bad)-SRH(Good)	1.351	0.712	2.563	0.357
Health(Bad)-SRH(Moderate)	1.227	0.861	1.748	0.258
Health(Bad)-SRH(Bad)	1.951	1.502	2.534	<.0001

*Hypertension, diabetes, cancer, chronic obstructive pulmonary disease, liver disease, heart disease, cerebrovascular diseases, mental illness and arthritis or rheumatoid arthritis

Table 5 shows a comparison of the HRs of all-cause mortality and the combined associations with the HS and SRH for participants ≥65 and <65. For those <65, compared to the HS-Good–SRH-Good group, the HS-Moderate–SRH-Bad group had a 2.420 times higher mortality (95% CI: 1.536-3.812, *P*<.001). The mortality in the HS-Bad–SRH-Bad group was significantly (2.160 times) higher (95% CI: 1.346-3.467, *P*=.001). For those ≥65, compared to the HS-Good–SRH-Good group, the mortality in the HS-Bad–SRH-Bad group was 1.892 times higher (95% CI: 1.339-2.673, *P*<.001), the HS-Good–SRH-Bad group mortality was 1.768 times higher (95% CI: 1.245-2.511, *P*=.001), and the HS-Moderate–SRH-Bad group was 1.676 times higher (95% CI: 1.176-2.390, *P*=.004).

Table 5: Combined associations between health status and self-rated health on death for participants ≥65 and <65

	Death			
Variable	**HR**	**95% CI**		***P*-value**
Health status-SRH (45-64)				
Health(Good)-SRH(Good)	1.000			
Health(Good)-SRH(Moderate)	1.189	0.792	1.785	0.405
Health(Good)-SRH(Bad)	1.210	0.765	1.914	0.414
Health(Moderate)-SRH(Good)	1.845	0.815	4.176	0.142
Health(Moderate)-SRH(Moderate)	1.406	0.771	2.564	0.266
Health(Moderate)-SRH(Bad)	2.420	1.536	3.812	0.000
Health(Bad)-SRH(Good)	1.560	0.371	6.552	0.544
Health(Bad)-SRH(Moderate)	0.397	0.095	1.659	0.205
Health(Bad)-SRH(Bad)	2.160	1.346	3.467	0.001
Health status-SRH (≥65)				
Health(Good)-SRH(Good)	1.000			
Health(Good)-SRH(Moderate)	1.125	0.781	1.622	0.527
Health(Good)-SRH(Bad)	1.768	1.245	2.511	0.001
Health(Moderate)-SRH(Good)	1.248	0.690	2.258	0.464
Health(Moderate)-SRH(Moderate)	1.244	0.839	1.842	0.277
Health(Moderate)-SRH(Bad)	1.676	1.176	2.390	0.004
Health(Bad)-SRH(Good)	1.294	0.620	2.697	0.492
Health(Bad)-SRH(Moderate)	1.289	0.844	1.966	0.240
Health(Bad)-SRH(Bad)	1.892	1.339	2.673	0.000

*Adjusted for all variables

Discussion

Using data from the Korea Longitudinal Study of Ageing (KLoSA), this study analyzed the longitudinal association of health status and SRH on all-cause mortality and the longitudinal association of the combined association of health status and SRH on mortality. The main results and discussions are as follows.

First, several longitudinal associations of sociodemographic variables on mortality were identified. Men had significantly higher mortality than women did. People with lower levels of education showed higher mortality than people with higher levels of education (18,19). People with no income showed higher mortality than those with income, supporting prior studies (20). Rural dwellers had significantly higher mortality than city dwellers, perhaps due to the relative lack of medical facilities (21,22). Single people had significantly higher mortality than married people, supporting the findings of other studies (23,24). Finally, people with low social engagement had significantly higher mortality than more social people, supporting studies showing that social engagement promotes SRH (25,26).

Second, the all-cause mortality of people medically diagnosed as HS-Bad was significantly higher than HS-Good people. This study emphasized hypertension, diabetes, cancer, mechanical/structural pulmonary disorder, liver disease, heart disease, cerebrovascular disease, and arthritis/rheumatoid arthritis; the findings revealed the long-term association of HS on mortality.

Third, SRH-Bad people had significantly higher mortality than the SRH-Good people, which is consistent with studies showing that SRH was a predictor of mortality (27,28). SRH can be used as a predictive indicator of mortality (29,30).

Fourth, this study confirmed the combined association of HS and SRH on all-cause mortality. Mortality was the highest when both HS and SRH were deemed Bad. This finding could improve basic data sorting for high-risk groups to trigger early intervention to help the vulnerable aged. This study showed that in all SRH-Bad cases, regardless of HS, the mortality was statistically and significantly high; even among HS-Good people; self-perceived Bad health (SRH-Bad) increased the risk of death. SRH may have a relatively greater association on all-cause mortality and SRH-Good may be a protective factor for lowering mortality.

Fifth, we compared the combined associations of HS and SRH on all-cause mortality for those aged 45–64 and those aged 65 and over. The HS-Moderate–SRH-Bad groups and the HS-Bad–SRH-Bad groups under 65 yr of age showed higher mortality than the matched groups over 65. Middle-aged people with diseases who consider their health Bad are at greater risk of dying than older people in worse health. Among those aged 65 and over, the mortality was significantly high when the SRH was deemed Bad for all HSs. This highlights the need to research policies and risk factors surrounding the elderly and SRH, regardless of the presence or absence of disease.

This study has limitations that patients at facilities and hospitals were excluded from the investigation. However, it analyzed the longitudinal data on a national scale and identified the combined associations of health status and SRH vis-à-vis predicting mortality, compared the associations of various combinations on mortality, and showed the differences for ages.

Conclusion

This longitudinal study of the associations of health status and self-reported health on all-cause mortality among middle-aged and the elderly found higher mortality in the combined associations. Notably, SRH was relatively more influential. Among older adults, SRH strongly predicted mortality for all HSs. Therefore, future economic, medical, psychological, and physical activities aimed at the prevention, detection, and treatment of chronic diseases should consider the impacts

of SRH when developing social and policy support.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interest.

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