RIETI Discussion Paper Series 16-E-069

Association among Socioeconomic Status, Health and Function-related Variables, and Onset of Depression in the Case of Middle-aged and Older People in Japan

SEKIZAWA Yoichi
RIETI

The Research Institute of Economy, Trade and Industry
http://www.rieti.go.jp/en/

RIETI Discussion Paper Series 16-E-069
May 2016

Association among Socioeconomic Status, Health and Function-related Variables, and Onset of Depression in the Case of Middle-aged and Older People in Japan[1]

SEKIZAWA Yoichi
Research Institute of Economy, Trade and Industry

Abstract

Although many studies show that people at low socioeconomic states (SES) are more likely to be depressed, longitudinal studies on SES and depression which take into account health and function-related variables in the case of middle-aged and older people are scarce, especially in Asian nations. By performing multivariate logistic regressions using longitudinal data from the Japanese Study of Aging and Retirement (JSTAR), we investigate the longitudinal association between SES plus health and function-related variables at baseline and an onset of depression two years later for people over the age of 50. We find that, out of the respondents who are not depressed at baseline, respondents with the lowest education levels are more likely to develop depression two years later. This result was maintained after adjusting for total family income and total wealth, but was attenuated and not significant after adjusting for health and function-related variables. We also find that those with any disability in the instrumental activities of daily living (IADL) and intellectual activities (IA) at baseline are more likely to develop depression two years later.

Keywords: Depression, Socioeconomic status, IADL, Intellectual activity, JSTAR
JEL classification: I14

[1]This study is conducted as a part of the Project "Research Project on Mental Health from the Perspective of Human Capital 2" undertaken at Research Institute of Economy, Trade and Industry (RIETI). The author is grateful for helpful comments and suggestions by Discussion Paper seminar participants at RIETI.

1. Introduction

Depression management is a significant issue worldwide (Moussavi et al., 2007). Although depression tends to be regarded as a purely medical problem and treated with medication and psychotherapy, there is growing evidence that the prevalence of depression is high in people with low SES as indicated by educational attainment, income, and wealth (Lorant et al., 2003). Although this association between SES and depression (or other mental health problems) are confirmed in several studies in Western nations as well as Asian nations (Murata, Kondo, Hirai, Ichida, and Ojima, 2008; Fukuda and Hiyoshi, 2012; Back and Lee, 2012), many of the previous studies especially in Asia are cross-sectional, thus making the interpretation of the results difficult. It is not clear from cross-sectional studies whether depression leads to low SES, or if low SES leads to depression, or if third-party factors cause both of them.

In order to make clearer the causal relationship between SES and depression, several longitudinal studies were performed in Western nations. One approach of examining the effect of SES on depression (or other mental health problems) in the longitudinal studies is analyzing whether variables on SES at baseline predict an onset of depression or other mental health problems at later stages by excluding those who were depressed at baseline from the analyses (Skapinakis, Weich, Lewis, Singleton, and Araya, 2006; Wang, Schmitz, and Dewa, 2010; Kosidou et al. 2011). This approach can show if there are any SES variables which are risk factors of future depression. In addition, if any modifiable SES variable is found in such

longitudinal studies, changing such modifiable variables can become policy targets to improve mental health. Using panel data in Britain, Skapinakis et al. (2006) showed that no objective SES variables at baseline are associated with an onset of common mental disorders 18 months later. Using panel data in Canada, Wang et al. (2010) showed that a low education level at baseline is associated with a higher risk of an onset of depression in the following six years for respondents who worked in the past 12 months, but a low education level is associated with a lower risk of an onset of depression for respondents who did not work in the same period. Using panel data in Sweden, Kosidou et al. (2011) found that occupational class and income at baseline are associated with an onset of depression during the subsequent five years. They found no association between education and depression.

The present study advanced the previous longitudinal studies on the relationship between SES and depression in the following two ways. First, we focused on middle-aged and elderly people in Japan, which is one of the Asian nations where longitudinal studies on SES and depression are scarce. For countries with a rapidly aging society such as Japan, managing depression for middle-aged and older people is an important issue. Middle-aged and older people tend to commit suicide more often than younger people. Depression is known as a possible risk factor for dementia (Diniz, Butters, Albert, Dew, and Reynolds, 2013) and functional decline (Iwasa et al., 2009) which are prevalent among elderly people and are becoming a burden for the whole country. Second, as explanatory variables, we used not only SES variables but also physical health and function-related variables. Although

physical health problems and functional disability can be potential confounders when analyzing the relationship between SES and mental health, they are not taken into account sufficiently in previous studies (Lorant et al., 2003). In the case of older people, this may be particularly important because they tend to have more physical health problems and functional disability than younger people, and there seems to be a bi-directional association between physical health and functional disability and depression (Gunn et al., 2012; Ormel, Rijisdijk, Sullivan, van Sonderen, and Kempen, 2002).

Based on the previous studies, we hypothesized that middle-aged and older people with low SES and people with physical health problems and/or functional disabilities tend to develop depression two years later.

2. Methods

2.1. Dataset

Data used in the present study are from the Japanese Study of Aging and Retirement (JSTAR). JSTAR aims at developing a panel data survey covering data on middle-aged and older people living in Japan. JSTAR is conducted by the Research Institute of Economy, Trade and Industry (RIETI), University of Tokyo, and Hitotsubashi University. The baseline sample of individuals range between ages 50 and 75. There are three waves available at the timing of the present study: 2007, 2009, and 2011. The first wave research was carried out in five municipalities (Sendai, Kanazawa, Takikawa, Shirakawa, and Adachi) in 2007. The second wave

research was carried out in seven municipalities, including the five original municipalities and two new ones (Naha and Tosu) in 2009. The third wave research was carried out in 10 municipalities including the already mentioned seven municipalities and an additional three new ones in 2011. As a longitudinal study, the three newly added cities in 2011 are not factored into the analyses from the present study. Details of JSTAR are available elsewhere (Ichimura, Shimizutani, and Hashimoto, 2009).

2.2. Measures

2.2.1. Depression

Depression was measured by using the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1977). CES-D is a 20-item scale that assesses the presence and severity of depressive symptoms experienced during the previous week. Four items in CES-D are reverse-scored and used for assessing the absence of positive emotion. CES-D scores range from 0 to 60, with higher scores indicating a higher level of depression. Although Radloff (1977) set the CES-D cutoff score for depression at 16, the cutoff score was set at 19 in the present study, meaning that people with a CES-D score of 19 or higher are defined as being depressed, following Wada et al. (2007) who argued that the optimal CES-D cutoff score for screening of major depressive disorders of Japanese workers should be 19 instead of 16.

2.2.2. SES Variables

As SES variables, we used educational attainment, total family income, and total wealth. Educational attainment was measured by the last school attended and whether the subject graduated or dropped out. The answers of the respondents were classified into four categories: (1) 11 years or less, (2) 12 years (equal to senior high school graduates), (3) 13-15 years, (4) 16 years or more (four-year college graduates or higher). Total family income and total wealth were based on the Harmonized JSTAR (Matsuyama, Phillips, Chien, Ichimura, and Lee, 2014) in which imputed values are used for some of missing variables. We categorized total family income in quartiles, according to the distribution among all study responses as: (1) 0 – 2.10 million yen; (2) 2.11 – 3.70 million yen; (3) 3.71 – 5.80 million yen; (4) 5.81 million yen or more. We categorized total wealth similarly as: (1) -44.00 – 6.00 million yen; (2) 6.03 – 24.00 million yen; (3) 24.10 – 50.00 million yen; (4) 50.10 million yen or more.

2.2.3. Health and Function-related Variables

As health and function-related variables, we used the number of past clinical diagnoses, past mental disease diagnoses, and functional disabilities in IADL, IA, social role (SR), and activities of daily living (ADL). For the number of past clinical diagnosis, we summed up the number of major medical problems (high blood pressure, diabetes, cancer, lung diseases, heart problems, stoke, and arthritis) as previously diagnosed by a physician. For past mental disease diagnoses, a separate binary variable was created (not having been diagnosed for any psychiatric disorder

/ having been diagnosed) because it is known that a past history of depression is a major risk factor for future depression (Burcusa and Iacono, 2007). For the number of past clinical diagnoses and past mental disease diagnoses, data of the Harmonized JSTAR were used.

For functional disabilities, six questions on ADL and the Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC) were used (Koyano, Shibata, Nakazato, Haga, and Suyama, 1991). The six questions on ADL are taking on/off shoes, moving within the room, bathing by oneself, etc. The TMIG-IC measures a higher level of competence than basic ADL and is composed of 13 questions. There are three subscales in the TMIG-IC which are IADL (five questions: using public transportation, shopping for daily necessities, boiling water, paying bills, and handling banking deposits), IA (four questions: filling out forms of pension, reading newspaper, reading books or magazines, and being interested in health programs), and SR (four questions: visiting friends' homes, being called on for advice, visiting sick friends, and initiating conversations with young people). In the questions on ADL and the TMIG-IG, the response to each question is coded as 1 if respondents can do the activity and as 0 otherwise. The scores from each question are simply summed up. However, we constructed dummy variables for disabilities in IADL, IA, SR, and ADL respectively in which respondents who can do all of the activities in each category were coded as 0 and respondents who cannot do one or more activities were coded as 1.

2.2.4. Other Variables

In addition to the abovementioned variables, we used gender, age, age squared, marital status, work status, number of children, and city and year dummy as explanatory variables. Age and age squared were measured as continuous variables. Marital status was classified into four categories: (1) currently married, (2) divorced, (3) widowed, (4) never married. Work status was classified into seven categories based on the Harmonized JSTAR: (1) full time worker, (2) part time worker, (3) unemployed, (4) retired, (5) disabled, (6) not in labor force, (7) self-employed. The number of children was measured as a continuous variable and based on the Harmonized JSTAR. We made categorical variables for city and year: (1) the original five cities in 2007, (2) the original five cities in 2009, (3) new two cities in 2009.

2.3. Statistical Analysis

Multivariate logistic regressions were performed. For the dependent variable, we constructed a binary variable in which respondents who were not depressed at both the baseline year (2007 or 2009) and two years later (2009 or 2011) were coded as 0 and respondents who were not depressed at baseline and depressed two years later were coded as 1. Explanatory variables are those of the baseline year (2007 or 2009). Depressed respondents at baseline were excluded. This dependent variable is our best proxy of an onset of depression two years later following previous studies (Skapinakis et al., 2006). Using the pooling of repeated observations method

(Cupples, D'Agostino, Anderson, and Kannel, 1988), data of 2007 and 2009 at baseline were pooled for the analyses. In CES-D, it is reported that quite a large number of respondents choose the same column for all 20 items in the CES-D. In the present study, in order to avoid using unreliable data, we excluded those who chose the same column for all items from the analyses.

In Model 1, each category of explanatory variables plus age and age squared was analyzed separately to assess its association with the dependent variable. For example, in the category of educational attainment, only variables on educational attainment plus age and age squared are explanatory variables. The number of missing values is different in different explanatory variables. Hence, the number of observation is also different. That's why N is missing in Model 1 of Table 2. In Model 2, we adjusted for age, age squared, gender, educational adjustment, marital status, work status, number of children, and city and group dummy. In Model 3, we adjusted for total family income and total wealth in addition to the variables entered in Model 2. In Model 4, we adjusted for health and function-related variables (number of past clinical diagnosis, past mental disease diagnosis, and disabilities in IADL, IA, SR and ADL) in addition to the variables entered in Model 2. In Model 5, we adjusted for all of the variables mentioned above.

3. Results

Table 1 shows the baseline characteristics of the respondents. In 2007, there were 3,861 respondents in the original five municipalities. In 2009, 2,723 from the

original five municipalities remained in the second wave, and 1,440 respondents from the two new municipalities joined. In sum, there were 8,024 responses from 5,301 people (= 3,861 + 1,440). Out of the responses, 1,705 did not fill in the CES-D questions. 1,421 responses answered CES-D incorrectly; they chose the same column for all 20 items in the CES-D. Most of them chose the far left column for all 20 items (1,419 answers out of 1,421 incorrect answers), meaning that their CES-D score was 12. Out of the remaining 4,898 responses, 4,296 free from depression at baseline were used for the main analyses. Out of the responses, 2,274 filled out CES-D correctly two years later. 2,083 responses were not depressed both at baseline and two years later. 191 responses were not depressed at baseline and depressed two years later. A chi-squared test showed that there were significant differences in the ratio of incidence of depression at baseline in the categories of gender, educational attainment, marital status, work status, total family income quartile, total wealth quartile, number of past clinical diagnoses, IADL disability, IA disability, SR disability, ADL disability, and past mental disease diagnosis (all ps<0.01), but not in the city and year dummy. A chi-squared test showed that there were significant differences in the ratio of onset of depression two years later (whether or not those who were not depressed at baseline were depressed two years later) in the categories of educational attainment (p=0.03), IADL disability (p<0.01), IA disability (p<0.01), SR disability (p=0.01), and past mental disease diagnosis (p<0.01), but not in gender, marital status, work status, total family income quartile, total wealth quartile, number of past clinical diagnoses, ADL disability, and city and

year dummy.

The results of multivariate logistic regressions are shown in Table 2. Respondents with the lowest education level were more likely to develop depression two years later than those with the second lowest education level (Model 1 and Model 2). This tendency was not attenuated in Model 3 in which income and wealth were adjusted for, but was attenuated and not significant in Model 4 in which health and function-related variables were adjusted for. Total family income and total wealth were not associated with an onset of depression two years later.

Regarding health and function-related variables, compared with no past diagnosis of major diseases, those who had two diagnoses tend to develop depression two years later. Regarding function-related variables, IADL disability and IA disability were associated with an onset of depression, even after adjusting for other variables. SR disability was associated with an onset of depression with no adjustments for other variables except age (Model 1), but this association was attenuated and no longer significant after adjusting for other health and function-related variables (Model 4 and Model 5).

The abovementioned findings suggest that some of health and function-related variables (number of past clinical diagnoses and disabilities in IADL, IA, SR, and ADL, and past mental health diagnoses) play a mediating role in the relationship between educational attainment and an onset of depression. In order to determine the mediating variables, we performed further multivariate logistic regressions in which each of these health and function-related variables plus variables in Model 2

of Table 2 with the sample of Model 4 of Table 2 were explanatory variables (Table 3). The results showed that IADL disability and IA disability were significant explanatory variables themselves and adding them in the regressions made the association between educational attainment and an onset of depression insignificant (Model 8 and Model 9), suggesting that they play a mediating role between them.

From the results of the present study, it was hypothesized that a low level of education leads to disabilities in IADL and IA, which then leads to an onset of depression. To confirm this hypothesis, we performed multivariate logistic regressions in which those who were free from IADL (IA, SR) disabilities both at baseline and two years later were coded as 0 and those who were free from IADL (IA, SR) disabilities at baseline and had any disabilities two years later were coded as 1 (Table 4). The results of the logistic regressions supported the hypothesis; those with the lowest education level were more likely to develop disabilities in IADL and IA, but not SR two years later (Models 13 through 18).

4. Discussion

According to the analyses in the present study, out of the middle-aged and older people who were not depressed at baseline, respondents with the lowest education level were more likely to develop depression two years later than those with the second lowest education level. This result was maintained after adjusting for total family income and total wealth, but attenuated and not significant after adjusting

for health and function-related variables. An additional finding is that those who had any disabilities in IADL or IA at baseline were more likely to develop depression two years later. Total family income and total wealth were not associated with an onset of depression two years later.

The result of the present study suggests that, in the case of middle-aged and elderly people, people with the lowest education level have a higher chance of developing depression two years later even if they are not depressed at the moment. This negative effect of low education levels on depression seems to be not mediated by income and wealth, but by disabilities in IADL and IA. The finding of the present study suggests that low education levels lead to disabilities in IADL and IA and such disabilities leads to an onset of depression. This is partly consistent with the results of previous studies which found that a higher education level has a protective effect against future depression and this effect is mediated by somatic health (Miech & Shanahan, 2000; Bjelland et al., 2008) although disabilities in IADL and IA rather than number of past clinical diagnosis were mediators in the present study. The finding of the present study is consistent with the previous studies which found that the least educated tend to experience functional limitation (Zimmer, Liu, Hermalin, and, Chuang, 1998; Ishizaki, Kobayashi, and Kai, 2000)

Although some of the previous cross-sectional studies (Murata et al., 2008; Back and Lee, 2012) and a longitudinal study (Carter, Blakely, Collings, Imlach Gunasekara, and Richardson 2008; Kosidou et al., 2011) indicated the effects of income/wealth on depression, such effects were not found in the present study. It is

not clear why this difference exists. One possible explanation is that association between income/asset and depression is formed in the long term and income/wealth level at a particular time point does not affect depression status in a period of only two years, especially in older people. This explanation may be supported by the basic statistics in the present study. Table 1 shows that there is significant trend that lower income and wealth are associated with a higher incidence of depression, but the association between income/wealth and an onset of depression two years later is less clear and insignificant. Another possibility is simply a lack of power. Unlike a longitudinal study with large sample size (n=23794) and long follow-up period (five years) (Kosidou et al., 2011), the present study may not have enough follow-up time and statistical power to reveal the association between income/wealth and an onset of depression.

The most significant predictors of an onset of depression in the present study were disabilities in IADL and IA. For IADL, this result is consistent with a previous study which found that IADL/ADL disability can lead to depression (Ormel, Rijisdijk, Sullivan, van Sonderen, and Kempen, 2002). What was rather unexpected was that disabilities in IA were independent predictors of an onset of depression. Exposure to IA is known to be associated with better functional trajectory in later years (Fujiwara et al., 2009). IA may be a modifiable factor and studies in Japan show that intervention programs for improving IA such as cognitive training using video games (Nouchi et al., 2012) and reading picture books aloud for children (Suzuki et al., 2014) can improve cognitive function of elderly people. Similarly,

impairment in IADL can be preventable and irreversible and raising digital literacy through internet use may be effective in this direction (d'Orsi, et al., 2014). In addition, a recent randomized controlled trial showed that the cognitive speed of processing training not only arrested the development of additional IADL difficulties, but also reduced depression symptoms (Wolinsky, Vander Weg, Howren, Jones, and Dotson; 2014). Considering that maintaining IADL and IA may lead to prevention of both depression and functional decline and can be modifiable through promoting activities such as reading books for children and internet use, it may be worthwhile to promote such activities, especially focusing on those with low education levels. The findings shown in the present study and the previously mentioned studies suggest that prevention of functional decline and depression should be pursued in tandem rather than separately in the case of middle-aged and older people.

There are several limitations in the present study. First of all, we used the CES-D score as an indicator of depression, which may have led to an inaccurate classification of depression. Although the CES-D can be a good screening tool for depression, interview-based classification can measure depression more accurately. In addition, in the present study, approximately 20% of respondents chose the far left column for all 20 questions in the CES-D, suggesting that they did not understand the questionnaire accurately. There is also a possibility that other respondents, especially older people, may have misunderstood reverse-scored items, making their CES-D scores higher than the real scores (Carlson et al., 2011) and

suggesting that depression is overestimated in the present study. Second, a large number of missing values may have led to biased parameter estimates. Approximately 40% of total responses were excluded only for CES-D related problems. There were many missing values in total family income and total wealth as well. Third, although a variety of potential confounders were adjusted for, unadjusted-for confounders may still remain. Taking these limitations into account, the findings of the present study are not conclusive and further investigation is warranted in the setting of a larger number of respondents with lower ratio of missing values.

5. Acknowledgment

This analysis uses data or information from the Harmonized JSTAR dataset and Codebook, Version A as of April 2014 developed by the Gateway to Global Aging Data. The development of the Harmonized JSTAR was funded by the National Institute on Ageing (R01 AG030153, RC2 AG036619, 1R03AG043052).

References

Back, J. H. and Y. Lee (2011) "Gender differences in the association between socioeconomic status (SES) and depressive symptoms in older adults," *Archives of Gerontology and Geriatrics*, Vol. 52, No. 3, pp. e140-e144.

Bjelland, I., S. Krokstad, A. Mykletun, A. A. Dahl, G. S. Tell, and K. Tambs (2008) "Does a higher educational level protect against anxiety and depression? The HUNT study," *Social Science & Medicine*, Vol. 66, No. 6, pp. 1334-1345.

Burcusa, S. L. and W. G. Iacono (2007) "Risk for recurrence in depression," *Clinical Psychology Review*, Vol. 27, No. 8, pp. 959-985.

Carlson, M., R. Wilcox, C. Chou, M. Chang, F. Yang, J. Blanchard, A. Marterella, A. Kuo, and F. Clark (2011) "Psychometric properties of reverse-scored items on the CES-D in a sample of ethnically diverse older adults," *Psychological Assessment*, Vol. 23, No. 2, pp. 558-562.

Carter, K. N., T. Blakely, S. Collings, F. Imlach Gunasekara, and K. Richardson (2009) "What is the association between wealth and mental health?" *Journal of Epidemiology and Community Health*, Vol. 63, No. 3, pp. 221-226.

Cupples, L. A., D'Agostino, R. B., Anderson, K., & Kannel, W. B. (1988). "Comparison of baseline and repeated measure covariate techniques in the Framingham Heart Study." *Statistics in medicine*, Vol. 7, 205-218.

Diniz, B. S., M. A. Butters, S. M. Albert, M. A. Dew, and C. F. Reynolds (2013) "Late-life depression and risk of vascular dementia and Alzheimer's disease:

Systematic review and meta-analysis of community-based cohort studies," *The British Journal of Psychiatry*, Vol. 202, No. 5, pp. 329-335.

d'Orsi, E., A. J. Xavier, A. Steptoe, C. Oliveira, L. R. Ramos, M. Orrell, P. Demakakos, and M. G. Marmot (2014) "Socioeconomic and lifestyle factors related to instrumental activity of daily living dynamics: Results from the English longitudinal study of ageing," *Journal of the American Geriatrics Society*, Vol. 62, No. 9, pp. 1630-1639.

Fujiwara, Y., P. H. Chaves, H. Yoshida, H. Amano, T. Fukaya, N. Watanabe, M. Nishi, S. Lee, H. Uchida, and S. Shinkai (2009) "Intellectual activity and likelihood of subsequently improving or maintaining instrumental activities of daily living functioning in community-dwelling older Japanese: a longitudinal study," *International Journal of Geriatric Psychiatry*, Vol. 24, No. 6, pp. 547-555.

Fukuda, Y. and A. Hiyoshi (2012) "Influences of income and employment on psychological distress and depression treatment in Japanese adults," *Environmental Health and Preventive Medicine*, Vol. 17, No. 1, pp. 10-17.

Gunn, J. M., D. R. Ayton, K. Densley, J. F. Pallant, P. Chondros, H. E. Herrman, and C. F. Dowrick (2012) "The association between chronic illness, multimorbidity and depressive symptoms in an Australian primary care cohort," *Social Psychiatry and Psychiatric Epidemiology*, Vol. 47, No. 2, pp. 175-184.

Ichimura, H., S. Shimizutani, and H. Hashimoto (2009) "JSTAR First Results 2009 Report," Research Institute of Economy, Trade and Industry (RIETI).

Ishizaki, T., Y. Kobayashi, and I. Kai (2000) "Functional transitions in instrumental activities of daily living among older Japanese," *Journal of Epidemiology*, Vol. 10, No. 4, pp. 249-254.

Iwasa, H., Y. Yoshida, S. Kumagai, K. Ihara, H. Yoshida, and T. Suzuki (2009) "Depression status as a reliable predictor of functional decline among Japanese community-dwelling older adults: A 12-year population-based prospective cohort study," *International Journal of Geriatric Psychiatry*, Vol. 24, No. 11, pp. 1192-1200.

Kosidou, K., C. Dalman, M. Lundber, J. Hallqvist, G. Isacsson, and C. Magnusson (2011) "Socioeconomic status and risk of psychological distress and depression in the Stockholm Public Health Cohort: A population-based study," *Journal of Affective Disorders*, Vol. 134, No. 1, pp. 160-167.

Koyano, W., H. Shibata, K. Nakazato, H. Haga, and Y. Suyama (1991) "Measurement of competence: reliability and validity of the TMIG Index of Competence," *Archives of Gerontology and Geriatrics*, Vol. 13, No. 2, pp. 103-116.

Lorant, V., D. Deliège, W. Eaton, A. Robert, P. Philippot, and M. Ansseau (2003) "Socioeconomic inequalities in depression: a meta-analysis," *American Journal of Epidemiology*, Vol. 157, No. 2, pp. 98-112.

Matsuyama, H., D. Phillips, S. Chien, H. Ichimura, and J. Lee (2014) "Harmonized JSTAR Documentation: Version A, May 2014," USC Davis Center for Global aging Research.

Miech, R. A. and M. J. Shanahan (2000) "Socioeconomic status and depression over the life course," *Journal of Health and Social Behavior*, Vol. 41, No. 2, pp. 162-176.

Moussavi, S., S. Chatterji, E. Verdes, A. Tandon, V. Patel, and B. Ustun (2007) "Depression, chronic diseases, and decrements in health: Results from the World Health Surveys," *The Lancet*, Vol. 370, No. 9590, pp. 851-858.

Murata, C., K. Kondo, H. Hirai, Y. Ichida, and T. Ojima (2008) "Association between depression and socio-economic status among community-dwelling elderly in Japan: the Aichi Gerontological Evaluation Study (AGES)," *Health & Place*, Vol. 14, No. 3, pp. 406-414.

Nouchi R., Y. Taki, H. Takeuchi, H. Hashizume, T. Nozawa, T. Kambara, A. Sekiguchi, C. M. Miyauchi, Y. Kotozaki, H. Nouchi, and R. Kawashima (2012) "Brain training game improves executive functions and processing speed in the elderly: a randomized controlled trial." *PLoS ONE,* Vol. 7, No. 1, e29676.

Ormel, J., F. V. Rijsdijk, M. Sullivan, E. van Sonderen, and G. I. Kempen (2002) "Temporal and reciprocal relationship between IADL/ADL disability and depressive symptoms in late life," *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, Vol. 57, No. 4, pp. 338-347.

Radloff, L. S. (1977) "The CES-D Scale: A self-report depression scale for research in the general population," *Applied Psychological Measurement*, Vol. 1, No. 3, pp. 385-401.

Skapinakis, P., S. Weich, G. Lewis, N. Singleton, and R. Araya (2006)

"Socio-economic position and common mental disorders Longitudinal study in the general population in the UK," *The British Journal of Psychiatry*, Vol. 189, No. 2, pp. 109-117.

Suzuki, H., M. Kuraoka, M. Yasunaga, K. Nonaka, R. Sakurai, R. Takeuchi, Y, Murayama, H, Ohba, and Y. Fujiwara (2014) "Cognitive intervention through a training program for picture book reading in community-dwelling older adults: a randomized controlled trial," *BMC Geriatrics*, Vol. 14, No. 1, pp. 122.

Wada, K., K. Tanaka, G. Theriault, T. Satoh, M. Mimura, H. Miyaoka, and Y. Aizawa (2007) "Validity of the Center for Epidemiologic Studies Depression Scale as a screening instrument of major depressive disorder among Japanese workers," *American Journal of Industrial Medicine*, Vol. 50, No. 1, pp. 8-12.

Wang, J. L., N. Schmitz, and C. S. Dewa (2010) "Socioeconomic status and the risk of major depression: The Canadian National Population Health Survey," *Journal of Epidemiology and Community Health*, Vol. 64, No. 5, pp. 447-452.

Wolinsky, F. D., M. W. Vander Weg, M. B. Howren, M. P. Jones, and M. M. Dotson (2014) "The effect of cognitive speed of processing training on the development of additional IADL difficulties and the reduction of depressive symptoms: Results from the IHAMS randomized controlled trial," *Journal of Aging and Health*, Vol. 27, No. 2, pp. 334-354.

Zimmer, Z., X. Liu, A. Hermalin, and Y. L. Chuang (1998) "Educational attainment and transitions in functional status among older Taiwanese," *Demography*, Vol. 35, No. 3, 361-375.

Table 1. Basic Characteristics of Respondents

		Incidence of Depression at Baseline					Onset of Depression Two Years Later				
	Total	Answer missing	Incorrect answer	No	Yes	Yes/ Yes+ No	Answer missing	Incorrect answer	No	Yes	Yes/ Yes+ No
Age	64.24	65.99	64.66	63.52	63.39		63.71	64.42	63.23	63.32	
(s.d.)	(7.12)	(7.06)	(6.93)	(7.03)	(7.47)		(7.17)	(6.69)	(6.91)	(7.65)	
Gender											
Male	3,917	754	783	2,119	261	11.0%	740	229	1,062	88	7.7%
Female	3,957	922	614	2,093	328	13.5%	804	165	1,021	103	9.2%
Educational attainment											
Less than 12 years	2,555	699	499	1,153	204	15.0%	468	128	494	63	11.3%
12 years	3,309	632	596	1,855	226	10.9%	673	173	933	76	7.5%
13–15 years	998	176	138	606	78	11.4%	198	46	332	30	8.3%
16 years or more	971	153	157	583	78	11.8%	203	46	313	21	6.3%
Marital status											
Married	6,256	1,282	1,175	3,396	403	10.6%	1,234	329	1,693	140	7.6%
Divorced	434	105	44	220	65	22.8%	83	8	114	15	11.6%
Widowed	787	203	115	385	84	17.9%	152	39	171	23	11.9%
Never Married	312	65	53	161	33	17.0%	61	12	79	9	10.2%
Work status											
Full time worker	1,746	257	350	1,028	111	9.7%	363	91	528	46	8.0%
Part time worker	1,325	276	221	744	84	10.1%	261	67	386	30	7.2%
Unemployed	276	59	42	141	34	19.4%	59	15	62	5	7.5%
Retired	1,105	234	212	587	72	10.9%	204	60	294	29	9.0%
Disabled	279	96	32	80	71	47.0%	39	5	29	7	19.4%
Not in labor force	1,811	448	291	935	137	12.8%	381	85	421	48	10.2%
Self-employed	1,082	228	208	590	56	8.7%	205	64	299	22	6.9%
Number of children	2.03	2.07	2.07	2.02	1.92		2.02	2.02	2.02	2.12	
(s.d.)	(0.97)	(1.04)	(0.92)	(0.96)	(1.00)		(0.97)	(0.86)	(0.96)	(0.99)	
City and year											
Five cities in 2007	3,861	713	757	2,093	298	12.5%	853	224	934	82	8.1%
Five cities in 2009	2,723	564	479	1,470	210	12.5%	449	134	817	70	7.9%
Two cities in 2009	1,440	428	185	733	94	11.4%	326	36	332	39	10.5%
Total family income (million yen)											
Lowest (0–2.10)	1,887	462	299	922	204	18.1%	357	68	446	51	10.3%
Second (2.11–3.70)	1,908	398	391	982	137	12.2%	350	119	473	40	7.8%
Third (3.71–5.80)	1,836	374	339	1,009	114	10.2%	357	89	517	46	8.2%
Fourth (5.81–)	1,852	316	314	1,118	104	8.5%	409	100	566	43	7.1%
Total wealth (million yen)											
Lowest (–44.00–6.00)	1,624	362	275	825	162	16.4%	313	70	397	45	10.2%
Second (6.03–24.00)	1,544	254	293	873	124	12.4%	313	104	422	34	7.5%
Third (24.10–50.00)	1,619	267	318	930	104	10.1%	334	86	475	35	6.9%
Fourth (50.10–)	1,481	297	278	821	85	9.4%	302	73	410	36	8.1%
Number of past clinical diagnosis											
0	3,897	758	731	2,165	243	10.1%	798	185	1,091	91	7.7%
1	2,492	528	437	1,323	204	13.4%	459	131	673	60	8.2%
2	1,022	235	176	511	100	16.4%	183	58	239	31	11.5%
3 or more	320	100	38	149	33	18.1%	71	14	57	7	10.9%
IADL disability											
No disability	6,996	1,113	1,330	4,053	500	11.0%	1,518	374	1,992	169	7.8%
Any disability	512	126	83	207	96	31.7%	91	19	76	21	21.6%
IA disability											
No disability	5,808	883	1,127	3,419	379	10.0%	1,257	327	1,704	131	7.1%
Any disability	1,620	322	271	819	208	20.3%	337	66	358	58	13.9%
SR disability											
No disability	5,321	813	1,079	3,131	298	8.7%	1,150	289	1,564	128	7.6%
Any disability	2,153	402	327	1,129	295	20.7%	462	104	501	62	11.0%
ADL disability											
No disability	7,468	1,544	1,342	4,064	518	11.3%	1,473	388	2,022	181	8.2%
Any disability	376	118	51	137	70	33.8%	61	6	60	10	14.3%
Past mental disease diagnosis											
No	7,550	1,573	1,374	4,075	528	11.5%	1,482	384	2,030	179	8.1%
Yes	181	48	8	73	52	41.6%	29	4	30	10	25.0%

Note. Respondents with a CES-D score of 19 or higher were defined as being depressed. Onset of depression two years later means depression status of those who showed no incidence of depression at baseline two years later. Incorrect answer means choosing the same column for all 20 items in CES-D. IADL, instrumental activities of daily living; IA, intellectual activities; SR, social role; ADL activities of daily living.

Table 2. Odds ratio for occurrence of depression at two years after baseline in respondents who were not depressed at baseline

	Model 1	Model 2	Model 3	Model 4	Model 5
	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
Gender (ref: Male)					
Female	1.21[0.90,1.63]	0.99[0.65,1.51]	0.85[0.52,1.38]	1.12[0.72,1.74]	1.01[0.60,1.68]
Educational attainment (ref: 12 years)					
Less than 12 years	1.62[1.12,2.33]*	1.53[1.04,2.25]*	1.78[1.14,2.77]*	1.31[0.88,1.96]	1.50[0.94,2.38]
13–15 years	1.04[0.67,1.63]	1.01[0.64,1.59]	1.07[0.63,1.83]	0.97[0.61,1.54]	1.05[0.61,1.80]
16 years or more	0.78[0.47,1.30]	0.76[0.44,1.29]	0.84[0.46,1.54]	0.81[0.47,1.40]	0.93[0.50,1.72]
Marital status (ref: Married)					
Divorced	1.59[0.90,2.81]	1.71[0.95,3.09]	2.07[1.03,4.18]*	1.66[0.90,3.06]	2.16[1.04,4.47]*
Widowed	1.61[0.99,2.62]	1.48[0.89,2.49]	1.72[0.92,3.21]	1.46[0.86,2.50]	1.79[0.94,3.43]
Never Married	1.28[0.62,2.61]	1.64[0.71,3.78]	1.85[0.73,4.72]	1.67[0.71,3.93]	2.15[0.82,5.63]
Work status (ref: Full time worker)					
Part time worker	0.97[0.60,1.59]	0.86[0.50,1.47]	0.98[0.53,1.82]	0.82[0.47,1.41]	0.90[0.48,1.68]
Unemployed	0.97[0.37,2.55]	0.83[0.31,2.24]	0.98[0.31,3.03]	0.75[0.27,2.10]	0.84[0.26,2.74]
Retired	1.26[0.72,2.20]	1.31[0.74,2.31]	1.51[0.79,2.89]	1.27[0.71,2.28]	1.48[0.76,2.89]
Disabled	3.05[1.21,7.65]*	2.55[0.98,6.63]	2.10[0.69,6.44]	1.48[0.50,4.39]	1.14[0.31,4.22]
Not in labor force	1.42[0.89,2.28]	1.37[0.77,2.42]	1.56[0.79,3.06]	1.23[0.68,2.22]	1.25[0.61,2.53]
Self-employed	0.91[0.53,1.56]	0.88[0.51,1.52]	0.83[0.44,1.56]	0.90[0.52,1.56]	0.80[0.42,1.52]
Number of children	1.11[0.95,1.30]	1.16[0.97,1.39]	1.10[0.89,1.35]	1.17[0.97,1.41]	1.11[0.89,1.38]
City and year (ref: Five cities in 2009)					
Five cities in 2007	1.03[0.73,1.44]	1.02[0.72,1.45]	1.24[0.83,1.87]	1.03[0.72,1.48]	1.27[0.83,1.93]
Two cities in 2009	1.35[0.89,2.04]	1.25[0.81,1.94]	1.06[0.60,1.89]	1.17[0.74,1.85]	1.00[0.55,1.81]
Total family income (ref: Lowest quartile)					
2nd quartile	0.76[0.49,1.18]		0.81[0.46,1.42]		0.86[0.48,1.55]
3rd quartile	0.80[0.53,1.22]		1.18[0.67,2.09]		1.41[0.78,2.53]
Highest quartile	0.66[0.42,1.02]		0.88[0.46,1.65]		0.99[0.51,1.89]
Total wealth (ref: Lowest quartile)					
2nd quartile	0.74[0.46,1.18]		0.87[0.52,1.45]		0.98[0.58,1.65]
3rd quartile	0.69[0.43,1.10]		0.89[0.53,1.49]		0.98[0.57,1.67]
Highest quartile	0.82[0.52,1.30]		1.13[0.66,1.93]		1.09[0.62,1.91]
Number of past clinical diagnosis (ref: 0)					
1	1.09[0.77,1.54]			0.95[0.66,1.38]	1.00[0.65,1.54]
2	1.61[1.04,2.52]*			1.52[0.94,2.44]	1.71[1.00,2.92]*
3 or more	1.39[0.60,3.20]			1.26[0.53,3.00]	1.21[0.44,3.33]
IADL disability	3.30[1.96,5.54]**			2.50[1.34,4.67]**	2.44[1.21,4.93]*
IA disability	2.11[1.51,2.94]**			1.64[1.10,2.44]*	2.17[1.39,3.40]**
SR disability	1.52[1.10,2.09]*			1.00[0.68,1.47]	0.77[0.49,1.22]
ADL disability	1.91[0.96,3.80]			0.83[0.34,2.05]	0.88[0.33,2.37]
Past mental disease diagnosis	3.72[1.78,7.76]**			2.33[0.99,5.50]	2.59[0.99,6.77]
N		2164	1750	2109	1717

Note. Respondents with a CES-D score of 19 or higher were defined as being depressed. For dependent variable, respondents not depressed at both baseline and two years later were coded as 0 and respondents not depressed at baseline and depressed two years later were coded as 1. Depressed respondents at baseline were excluded. Model 1: adjusted for only each category of explanatory variable plus age and age squared. Model 2: adjusted for age, age squared, gender, educational attainment, marital status, work status, number of children, and city and group dummy. Model 3: adjusted for total family income and total wealth in addition to the variables entered in Model 2. Model 4: adjusted for health and function-related variables (number of past clinical diagnosis, past mental disease diagnosis, and disabilities in IADL, IA, SR and ADL) in addition to the variables entered in Model 2. Model 5: adjusted for all the variables mentioned above. IADL, instrumental activities of daily living: IA, intellectual activities; SR, social role; ADL, activities of daily living. * $p < 0.05$; ** $p < 0.01$.

Table 3. Odds ratio for occurrence of depression at two years after baseline in respondents who were not depressed at baseline (adjusting for each health and function-related variable)

	Model 6 OR [95% CI]	Model 7 OR [95% CI]	Model 8 OR [95% CI]	Model 9 OR [95% CI]	Model 10 OR [95% CI]	Model 11 OR [95% CI]	Model 12 OR [95% CI]	Model 4 OR [95% CI]
Educational attainment (ref: 12 years)								
Less than 12 years	1.52[1.03,2.24]*	1.52[1.03,2.25]*	1.42[0.95,2.10]	1.39[0.93,2.06]	1.47[0.99,2.18]	1.51[1.03,2.24]*	1.48[1.00,2.20]*	1.31[0.88,1.96]
13-15 years	0.98[0.62,1.56]	0.98[0.62,1.55]	0.97[0.61,1.54]	1.00[0.63,1.59]	0.98[0.62,1.56]	0.99[0.62,1.56]	0.96[0.61,1.53]	0.97[0.61,1.54]
16 years or more	0.75[0.44,1.29]	0.76[0.44,1.30]	0.77[0.45,1.32]	0.81[0.47,1.39]	0.77[0.45,1.31]	0.75[0.44,1.29]	0.75[0.44,1.29]	0.81[0.47,1.40]
Number of past clinical diagnosis (ref: none)								
1		0.95[0.66,1.38]						0.95[0.66,1.38]
2		1.61[1.01,2.56]*						1.52[0.94,2.44]
3 or more		1.29[0.54,3.04]						1.26[0.53,3.00]
IADL disability			3.12[1.75,5.57]**					2.50[1.34,4.67]**
IA disability				1.94[1.36,2.78]**				1.64[1.10,2.44]*
SR disability					1.29[0.90,1.83]			1.00[0.68,1.47]
ADL disability						1.29[0.56,2.96]		0.83[0.34,2.05]
Past mental disease diagnosis							2.62[1.14,6.03]*	2.33[0.99,5.50]
N	2109	2109	2109	2109	2109	2109	2109	2109

Note. Respondents with a CES-D score of 19 or higher were defined as being depressed. For dependent variable, respondents not depressed at both baseline and two years later were coded as 0 and respondents not depressed at baseline and depressed two years later were code as 1. Depressed respondents at baseline were excluded.

Model 6: The same as the Model 2 of Table 2 with the sample of Model 4 in Table 2. Model 7: Further adjusted for number of past clinical diagnosis in addition to the variables entered in Model 6. Model 8: Further adjusted for IADL disability in addition to the variables entered in Model 6. Model 9: Further adjusted for IA disability in addition to the variables entered in Model 6. Model 10: Further adjusted for SR disability in addition to the variables entered in Model 6. Model 11: Further adjusted for ADL disability in addition to the variables entered in Model 6. Model 12: Further adjusted for past mental disease diagnosis in addition to the variables entered in Model 6. Model 4: The same as Model 4 in Table 2. IADL, instrumental activities of daily living; IA, intellectual activities; SR, social role; ADL, activities of daily living.

* $p < 0.05$; ** $p < 0.01$.

Table 4. Odds ratio for occurrence of disabilities in IADL, IA, and SR at two years after baseline in respondents who were free from the disabilities at baseline

Dependent variables	Onset of IADL disability	Onset of IADL disability	Onset of IA disability	Onset of IA disability	Onset of SR disability	Onset of SR disability
	Model 13	Model 14	Model 15	Model 16	Model 17	Model 18
	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
Educational attainment (ref: 12 years)						
Less than 12 years	1.63[1.20,2.21]**	1.51[1.05,2.18]*	1.55[1.26,1.90]**	1.48[1.15,1.92]**	0.95[0.78,1.15]	0.94[0.74,1.18]
13–15 years	0.84[0.51,1.41]	0.85[0.46,1.58]	0.67[0.48,0.91]*	0.84[0.59,1.21]	1.04[0.82,1.32]	1.07[0.80,1.43]
16 years or more	0.55[0.30,1.03]	0.61[0.32,1.16]	0.56[0.40,0.79]**	0.51[0.34,0.75]**	1.07[0.83,1.38]	0.85[0.63,1.16]
N	4978	3862	4170	3237	3811	2959

Note. For dependent variables, respondents not having disabilities in IADL (IA, SR) both at baseline and two years later were coded as 0 and respondents not having disabilities in IADL (IA, SR) at baseline and having disabilities two years later were code as 1. In Model 13, Model 15, and Model 17, educational attainment, age and age squared were adjusted for. In Model 14, Model 16, and Model 18, educational attainment, age, age squared, gender, marital status, work status, number of children, city and year dummy, total family income, total wealth, number of past clinical diagnoses, and past mental disease diagnosis were adjusted for. IADL, instrumental activities of daily living; IA, intellectual activities; SR, social role. * $p < 0.05$; ** $p < 0.01$.