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Self-rated Health in Older Adults

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Abstract

In this study, the relationship between mental health measured by the CES-D scale and self-rated health (SRH) in older Japanese adults was examined using longitudinal micro datasets from the National Survey of the Japanese Elderly (NLSG). Two equations for the relationship between mental health and SRH are estimated simultaneously, and the results showed that SRH had an effect on mental health, and mental health had an effect on SRH. Thus, the mind and body are connected and influence each other. We also determine other important factors that influence health. Age, gender, physical activity, functional abilities such as ADL and IADL, and economic status are associated with both mental and perceived health; having a chronic illness is strongly associated with perceived health; and interpersonal relationships have an effect on mental health. The results suggest that older adults should work on both mind and body to live healthy lives.

Key words: mental health, self-rated health, the mutual dependence of mind and body

[※] The data for this secondary analysis, "National Survey of the Japanese Elderly (NLSG), the University of Michigan and the Tokyo Metropolitan Institute of Gerontology," was provided by the Social Science Japan Data Archive, Center for Social Research and Data Archives, Institute of Social Science, The University of Tokyo. I wish to thank the participants for permission to use these data.

1. Introduction

It is difficult for older adults to stay healthy. Many older adults seek methods for acquiring, maintaining, and enforcing body and mental health. Considerable research has shown that lower perceived health or poor self-rated health (SRH) predicts long-term declines in functional ability (Wilcox et al., 1996) and poorer SRH is a robust predictor of mortality in older adults (Kaplan & Camacho, 1983; Mulsant et al., 1997). Therefore, many older adults are mindful of their health status.

Perceived health or SRH can be explained by many variables, such as chronic illness (Barsky et al., 1992); lifestyle, including exercise, diet, and smoking (Han, 2002; Rohrer et al., 2004; Sargent-Cox et al., 2014); social support (Hirides & Forbes, 1993; Zunzunegui et al., 2001); marital status (Hirides & Forbes, 1993); job stress (Shimizu & Nagata, 2005); job security (Ferrie et al., 2001); effort/reward imbalance at work (Pikhart et al., 2001); income and inequality (Franks et al., 2003; Weich et al., 2002); and housing quality (Dunn, 2002). Importantly, SRH is related to mental health, including depression and vitality (Burns et al., 2013). Depressive symptoms also affect the risk of fiscal disability (Bruce & Merrill, 1994), and a nursing study showed that critical thinking is related to perceived health status (Settersten & Lauver, 2004). Moriyama et al. (2004) studied the relationship between physical condition and mental health in elderly people living in Okinawa, Japan, and found that subjective well-being was strongly affected by subjective health and ADL, and there was a correlation between mental health and physical condition.

Mental health is also affected by physical health. A number of studies have found that depressive symptoms are strongly associated with illness or poorer SRH (Blazer et al., 1991; Callahan et al., 1994; Han, 2002; Kenedy et al., 1990; Terner & Beiser, 1990).

Physical disorders such as loss of appetite and sleeplessness are symptoms of depression, and older people may exhibit high rates of depressive symptoms because of physical problems (Davidson et al., 1994; Pijls, et al., 1993). Thus, older people in poor physical condition have a high risk of serious depression.

Together, previous results suggest that mental health, e.g., well-being or depression, and physical health are related. In this study, we will verify the relationship between mental health and somatic, physical health in older adults. Self-rated, perceived health is clearly related to objective health status (Scott et al., 1999; Liang, 1986; Rodin & McAvay, 1992), and we believe that SRH is strongly related to physical health. Therefore, in our analysis, the relationship between mental health and physical health will be examined by looking at the relationship between mental health and SRH.

Previous medical research has examined the correlation between mental states and physical conditions using psychological tests. This research found that for patients in a depressive state, psychological properties correlated with blood pressure and pulse rate, and for patients with anxiety, psychological properties of hysterical states correlated with abnormal respiratory patterns (Ishikawa & Kikuchi, 1976). Naruo (2003) found that the growth hormone ghrelin may play an important role in the correlation between mind and body.

2. Data

Longitudinal micro datasets from the National Survey of the Japanese Elderly (NLSG) were used in our analysis. This data were collected by the University of Michigan and the Tokyo Metropolitan Institute of Gerontology, and it include six datasets collected every three years between 1983 and 2002. We pooled two datasets

from 1999 and 2002 in our analysis because these datasets addressed some particularly fascinating questions. NLSG surveyed adults who were 60 years old and older in 1983, and the follow-up survey added samples of older respondents. In 1999, many individuals in the sample were 70 years old and older.

The NLSG asked respondents about their health conditions (including chronic illness), lifestyle including exercise, diet, and smoking, social support, marital status, and socioeconomic status e.g., income. We analyzed data from two samples with a total of 2883 respondents.

3. Measures

mental health

Mental health was assessed with twenty items from the Center for Epidemiological Studies Depression Scale (CES-D). Respondents were asked about their depressive affect (“I feel nervous,” “I have no appetite,” “I feel depressed,” “I cannot concentrate,” “I feel troubled,” “I feel like I failed in my life,” “I feel horrible,” “I cannot sleep well”, “I am taciturn,” “I feel lonely,” “I feel alienated,” “I wanted to cry,” “I feel sad,” “I feel that I am disliked,” and “I cannot get motivated”) and well-being (“I have confidence in my ability,” “I feel that the future is bright,” “I feel happy,” and “I feel gay”). Respondents were asked how many times they experienced the feelings listed above in the past week. Well-being items are scored as follows: 3 = 5~7 days per week, 2 = 3~4 days per week, 1 = 1~2 days per week, and 0 = they hardly felt that feeling. Depressive affect items are scored negatively. Scale scores can range from 0 to 60. Mental health scores are high if depressive symptoms are low and well-being is high.

Elderly people tend to have high rates of depressive symptoms, and Davidson et al.

(1994) showed that CES-D is an appropriate measure of depressive symptoms in the elderly. In our analysis, higher mental health scores indicate good mental health and fewer depressive symptoms.

○self-rated health (SRH)

Subjective health status was measured by the question “Overall, how is your current health: excellent, very good, good, fair, or poor?” (5 = excellent, 4 = very good, 3 = good, 2 = fair, 1 = poor). Higher SRH scores indicate better health.

○other variables

Respondents were asked about their ability to work without help, measured by the number of activities of daily living (ADL; take a bath, dress, eat, get up from bed and stand up from chairs, go out, and use the toilet) and number of instrumental activities of daily living (IADL; go shopping, use telephone, take the bus and train alone, and do light housework). Respondents are considered to have ADL ability if they do not find it difficult to engage in all six daily living activities without help, and IADL ability if they do not find it difficult to complete the four instrumental activities without help.

Respondents were asked if they smoked and about their drinking behavior. To determine whether respondents could do moderate exercise, a question about physical activities like gardening, doing gymnastic exercises, and taking a walk was included. To determine whether respondents had maintained their physical strength, they were asked about their ability to move their body without the aid of sticks or tools.

Socioeconomic status was measured by the amount of public pension receipt, private pension receipt, income, and other revenues such as property revenue and financial support from others. Respondents were asked about their source of income in the 1999 and 2002 data.

Respondents chose one class value for their income level for each income source. Mean class values were used in the analysis.

Because lack of emotional or instrumental support affects depressive symptoms and health, variables about the presence of social support were included. The presence of key persons was based on whether respondents had social support including emotional support, sending consideration, financial support, or daily support. Stress from people who scold or complain and who are an economic burden could affect respondents' mental and physical health.

Separation from someone close due to death could lead to sadness, and grief caused by death could affect depressive symptoms and health conditions.

Chronic illness could affect perceived health and depressive symptoms. Fourteen chronic diseases were included in the analysis. Finally, socio-demographic variables (age, gender) were examined.

4. Analysis

It is possible that the equations relating mental health and SRH in older adults are not independent, and estimation using the ordinary least squares (OLS) might be inappropriate in this case. If the error terms of the two equations are correlated, the two equations should be estimated simultaneously. It is possible that mental health and SRH are mutually related in older adults, such that mental health affects SRH and SRH also affects mental health. In that case, the estimated equations will be as follows:

$$\text{Eq. (Mental health)} = f_1(\text{SRH, age, gender, chronic illness, income...}) \quad (1)$$

$$\text{Eq. (SRH)} = f_2(\text{mental health, age, gender, chronic illness, income...}) \quad (2)$$

In equation (1), the SRH variable is correlated with the error term. Similarly, in

equation (2), the mental health variable is correlated with the error term. The estimators will be biased if the equations are estimated separately. Therefore, the equations were estimated using Three-Stage Least Squares (3SLS) to eliminate this bias.

In addition, because data from two periods are used (the question about source of income was asked for three periods—1993, 1999, and 2002—and data from the latter two were used), the two equations are estimated using both fixed and random effects analyses, and the interaction between the two variables is checked.

5. Results

First, the two equations were estimated as follows:

$$\text{Eq(Mental health)} = f_1(\text{age, gender, chronic illness, income....}) \quad (3)$$

$$\text{Eq(SRH)} = f_2(\text{age, gender, chronic illness, income.....}) \quad (4)$$

As mentioned above, the error terms of the two equations are correlated, so the two equations are estimated simultaneously using Seemingly Unrelated Regressions (SUR; Zellner, 1962). The results of the Breusch-Pagan test indicated that the null hypothesis that there is no contemporaneous correlation among error terms should be rejected (mental health: $\chi^2=684.73$, probability $> \chi^2 = .000$; SRH: $\chi^2 = 57.30$, probability $> \chi^2 = 0.023$).

The results for the three stage least squares are shown in Figure 2 and Figure 3.

The results in Table 2 include health condition variables, such as smoking, drinking, body mass index (BMI), ADL, and IADL, and the results in Table 3 include 14 chronic illnesses instead of health conditions.

In both cases, there is an interdependent relationship between mental health and

SRH, such that SRH exerts a positive effect on mental health, and mental health exerts a positive effect on SRH. However, the effect of SRH on mental health is larger, suggesting that perceived health has a large influence on mental condition in older adults. This suggests that body and mind are at one and the two functions are interdependent.

Next, we examine the factors that could influence mental health and SRH. Older women feel more unhealthy than older men. Moreover, women live longer than men, suggesting that women remain inactive for a longer period of time. In contrast, fewer women have depressive symptoms compared to men.

Age has a negative influence on health condition, and older people feel more unhealthy. This suggests that getting older increases the risk for infection as body function decreases.

Physical abilities such as gardening and exercising enhance mental and perceived health. These activities invoke a refreshing change of mood and improve physical functions.

Contrary to our expectations, smoking has a positive influence on SRH. It may be that smoking is refreshing and makes people feel healthy in the short term, even though it gradually harms their body and increases the risk for chronic diseases. This suggests that the short-term effects of smoking are good for older adults. Drinking alcohol also has a positive influence on perceived health. Moderate drinking may contribute to health because it is good for the blood.

Good ADL and IADL have positive effects on mental health and SRH, and are strongly associated with mental health in older adults. Less decline in body functioning not only increases feeling of health, but also reduces depressive symptoms in older

adults. Inconvenience caused by the body might easily lead to feelings of dejection.

Good physical abilities have a positive effect on SRH. Older adults with physical strength tend to have strong, healthy bodies¹.

Public pension income is strongly associated with mental health, and salary is associated with SRH. Most elderly people live on their pension income, and some elderly people receive employment salaries. A stable economic condition gives older adults a feeling of security, and sufficient money enables older adults to see doctors and get checks-up at hospitals.

Human relations are strongly associated with mental health in older adults. Having helpful people around or having good interpersonal relationships is good for mental health in older people². Conversely, difficult interpersonal relationships may cause older adults to worry, and are not good for their mental health.

Finally, suffering from chronic illness has a strong negative influence on perceived health. In particular, cancer, kidney disease, and chronic respiratory disease were strongly associated with SRH. Deadly diseases tend to make older adults perceive that they are unhealthy.

Table 4 shows the results from pooled OLS and pooled 2SLS for mental health in column one and for SRH in column two. Table 5 shows the panel analysis results for mental health and SRH³. Most of the results show mutually influencing relationships. We checked whether mental and perceived health were correlated, and it is possible

¹ The effects of these variables on mental health were not statistically significant, and these variables were used as identification variables for estimation.

² The effect of relationships on SRH was not statistically significant, and these variables were used as identification variables for estimation.

³ Here, we estimated the equations for mental health and SRH independently.

that the mind and body are mutually dependent in older adults.

6. Conclusion

Medical research suggests that the mind and body are mutually dependent. We examined the relationship between mental health and SRH in older adults using micro-data. Our results suggest that SRH affects mental health, and mental health also affects SRH; the mind and body are connected. These results suggest that a balance between mind and body (including psychiatric state) is important for good health, and when one becomes unhealthy, the other becomes unhealthy, too. This leads to a vicious cycle in older adults. Therefore, being physically healthy leads to well-being, and a healthy mind is good for a healthy body. Exercise and a healthy diet are important for maintaining good health, and it is important to build environments that are good for the mind.

This study suggests some future directions. First, this longitudinal analysis was only based on data from two periods. Studying more periods may provide more accurate results. Second, although we found many factors that affect mental health or SRH in older adults, the effects of other psychological factors (e.g., self-efficacy, quality of the life) should be assessed. We view these as future challenges.

References

- Blazer, D., Burchett, B. et al. (1991), The association of age and depression among elderly: An epidemiologic exploration. *Journal of Gerontology: Medical Science*, 46(6), M210-M215.
- Bruce, M.L. and Merrill, S. S. (1994), The impact of depressive symptomatology on physical disability: MacArthur Studies of successful aging. *American Journal of Public Health*, 84(11), 1796-1799.
- Burns, R.A., Sargent-Cox, K. et al. (2014), An examination of the effects of intra and inter-individual changes in wellbeing and mental health on self-rated health in a population study of middle and older-aged adults. *Social Psychiatry and Psychiatric Epidemiology*.
- Barsky, A.J., Clearly, P. D., and Klearman, G. L. (1992), Determinants of perceived health status of medical outpatients. *Social Science & Medicine*, 34(10), 1147-1154.
- Callahan, C.M., Hui, S. L. et al. (1994), Longitudinal study of depression and health services use among elderly primary care patients. *Journal of the American Geriatrics Society*, 42, 833-838.
- Davidson, H., Feldman, P.H., and Crawford, S. (1994), Measuring depressive symptoms in the frail elderly. *Journal of Gerontology: Psychological Science*, 49, P159-P164.
- Dunn, J.R. (2002), Housing and inequalities in health: a study of socioeconomic dimensions of housing and self reported health from a survey of Vancouver residents. *Journal of Epidemiology & Community Health*, 56, 671-681.
- Ferrie, J. E., Shipley, M. J. et al (2001), Effects of chronic job insecurity and change in job security on self reported health, minor psychiatric morbidity, physiological measures, and health related behaviours in British civil servants: The Whitehall II

- study. *Journal of Epidemiology & Community Health*, 56, 450-456.
- Franks, P., Gold, M. R., and Fiscella, K. (2003), Sociodemographics, self-rated health, and mortality in the US. *Social Science & Medicine*. 45, 2505-2514.
- Greene, W.H. (2000), Econometric analysis, *Prentice Hall, New Jersey*, pp.1004.
- Han, B. (2002), Depressive symptoms and self-rated health in community-dwelling older adults: A longitudinal study. *Journal of the American Geriatrics Society*, 50, 1549-1556.
- Hirdes, J.P. and Forbes, W.F. (1993), Factors associated with the maintenance of good self-rated health. *Journal of Aging and Health*, 5(1), 101-122.
- Ishikawa, H. and Kikuchi, T. (1976), The study of the human feedback properties. *Japanese Journal of Psychosomatic Medicine*, 16, 329-335.
- Kaplan, G. and Camacho, T. (1983), Perceived health and mortality: A nine-year follow-up of the human population laboratory cohort. *American Journal of Epidemiology*, 117(3), 292-304.
- Kennedy, J. G., Kelman R. H., and Thomas, C. (1990), The emergence of depressive symptoms in late life: the importance of declining health and increasing disability. *Journal of Community Health*, 15(2), 93-114.
- Liang, J. (1986), Self-reported physical health among aged adults. *Journal of Gerontology*, 41(2), 248-260.
- Naruo, T. (2003). Ghrelin, a novel orexigenic peptide from the stomach, and relationship between body, brain and mind. *Japanese Journal of Psychosomatic Medicine*, 43, 671-677.
- Moriyama, K., Ishizu, H., et al (2004). Relationship between subjective healthiness and mental health on elderly persons in Okinawa: A fieldwork survey of Kudakajima

- Ialand and Kitanakagusuku village. *Japanese Journal of Psychosomatic Medicine*, 44, 661-669.
- Mulsant, B. H., Ganguli, M., and Seaberg, E. C. (1997), The relationship between self-rated health and depressive symptoms in epidemiological sample of community-dwelling older adults. *Journal of the American Geriatrics Society*, 45, 954-958.
- Pijls, L. T., Feskens, E. J., and Kromhout, D. (1993), Self-rated health, mortality, and chronic deceases in elderly men: The Sutphen Study. *American Journal of Epidemiology*, 138, 840-848.
- Pikhart, H., Mobak, M. et al (2001), Psychosocial work characteristics and self rated health in four post-communist countries. *Journal of Epidemiology & Community Health*, 55, 624-630.
- Rodin, J. and McAvay, G. (1992), Determinants of change in perceived health in a longitudinal study of older adults. *Journal of Gerontology: Psychological Science* , 47, P373-P384.
- Rohrer, J.E. and Young, R. (2004), Self-esteem, stress, and self-rated health in family planning clinic. *BMC Family Practice*, 5.
- Scott, C. et al (1999), Determinants of self rated health for Canadians with chronic disease and disability. *Journal of Epidemiology & Community Health*, 53, 731-736.
- Setterstein, L and Lauver, D.R. (2004), Critical thinking, Perceived health status, and participation in health behaviors. *Nursing Research*, 53(1), 11-18.
- Shimizu, T. and Nagata, S. (2005), Relationship between job stress and self-rated health among Japanese full-time occupational physicians. *Environmental Health and Preventive Medicine*, 10, 227-232.

- Turner, R.J. and Beiser, M. (1990), Depression and depressive symptomatology among the physically disabled. *The Journal of Nervous and Mental Disease*, 178, 343-350.
- Weich, S., Lewis, G. and Jenkins, S. P. (2002), Income inequality and self rated health in Britain. *Journal of Epidemiology & Community Health*, 56, 436-441.
- Wilcox, V. L., Kasl, S. V., and Idler, E. L. (1996), Self-rated health and physical disability in elderly survivors of a major medical event. *The Journal of Gerontology* , 51B, S96-S104.
- Zellner, A. (1962), An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. *Journal of the American Statistical Association*, 57, 348-368.
- Zunzunegui, M. V., Beland, F., and Otero, A. (2001), Support from children, living arrangements, self-rated health and depressive symptoms of older people in Spain. *International Journal of Epidemiology*, 30, 1090-1099.

Table 1: Descriptive statistics

Variables	Description	mean	SD	min	max
self-rated health	self-rated health condition scores	3.402	0.992	1	5
mental health	CES-D score	48.319	5.371	9	60
sex	Dummy variable, female=1	0.554	0.497	0	1
age	current age	74.415	6.162	56	99
marital status	Dummy variable, 1 = married (i.e., the spouse is not dead, missing, or divorced)	0.632	0.482	0	1
number of children		2.387	1.213	0	8
alcohol consumption	Dummy variable, 1 = drink alcohol	0.384	0.486	0	1
smoking	Dummy variable, 1 = smoke cigarettes	0.180	0.384	0	1
BMI	BMI values				
physical activity					
gardening	Dummy variable, 1 = do often or sometimes	0.711	0.453	0	1
gymnastic exercises	Dummy variable, 1 = do often or sometimes	0.542	0.498	0	1
take walks	Dummy variable, 1 = do often or sometimes	0.610	0.488	0	1
activity of daily life (ADL)	Dummy variable, 1 = able to do all six activities (taking baths, putting on and taking off clothes, etc.) without difficulty.	0.919	0.272	0	1
instrumental activity of daily life (IADL)	Dummy variable, 1 = able to do all four activities (shopping, making a telephone call, etc.) without difficulty.	0.879	0.326	0	1
economic condition					
public pension income	amount of public pension receipt	207.300	142.315	0	1344
personal pension level	amount of private pension receipt	6.469	30.198	0	420
salary	amount of employment income	53.073	177.424	0	1344
other income	total amount of property revenue and help from a relative	63.615	134.506	0	1434
separation by death					
friend	Dummy variable, 1 = lost close friend during past year	0.244	0.429	0	1
spouse	Dummy variable, 1 = lost spouse during past year	0.136	0.343	0	1
child	Dummy variable, 1 = lost child during past year	0.439	0.496	0	1
physical ability					
walk	Dummy variable, 1 = able to walk 200–300 meters	0.886	0.318	0	1
squat down and kneel	Dummy variable, 1 = able to squat down and kneel	0.883	0.318	0	1
muscle strength	Dummy variable, 1 = 1 able to lift and carry about 10 kg of rice	0.767	0.423	0	1
having key person					
to listen to closely	Dummy variable, 1 = have someone who listens closely	0.941	0.235	0	1
who is thoughtful	Dummy variable, 1 = have someone who is thoughtful	0.941	0.236	0	1
provide financial support	Dummy variable, 1 = 1 have dependable person who provides financial support)	0.681	0.466	0	1
daily support	Dummy variable, 1 = have dependable person for daily support	0.932	0.251	0	1
attitudes of people who are close					
scold and complain	Dummy variable, 1 = scold and complain	0.089	0.285	0	1
financial burden	Dummy variable, 1 = financial burden	0.004	0.062	0	1
not feeling alone	Dummy variable, 1 = not feeling alone	0.853	0.355	0	1
disease and illness aftereffects					
heart disease	Dummy variable, 1 = have heart disease or illness aftereffect	0.150	0.357	0	1
Joint pain, rheumatism, neuralgia	Dummy variable, 1 = have joint pain, rheumatism, or neuralgia	0.169	0.375	0	1
hypertension	Dummy variable, 1 = have hypertension	0.344	0.475	0	1
diabetes	Dummy variable, 1 = 1 have diabetes			0	1
cerebrovascular disorder	Dummy variable, 1 = have cerebrovascular disorder and illness aftereffects	0.093	0.290	0	1
cancer	Dummy variable, 1 = have cancer	0.021	0.144	0	1
eye disease	Dummy variable, 1 = have glaucoma, cataract, and eye disease	0.231	0.421	0	1
anemia	Dummy variable, 1 = have anemia	0.051	0.219	0	1
kidney disease	Dummy variable, 1 = have kidney disease	0.030	0.171	0	1
venous inflammation	Dummy variable, 1 = have venous inflammation	0.017	0.131	0	1
chronic respiratory disease	Dummy variable, 1 = have chronic respiratory disease	0.056	0.230	0	1
chronic lumbago (back) ache	Dummy variable, 1 = have chronic lumbago (back) ache	0.207	0.405	0	1
bone fracture	Dummy variable, 1 = have bone fracture, bone crack, and aftereffects of a broken bone	0.032	0.177	0	1
liver and gallbladder disease	Dummy variable, 1 = have a liver and gallbladder disease	0.041	0.197	0	1

Table 2: Three stage least squares results (1)

	mental health			self-rated health	
	Coef.		S.E	Coef.	S.E
self-rated health	1.073	**	0.431	-	
mental health	-			0.057	*** 0.009
sex (female=1)	-0.688	***	0.234	0.186	*** 0.043
age	-0.032	*	0.017	0.007	** 0.003
marrital status	-0.053		0.229	-0.013	0.042
number of children	0.036		0.077	0.012	0.014
alcohol consumption	0.243		0.217	0.160	*** 0.037
smoking	-0.225		0.264	0.167	*** 0.046
BMI	0.0001		0.004	0.0002	0.001
physical activity					
gardening	0.411	*	0.234	0.104	** 0.041
gymnastic exercises	0.279		0.202	0.073	** 0.036
take walks	0.394	*	0.216	0.107	*** 0.037
activity of daily life (ADL)	1.031	**	0.482	0.150	* 0.085
instrumental activity of daily life (IADL)	0.738	*	0.440	0.159	** 0.075
economic condition					
public pension income	0.002	***	0.001	-0.0001	0.000
personal pension level	0.003		0.003	-0.001	* 0.001
salary	-0.0002		0.001	0.0003	*** 0.000
other income	-0.0003		0.001	0.0001	0.000
separation by death					
friend	-0.220		0.210	0.014	0.038
spouse	0.144		0.258	-0.083	* 0.047
child	-0.061		0.188	-0.022	0.034
physical ability					
squat down and kneel	-			0.275	*** 0.052
muscle strength	-			0.453	*** 0.049
having key person	-				
to listen to closely	1.096	***	0.395	-	
who is thoughtful	0.639	*	0.388	-	
provide financial support	0.958	***	0.197	-	
daily support	1.993	***	0.366	-	
attitudes of people who are close					
scold and complain	-0.861	***	0.302	-	
financial burden	-9.968	***	1.383	-	
not feelig alone	2.607	***	0.274	-	
constant	37.946	***	1.671	-1.037	** 0.488
Number of observation			2880		2880
R-squ			0.241		0.257
chi2			745.67		832.4
Prob>chi2			0.000		0.000

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

We performed the control by regions.

Table 3: Three stage least squares results (2)

	mental health			self-rated health		
	Coef.		S.E	Coef.		S.E
self-rated health	1.468	***	0.400	-		
mental health	-			0.045	***	0.009
sex (female=1)	-0.656	***	-0.656	0.060	*	0.036
age	-0.035	**	-0.035	0.004		0.003
marital status	-0.057		0.230	-0.051		0.040
number of children	0.035		0.077	0.006		0.013
physical activity						
gardening	0.477	**	0.234	0.100	***	0.039
gymnastic exercises	0.271		0.204	0.101	***	0.034
take walks	0.408	*	0.213	0.090	**	0.035
economic condition						
public pension income	0.002	***	0.001	-0.000002		0.0001
personal pension level	0.003		0.003	-0.001	*	0.001
salary	-0.0002		0.001	0.0003	***	0.0001
other income	-0.0004		0.001	0.0001		0.0001
separation by death						
friend	-0.159		0.211	0.041		0.036
spouse	0.176		0.257	-0.066		0.045
child	-0.067		0.188	-0.016		0.033
physical ability						
squat down and kneel	-			0.228	***	0.048
muscle strength	-			0.469	***	0.045
having key person	-					
to listen to closely	1.127	***	0.393	-		
who is thoughtful	0.535		0.386	-		
provide financial support	0.866	***	0.193	-		
daily support	1.965	***	0.361	-		
attitudes of people who are close						
scold and complain	-0.927	***	0.298	-		
financial burden	-9.622	***	1.371	-		
not feelig alone	2.607	***	0.269	-		
disease and illness aftereffects						
heart disease	-0.462		0.282	-0.258	***	0.045
Joint pain, rheumatism, neuralgia	-0.414		0.265	-0.132	***	0.044
hypertension	0.005		0.205	-0.191	***	0.033
diabetes	0.009		0.326	-0.217	***	0.054
cerebrovascular disorder	-0.560		0.438	-0.231	***	0.072
cancer	-0.107		0.230	-0.143	***	0.038
eye disease	-0.475		0.648	-0.417	**	0.108
anemia	-0.817		0.427	-0.179	**	0.072
kidney disease	1.238	*	0.687	-0.043		0.120
venous inflammation	-0.084		0.542	-0.360	***	0.092
chronic respiratory disease	0.070		0.411	-0.312	***	0.067
chronic lumbago (back) ache	-0.249		0.255	-0.218	***	0.040
bone fracture	-0.716		0.506	0.129		0.088
liver and gallbladder disease	0.719		0.475	-0.369	***	0.078
constant	38.828	***	1.983	0.467		0.492
Number of observation			2880			2880
R-squ			0.244			0.33
chi2			791.09			1278.75
Prob>chi2			0.000			0.000

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

We performed the control by regions.

Table 4: pooling OLS and pooling 2SLS

the estimation of pooling OLS					
	mental health		self-rated health		
	Coef.		S.E	Coef.	S.E
self-rated health	1.311	***	0.097	-	
mental health	-			0.054	*** 0.003
the estimation of pooling 2SLS					
	mental health		self-rated health		
	Coef.		S.E	Coef.	S.E
self-rated health	1.081	***	0.434	-	
mental health	-			0.057	*** 0.009

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

We controlled for the variables in Table 3 and region as a dummy variable.

Table 5: Fixed effect and random effect regressions

	mental health		self-rated health		
	Coef.		S.E	Coef.	S.E
(Fixed effect)					
self-rated health	0.785	***	0.156	-	
mental health	-			0.028	*** 0.005
(Random effect)					
self-rated health	1.243	***	0.097	-	
mental health	-			0.043	*** 0.003
(Fixed effect 2SLS)					
self-rated health	2.061	*	1.196	-	
mental health	-			0.043	0.027
(Random effect 2SLS)					
self-rated health	1.190	***	0.46	-	
mental health	-			0.057	*** 0.010

Note:***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

We controlled for the variables in Table 3 and region as a dummy variable..