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Abstract

Despite extensive research published in economic, psychological, and public health literature, a consensual view on the causal influence of leaving paid work on health, functions, lifestyle behavior, and social participation has not been reached. Recent review studies indicate that heterogeneous characteristics of the pre-retired should be accounted for to reveal the impact of leaving paid work. Related evidence is scarce in Japan where the effective retirement age is the highest among developed countries. We used panel data from the Japanese Study of Aging and Retirement (JSTAR) to fill this knowledge gap. Using propensity-matching difference-in-difference estimation stratified by age strata (under 65 vs. 65 and over), gender, and job characteristics, we find that transitioning from paid work status to retirement exerts limited impact on cognitive function, mobility, smoking behavior, body mass index, psychological distress, hypertension prevalence, fruit intake, and social participation to voluntary services. However, some segments of older people seem more vulnerable to specific impacts, e.g., men formerly engaged in white-collar jobs and secured jobs, or older women with unsecured jobs showed a negative impact on cognitive function, while men with stressful jobs show a reduced prevalence of hypertension after retirement. We argue that the heterogeneity of the population at retirement age should be considered to specify causal pathways and policy implications of health impacts after leaving paid work more effectively.

Keywords: Retirement, Cognitive function, Lifestyle behavior, Social participation, Gender difference, Propensity-matched difference-in-difference analysis
JEL classification: I12, J14, J26

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I. Background

Retirement and its impact on retiree's health status have been investigated by a large number of studies in the economics, psychological, and public health literature [Behncke 2012; Bound 1989; Bound and Waidman 2007; Coe and Zammaro 2011; Dave, Rashad, and Spasojevic 2006; Fe and Hollingsworth 2011; Gallo, Bradley, Siegel and Kasl 2000; Mojon-Azzi, Sousa-Poza, and Widmer 2007; Moon Glymour Suburamanian, Avendano, and Kawachi 2012; Sjo¨sten, Kivima¨ki, Singh-Manoux, et al. 2012; Lindeboom and Lindegaard, 2010; Westerlund Vahtera, Ferrie, et al. 2010; Zins, Gueguen, Kivimaki, et al. 2011]. Most recently, there have been published several review papers on the health impact of retirement [Barnett, van Sluijs, and Ogilvie, 2012; Wang and Shi, 2014; van der Heide, et al. 2013; Banks, Chandola and Matthews, 2015], though the current consensus on the causal relationship between retirement and health states is that it is not simple.

Several sources are attributable to mixed findings; most notable is the heterogeneity of life trajectories of the population in retirement age. To obtain their detailed pictures requires comprehensive measurement of socio-economic and health trajectories of older people living in community in longitudinal design [Banks, Chandola and Matthews 2015]. Besides, the nature of targeted health outcomes is diverse and depends on different bio-psychological pathways, e.g. hypertension may be quickly responsive to job-induced psychological stress, while cancer would be more related to smoking and other behavioral risk factors with years-long latent time until onset.

Another source of inconsistency may be derived from diversity in referred theories. Economists often used human capital theory to model the effect of retirement on health [Grossman 1972], though its implications for health investment after leaving paid work are somewhat vague [Dave, Rashad, and Spasojevic 2006]. Retirement may reduce time cost for health investment, resulting in better health. Conversely, less availability of economic and social resources after retirement may cause health worsening.

Instead, many gerontologists and psychologists increasingly rely on "role theory" and "life course theory" [Wang, Henkens, and van Solinge, 2011]. These theories regard retirement as a transition from work-related roles (e.g., as worker, or as organizational member) to other social roles, and transitions in social roles affect the wellbeing of older people through affecting psychological, tangible, and social resources [Mein, Higgs, Ferrie, and Stansfeld 1998]. Studies on social relationship and elderly wellbeing have consistently found that older people who enjoy frequent social interaction have better physical, mental, and cognitive prognoses, and better survival after illness [Sugisawa, Sugisawa, Nakatani, and Shibata 1997: Sirven and Debrand 2008].

Consistent with the role theory, labor participation in later life could be beneficial by allowing access to economic investment on health, and/or opportunities for health-generating social participation. One could argue, however, whether all types of labor participation can be health generating. Some types of labor have a deleterious effect on health (e.g., jobs with higher stress, hazardous toxic exposure, and excessive physical strain). Models published in the economic and social psychological literature have often failed to incorporate differences in retirement-health association across occupational types [van der Heide, et al. 2013]. In their panel survey of UK civil servants, Mein et al. (2003) found that retirement was related to stress reduction in workers of higher occupational class, but not for those in lower occupational class, indicating that the types of health stock (e.g., physical, mental, cognitive, functional and social aspects) may be differently affected by retirement, depending on the nature of pre-retirement occupational types and required capability.

The role theory also indicates that the trajectory to retirement matters. Some workers may engage in full-time work with full commitment to formal job, then suddenly move to full retirement without any roles, or shift to other roles in community. Others gradually move from full-time work to part-time job before full retirement [Ichimura and Shimizutani, 2012]. Women tended to participate part-time based job with concurrent roles in households, while men under classic bread-earner gender role may be more likely to face sudden change in roles. A drastic change in roles needs psychological adjustment which will affect health consequences [Wang, Henkens, and van Solinge, 2011].

In this paper, we intended to add evidence from Japanese context on the ongoing discussion over health impact of leaving paid work status in one's later life. Japan's proportion of aged 65 and over in the population reached 26 % as of May 2015 [Ministry of Internal Affairs and Communication, 2015], the highest number on the globe. Its legal minimum age for retirement is currently set at 60 years old, though its effective retirement age already reached 69 years old in males [OECD, 2013]. The government announced gradual upshift of legal minimum retirement age to 65 to induce further labor participation of old people, expecting improved financial sustainability of the country. Despite of the frontline situation of population ageing, evidence on the causal impact of leaving paid work onto retiree's wellbeing has been very scarce in this country due to limited data availability.

We overcome previous stagnation by use of a panel data newly available from the Japanese Study on Ageing and Retirement (JSTAR).[2] JSTAR is a sister survey with US Health and Retirement Study, Study of Health Ageing and Retirement in Europe, and their alliance of global harmonization [Ichimura, Hashimoto, and Shimizutani 2009]. JSTAR interviews consist of questions about current employment status, type of employment, job stresses, expectation of compulsory retirement, pension eligibility, and various measures of health (e.g., functional, cognitive, and

[2] The Japanese Study of Aging and Retirement (JSTAR) was conducted by the Research Institute of Economy, Trade and Industry (RIETI), Hitotsubashi University, and the University of Tokyo.

mental) and health related behaviors (smoking and nutrition intake). A supplemental questionnaire collected information about social network participation. The rich data of the JSTAR would allow us to specify any causal impact of work status transitions onto health behaviors, functions, and health status in specific segments of retirees characterized by age, gender, and job characteristics.

Using a panel data of wave 1 (in 2007) and 2 (in 2010) conducted in 5 cities, we identified that the health impact of leaving paid work was small for the majority of older workers in any of targeted health-related outcomes, though some segments of older retirees were more vulnerable to health impact after the status transition. For example, decreased cognitive function was observed in males formerly engaged in white-collar job, women age 65 and over, and women formerly engaged in job without job security; psychological distress after leaving paid work was likely among men formerly engaged in regular employment and with job security; and hypertension prevalence was decreased among men formerly with higher job stress. In the final section, we discuss implications of our results for ongoing labor policies in ageing society like Japan, and the strategy to further extend research on the causal inference of leaving paid work on wellbeing of older people.

II. Analytic model and data description

Previous studies on retirement and health have tackled the problem of model misspecification due to reverse causation and unmeasured heterogeneity in determinants of retirement and health, and there were used several strategies to countermeasure related biases. Dave, Rashad and Spasojevic (2006) relied on the fixed effects model to account for time-invariant unobserved heterogeneity in the use of panel data of Health and Retirement Study. They limited their participants to those without health conditions at the baseline to prevent reverse causation from health to retirement. However, they did not explicitly control for the retirement selection process in their model. Alternatively, Coe and Zammaro (2008) used the age of compulsory retirement across different countries participating in the Study of Health, Ageing and Retirement in Europe as an exogenous instrument for retirement. Although the instrument was tested by Hansen's J test, physiological age is a strong predictor of various health conditions, and at least theoretically, it could relate to health conditions via a path other than retirement.[3] Another strategy was adopted by Behnck (2010) where propensity to predict the likelihood of retirement in the subsequent wave was matched. However, there remained possible misspecification due to unobserved confounders.

[3] We did try to find a suitable instrumental variable for the purpose. Candidate variables were 1) age 65 dummy variable for pension eligibility age, 2) a dummy variable to indicate a within-two-year interval between stated compulsory retirement and current age, and 3) home ownership and home loan. However, any of the variables or their combinations did not reach statistical significance in Wu-Hausman's test after 2SLS regression.

To overcome pitfalls in the previous studies, we chose to adopt propensity-matching difference-in-difference approach to account for the likelihood of work status transition, while controlling for unobserved time-invariant confounders. Propensity to predict leaving the status of paid work at wave 2 was obtained by logistic regression model regressing on demographic, economic, social, and health conditions at the time of wave 1 to prevent reverse causation from health to retirement, following Dave, Rashad, and Spasojevic (2006). Then the matched pairs of those actually left paid work status (treated) and those remained at work status (control) were compared in terms of their health/behavioral differentials between wave 1 and wave 2.

In the JSTAR, we have a variety of health measures such as self-reported health status (SRH), instrumental activities of daily life (IADL), grip strength, psychological depression measured with the Center of Epidemiology Studies Depression scale (CESD), self-reported comorbidities (e.g. heart disease, stroke, cancer, etc.), and cognitive functions measured in word recall test. Among them, we chose cognitive function, grip strength, body mass index, psychological depression, and comorbidity of hypertension for reasons we argue shortly.

Grip strength is the most objective measurement of physical health among available measurement in JSTAR, and is known to predict the prognosis of survivorship and functional independence [Shibata, et al. 1992]. Most recently, the measurement of grip strength and body mass index is regarded as a sensitive indicator of sarcopenia, or pathological loss of skeletal muscle, resulting in functional decline and increased mortality among older people [the European Working Group on Sarcopenia in Older People, 2010]

JSTAR included comorbidities of chronic conditions such as heart disease, stroke, diabetes, and cancer, and some previous studies found the number of chronic conditions increased after retirement [Dave, Rashad, and Spasojevic, 2006]. We chose not to use the number of comorbidities because many of these conditions are more likely to result from life-course accumulation of risk factors after years-long latent time until onset rather than to happen as a temporal event induced by retirement. Moreover, self-report of comorbidity is more likely to be biased by one's availability of healthcare, which may be improved after retirement thanks to less time constraints especially under public health insurance coverage for older people in many developed countries. Instead, we chose hypertension as a targeted chronic condition because the status is very prevalent already even among 50s and 60s (about 60%) [the Japanese Society of Hypertension, 2014], and is known to be affected by physiological as well as psychological stress [Steptoe, 2008], likely to be responsive to changes in socio-psychological environments before/after retirement.

JSTAR as well as HRS adopted a depression screening scale called the Center of Epidemiology Study on Depression (CESD). The scale comprises of 20 items, and the sum score was dichotomized at the cutoff point of 6 points, following previous recommendations [Shima, 1998].

Depression was counted as an important health outcome after leaving paid work, by referring to previous studies on retirement and depression (Dave, Rashad and Spasojevic, 2006; Jokela, et al. 2010).

Cognitive function is also an important function affected by change in cognitive demand in daily lives as is discussed in Coe and Zammaro (2008). The function is also influenced by age-related diseases (e.g. Alzheimer disease) and one's educational achievement, of which impacts are rather time-invariant. In JSTAR, HRS, and their sister surveys, word recall measurement asks respondents to remember names of 10 objects (nouns) in presented cards, then to immediately recall as many as possible (Ofstedal, Fisher and Herzog, 2005). The count of correct answers ranges 0-10, reflecting short-term working memory and vocabulary abilities. We used initial word recall just after card presentation in our analysis as a marker of cognitive function.

We also counted behavioral change such as smoking and fruit intake[4] as well-known risk factors for various chronic conditions. Previous studies found that retirement may change life style behaviors such as smoking, habitual exercise, sleep, and food intake [Coe and Zammaro, 2011;Eibch, 2015].

Our sample was limited to those who were engaged in paid work at wave 1, and participated in wave 2 survey. Panel attrition may be a serious source of bias if attrition patterns were related to job characteristics and health-related changes. Appendix table 1 showed attrition patterns between wave 1 and wave 2 by work status and reasons of attrition. In this targeted population, attrition rate was about 27% in both genders. Regular employment workers and self-employed persons tended to refuse to participate the study at wave 2 by reasons other than health related causes.

We stratified our sample by age strata and genders because these features are likely to differentiate trajectories towards retirement. We divided the sample to age less than 65 vs. aged 65 and over. We chose this year because it is related to the legal eligibility for public pension.

The propensity of leaving paid work at wave 2 was obtained by regressing on age, educational achievement, economic, social, and health conditions at the time of wave 1, and regional dummy variables. Economic factors included income (log transformed), and work conditions (regular employment contract, full-time (>35hours per week), job security, expected compulsory retirement, and job stress measured in demand/control ratio). Social factors included respondent's participation to voluntary community services. Finally, health conditions included grip strength, body mass index (BMI), mobility limitation, depression (>16 points in CESD measure), current smoker status, energy adjusted daily fruit intake, and hypertension.

The predictive model of propensity score was constructed using a free-shared command

[4] Nutrition intake was measured using a validated dietary habit questionnaire (Kobayashi, et al. 2011)

of “pscore” in STATA with logistic regression with checking balanced distribution of included predictor variables. Then, one-to-one propensity score matching was conducted with “teffects psmatch” command available in STATA 13. All the procedures obtained Average Treatment Effect on the Treated (ATET) rather than Average Treatment Effect (ATE).

Because JSTAR data contained non-ignorable missing values in the dataset, we conducted multiple imputation with chained equations, following a recent recommendation [Ramaniuk, Patton, and Carlin, 2014]. Specifically, we used “mi impute chained” command in STATA 13, and created 100 cycles of datasets. The results of each dataset were combined following Rubin’s combination rule [Rubin, 1996]. The results of imputation were presented in Appendix table 2. Cognitive function at wave 2 had the largest proportion of imputation (22%).

III. Empirical results

Table 1 shows the descriptive statistics of 4 sample strata by age and gender after imputation. Leaving paid job at wave 2 was observed in 7.5% of males younger than 65, 13.2% of females younger than 65, 23.6% of males aged 65 and over, and 19.4% of females aged 65 and over.

Quick eye-ball observation can confirm that grip strength were decreased in all strata of the sample as they aged by 2 years. To the contrary, it may be surprising to see word recall was improved rather than declined over waves, and the score was higher in older strata of samples in both genders. It may be due to learning effects at wave 2 and differential cognitive efforts among older people at work. Fruit intake was decreased, and the proportion of psychological distress was increased over waves, except for younger males. BMI seemed relatively stable over waves. The proportion of current smoking was decreased, and that of hypertension was increased in all sample strata. Finally, income levels and social participation were decreased over time in all sample strata. Income levels were higher among males than females, while social participation rate was higher among females than males.

As for job characteristics, the proportion of regular employment contract at wave 1 was differential across age strata and genders; most frequent among males younger than 65 (56.3%), followed by males aged 65 and over (23.8%). To the contrary, the proportion of engagement in part-time job defined as less than 35 hours per week was the highest among 65+ females (61.9%), followed by 65+ males (52.1%). About 36% of women reported job-related stress at wave 1, compared to 23.8% among males <65. Job security was similarly observed across sample strata.

Tables 2 exhibits the estimated average treatment effects by leaving paid work for males. The extreme left column shows the results for all the male sample. None of t-statistics for studied outcomes reached conventional significant levels. Of all outcomes, cognitive function was declined after retirement (ATET=-0.350 words, t=-1.24) for all male workers. A closer look further shows that cognitive decline was marginally observed in males formerly engaged in white-collar jobs (ATET=-0.721, t=-1.65).

Change in grip strength, BMI, smoking behavior, and mobility limitation was virtually null across subsamples of males. Unexpectedly, income gap before/after leaving paid work was also null, though the gap was relatively larger among former white-collar workers. As for depression, those with regular employment and secured job showed relatively larger positive impact, though did not reach conventional significant levels. As for hypertension, those with stressful job showed a relatively larger reduction in the prevalence (ATET=-0.143, t=-1.55), which may be compatible with previous reports on the association between cardiovascular risks and job stress among men [Jokela, et al. 2012]. There was no observable change in the likelihood of social participation in males.

Table 3 shows the estimation results for women. The extreme left column shows the results for all the female sample. Contra to their male counterparts, women showed a significant decrease in income (ATET=-0.925, t=-2.23). Another difference between genders was found in larger positive change in grip strength and BMI, and larger negative change in fruit intake among women, though none of them reached conventional significant levels. A closer look at subsamples shows that women age 65 and over, and formerly with less secured job tended to show a decline in cognitive functions (ATET=-0.813, t=-1.90; ATET=-0.878, t=-1.87, respectively) and those formerly with secured and less stressful job tended to increase the likelihood of social participation (ATET=0.120, t=1.31; ATET=0.132, t=1.47, respectively)

IV. Discussion and Conclusion

Our results imply that health impact by leaving paid job is relatively small, but it should be noted that we could identify a "high risk" segment of retirees according to the nature of outcomes, pre-retirement job characteristics, and demographics. Transition in work status in JSTAR participants itself was diverse and gradual [Ichimura and Shimizutani, 2012]. In our analysis, we focused on "leaving paid work" as a transition event. Leaving paid work may imply a loss of labor income, a relief from social responsibility as a bread earner, or a loss of social roles [Chaix, Isacsson, et al. 2007]. One may choose to shift from full-time work to retirement, taking into consideration loss of income against gain in leisure, health investment, family care, or simply availability of job opportunity. In our analyses, income reduction was more magnificently observed among women, but not among men. Instead, depression was more likely to be observed among men with regular contract and job security, who may have larger commitment to work life before retirement. Leaving paid work status could be related to the likelihood of newly participating in some type of social networks, though our estimation did not show significant impact of leaving paid work onto the likelihood of social participation, especially among men.

The tendency of declined cognitive function after leaving paid work was in accord with what the role theory predicts. Those who had been with secured job may face a gap in social role when they loses their role as an employee, while workers with less job security may have been better prepared for role transitions. However, the role theory does not seem to explain well why older female engaged in unsecured job had the most observable negative impact on cognitive function by leaving paid job. These women tended to be less educated, were least likely to be married, and were least likely to be engaged in fulltime job. Thus, this segment of female workers may face limited social and economic resources after retirement, which may be related to their vulnerability to work status transitions. This may also explain a drastic drop in fruit intake in the same segment of women. To the contrary, majority of younger females worked as a part-time basis, and their balance between roles as a worker and as a homemaker may allow this segment of female workers to obtain richer role repertoire and economic security that may make them proof against cognitive decline due to status transitions.

Our results may indicate female workers with poor job conditions, and less socio-economic resource would face a higher risk of decline in functional and health status because of less resource availability, as the Human Capital theory partially predicts. The current system of public pension and healthcare insurances are biasedly weak to cover this segment of retirees, and should be improved for better economic and social security.

To the contrary, mental depression and cognitive decline observed among males with more commitment to regular and secured job would be better explained by the role theory. This segment of male retirees may be benefited from educational intervention to develop skills for post-retirement lives in the community. Otherwise, retirement is less likely to be a major health threat in older people, at least for an intermediate interval of time that we investigated.

Before we conclude, we have to admit limitations in our analytic strategies. Propensity-matching difference-in-difference approach we adopted may not treat well time-variant conditions, among which the most important will be the change in income. As we mentioned, our analyses showed income drop after retirement was observed in women, but not in men. According to the permanent income theory, the household expenditure should not receive a sudden impact at the time of work status transition thanks to saving. Besides, in Japanese full-time workers, retirement will be accompanied by lump-sum retirement allowance, which should also smooth the household expenditure level before/after retirement. However, women may not receive the same benefit as men do. At least, change observed among men is not likely to be explained by income change, but more likely to result from behavioral and psychological response to role transitions.

References

- Banks J, Chandola T, and Matthews K.(2015) Retirement and Health. In. International Encyclopedia of the Social and Behavioral Sciences, 2nd eds. Pp598-601.
- Barnett I, van Sluijs EM, Ogilvie D.(2012) Physical activity and transitioning to retirement: a systematic review. Am J Prev Med. 43(3):329-36. doi: 10.1016/j.amepre.2012.05.026.
- Behncke S. (2012) Does Retirement Trigger Ill Health? Health Econ. 21(3):282-300. doi: 10.1002/hec.1712.
- Bound J. (1989) Self-reported vs. Objective Measures of Health in Retirement Model. Working Paper Series, No. 2997, National Bureau of Economic Research (NBER) .
- Bound J, Waidman T. (2007) Estimating the Health Effects of Retirement. Prepared for the 9th Annual Joint Conference of the Retirement Research Consortium “Challenges and Solutions for Retirement Security” August 9-10, 2007. Washington, D.C.
- Chaix B, Isacsson SO, Råstam L, Lindström M, Merlo J.(2007) Income change at retirement, neighbourhood-based social support, and ischaemic heart disease: results from the prospective cohort study "Men born in 1914". Soc Sci Med. 64(4):818-29.
- Coe NB, Zamarro G. (2011) Retirement Effects on Health in Europe. J Health Econ 30(1):77-86.
- Dave D, Rashad I, Spasojevic J.(2006) “The Effects of Retirement on Physical and Mental Health Outcomes," Working Paper Series, No. 12123, National Bureau of Economic Research (NBER) .
- Eibich P.(2015) Understanding the effect of retirement on health: mechanisms and heterogeneity. J Health Econ. 3:43:1-12. doi:10.1016/j.healtheco.2015.05.001.
- The European Working Group on Sarcopenia in Older People. (2010) Sacropenia: European consensus on definition and diagnosis. Age and Ageing, 39:412-423.
- Fe E. Hollingsworth B. (2011) Estimating the effect or retirement on health via panel discontinuity designs. http://mpra.ub.uni-muenchen.de/38162/
- Gallo WT, Bradley EH, Siegel M, Kasl SV. (2000) Health effects of involuntary job loss among older workers. J Gerontol B Psychol Sci Soc Sci. 55(3):S131-40.
- Grossman M.(1972) “On the Concept of Health Capital and the Demand for Health," J Politic Econ. 80 (2); 223-255.
- Gupta ND, Larsen M.(2010) The impact of health on individual retirement plans: self-reported versus diagnostic measures. Health Econ. 19(7); 792-813.
- Ichimura H, Hashimoto H, Shimizutani S.(2009) Japanese Study on Aging and Retirement (JSTAR) First Results; 2009 Report. RIETI Discussion Paper Series 09-E-047. Research Institute of Economy, Trade, and Industry Japan. http://www.rieti.go.jp/jp/publications/dp/09e047.pdf
- Ichimura H, Shimizutani S. (2012) "Retirement Process in Japan: New Evidence from Japanese

Study on Aging and Retirement (JSTAR)" In Aging in Asia: Findings from New and Emerging Data Initiatives. Smith JP, Majmundar M, Eds. Panel on Policy Research and Data Needs to Meet the Challenge of Aging in Asia. Committee on Population, Division of Behavioral and Social Sciences and Education. Washington, DC: *The National Academies Press*, 2012, pp. 173-204.

- The Japanese Society of Hypertention.(2014) Guidelines for the management of hypertension. (JSH2014) Chapter 1: Epidemiology of hypertension. Hypert Res. 37, 260-265. Doi:10.1038/hr.2014.4
- Kobayashi S, Murakami K, Sasaki S, et al.(2011) Comparison of relative validity of food group intakes estimated by comprehensive and brief-type self-administered diet history questionnaires against 16 d dietary records in Japanese adults. Public Health Nutr. 14(7):1200-11.
- Lindeboom M. Lindegaard H. (2010) The Impact of Early Retirement on Health Available at SSRN: http://ssrn.com/abstract=1672025 or http://dx.doi.org/10.2139/ssrn.1672025.
- Jokela M, Ferrie JE, Gimeno D, Chandola T, Shipley MJ, Head J, Vahtera J, Westerlund H, Marmot MG, Kivimäki M. (2010) From midlife to early old age: Health trajectories associated with Retirement. Epidemiology. 21(3): 284–290. doi:10.1097/EDE.0b013e3181d61f53.
- Mein G, Martikainen P, Hemingway H, Stansfeld S, Marmot M.(2003) Is retirement good or bad for mental and physical health functioning? Whitehall II longitudinal study of civil servants. J Epidemiol Community Health. 57:46–49.
- Mein G, Higgs P, Ferrie J, Stansfeld SA.(1998) Paradigms of retirement: the importance of health and ageing in the Whitehall II study. Soc Sci Med. 47(4):535-45.
- Ministry of Internal Affairs and Communication. (2015) Monthly report; Population estimates by age and sex. http://www.stat.go.jp/english/data/jinsui/tsuki/index.htm (last access June 13, 2015)
- Mojon-Azzi S, Sousa-Poza A, Widmer R. (2007) The effect of retirement on health: a panel analysis using data from the Swiss Household Panel. SWISS MED WKLY. 137:581–585.
- Moon JR, Glymour MM, Subramanian SV, Avendaño M, Kawachi I.(2012) Transition to retirement and risk of cardiovascular disease: prospective analysis of the US health and retirement study. Soc Sci Med. 75(3):526-30. doi: 10.1016/j.socscimed.2012.04.004.
- OECD (2013) Pension at a glance 2013. pp129
- Ofstedal MB, Fisher GG, and Herzog AR for the HRS Health Working Group. Documentation of cognitive functioning measures in the Health and Retirement Study. Survey Research Center, University of Michigan, Ann Arbor, MI. 2005 HRS Documentation Report DR-006, March 2005.

- Romaniuk H, Patton GC, Carlin JB. Multiple imputation in a longitudinal cohort study: a case study of sensitivity to imputation methods.(2014) Am J Epidemiol. 180(9):920-32. doi: 10.1093/aje/kwu224.
- Rubin, D.B. (1996) Multiple imputation after 18+ years (with discussion). *Journal of the American Statistical Association*, 91, 473-489.
- Shibata H, Haga H, Ngai H, Suyama Y, Yasumura S, Koyano W, Suzuki T.(1992) Predictors of all –cause mortality between ages 70 and 80; the Koganei study. Arch Gerontol Geriat 14(3), 283-297.
- Shima S. CES-D Scale.(1998) Chiba test center, Tokyo
- Sirven N, Debrand T.(2008) Social participation and healthy ageing: an international comparison using SHARE data. Soc Sci Med. 67(12):2017-26. doi: 10.1016/j.socscimed.2008.09.056.
- Sjo¨sten NM, Kivima¨ki M, Singh-Manoux A, et al.(2012) Change in physical activity and weight in relation to retirement: the French GAZEL Cohort Study. BMJ Open. 2:e000522. doi:10.1136/bmjopen-2011-000522
- Steptoe A.(2008) Psychophysiological stress reactivity and hypertension. 52,220-221. doi:10.111/HYPERTENSIONAHA.108.115477.
- Sugisawa A, Sugisawa H, Nakatani Y, Shibata H. (1997) Effect of retirement on mental health and social well-being among elderly Japanese. *Nippon Koshu Eisei Zasshi (Japanese Journal of Public Health)*. 44, 123-130.
- van der Heide I, van Rijn RM, Robroek SJ, Burdorf A, Proper KI.(2013) Is retirement good for your health? A systematic review of longitudinal studies. BMC Public Health. 13:1180. doi: 10.1186/1471-2458-13-1180.
- Wang, M., Henkens, K., & van Solinge, H. (2011) Retirement Adjustment: A Review of Theoretical and Empirical Advancements. *American Psychologist*. doi: 10.1037/a0022414
- Wang M, Shi J.(2014) Psychological research on retirement. Annu Rev Psychol. 65:209-33. doi: 10.1146/annurev-psych-010213-115131.
- Westerlund H, Vahtera J, Ferrie JE, Singh-Manoux A, Pentti J, Melchior M, Leineweber C, Jokela M, Siegrist J, Goldberg M, Zins M, Kivima¨ki M. (2010) Effect of retirement on major chronic conditions and fatigue: French GAZEL occupational cohort study. BMJ. 341:c6149 doi:10.1136/bmj.c6149.
- Zins M, Gue´guen A, Kivimaki M, Singh-Manoux A, Leclerc A, et al. (2011) Effect of Retirement on Alcohol Consumption: Longitudinal Evidence from the French Gazel Cohort Study. PLoS ONE. 6(10): e26531. doi:10.1371/journal.pone.0026531.

Table 1. Descriptive statistics

	male 65-		female 65-		male 65 and over		female 65 and over	
	mean	std err	mean	std err	mean	std err	mean	std err
age	57.546	0.141	57.552	0.182	69.162	0.175	68.806	0.223
married at wave1	0.877	0.012	0.775	0.020	0.946	0.013	0.671	0.036
married at wave2	0.875	0.013	0.768	0.020	0.943	0.013	0.653	0.037
high school education	0.413	0.019	0.517	0.024	0.350	0.027	0.406	0.038
college and over	0.359	0.018	0.305	0.022	0.140	0.020	0.088	0.022
retired at wave 2	0.075	0.010	0.132	0.016	0.236	0.024	0.194	0.030
grip strength (kg) at wave 1	38.655	0.241	24.253	0.210	33.225	0.334	21.771	0.319
grip strength (kg) at wave 2	37.230	0.252	23.854	0.222	31.902	0.332	21.351	0.324
word recall at wave1	5.225	0.061	5.694	0.071	4.614	0.092	5.141	0.101
word recall at wave2	5.592	0.072	6.050	0.083	4.968	0.106	5.347	0.126
fruit intake (g/day/1000kcal) at wave1	46.159	1.492	77.083	2.488	63.708	2.842	91.373	4.690
fruit intake (g/day/1000kcal) at wave2	48.281	1.652	67.993	2.618	61.423	2.756	76.288	3.710
body mass index (kg/m^2) at wave1	23.529	0.116	22.975	0.178	23.622	0.174	23.070	0.269
body mass index (kg/m^2) at wave2	23.451	0.109	22.810	0.157	23.328	0.159	23.218	0.268
psychological distress (CESD>16) at wave1	0.149	0.014	0.152	0.017	0.108	0.018	0.097	0.024
psychological distress (CESD>16) at wave2	0.149	0.014	0.188	0.019	0.156	0.022	0.126	0.028
smoking at wave1	0.432	0.019	0.149	0.017	0.253	0.025	0.061	0.019
smoking at wave2	0.416	0.019	0.125	0.016	0.230	0.024	0.052	0.018
mobility limitation (1 if any exists) at wave1	0.040	0.007	0.095	0.014	0.115	0.018	0.265	0.034
mobility limitation (1 if any exists) at wave2	0.048	0.008	0.068	0.012	0.131	0.019	0.247	0.033
hypertension at wave1	0.268	0.017	0.210	0.019	0.347	0.027	0.371	0.037
hypertension at wave2	0.302	0.017	0.219	0.019	0.392	0.028	0.429	0.038
ln_income at wave1	5.655	0.069	5.404	0.085	5.369	0.104	5.100	0.150
ln_income at wave2	5.177	0.087	5.029	0.100	4.955	0.127	4.628	0.181
social participation at wave1	0.289	0.017	0.199	0.020	0.325	0.028	0.259	0.036
social participation at wave2	0.211	0.016	0.174	0.018	0.292	0.026	0.201	0.032
"regular employment" at wave 1	0.563	0.019	0.238	0.020	0.153	0.020	0.088	0.022
labor hour<35 hrs per week at wave1	0.122	0.013	0.521	0.024	0.414	0.029	0.619	0.040
white color job at wave1	0.557	0.019	0.776	0.020	0.506	0.029	0.694	0.036
stressful job at wave 1 (demand/control>1)	0.238	0.016	0.276	0.021	0.363	0.027	0.376	0.037
job secutiry at wave 1	0.718	0.017	0.737	0.021	0.701	0.026	0.729	0.034

Table 2. Estimated Average Treatment Effect in Treated of Leaving Paid Job (Male)

	total (male)		Age less than 65		Age 65 or over		Regular employment		Non-regular		Labor >35hrs/w		Labor<=35hrs/w	
Outcomes	ATET	t-stat	ATET	t-stat	ATET	t-stat	ATET	t-stat	ATET	t-stat	ATET	t-stat	ATET	t-stat
cognitive function	-0.350	-1.24	-0.319	-0.74	-0.481	-1.27	-0.423	-0.82	-0.265	-0.75	-0.373	-1.05	-0.445	-1.03
grip strength (kg)	-0.007	-0.01	-0.998	-0.75	0.903	0.91	-0.745	-0.73	0.678	0.63	-0.583	-0.53	0.912	0.80
body mass index (kg/m^2)	-0.073	-0.23	0.120	0.26	-0.237	-0.58	0.217	0.43	-0.192	-0.46	0.032	0.07	-0.194	-0.44
fruit intake (g/day/1000kcal)	2.966	0.36	3.410	0.33	1.719	0.15	2.716	0.26	3.455	0.34	1.910	0.20	0.028	0.00
income gap (ln transformed)	-0.292	-0.86	-0.477	-0.98	-0.101	-0.19	-0.498	-1.08	-0.127	-0.27	-0.248	-0.58	-0.577	-1.09
smoking	-0.004	-0.08	-0.033	-0.50	0.018	0.32	-0.063	-0.99	0.024	0.47	-0.010	-0.08	-0.016	-0.23
mobility limitation (1 if any exists)	0.042	0.78	0.003	0.05	0.041	0.54	0.020	0.35	0.033	0.43	0.029	0.42	0.041	0.45
psychological distress (CESD>16)	0.069	1.04	0.129	1.20	0.018	0.23	0.182	1.60	0.008	0.11	0.087	1.04	0.029	0.28
hypertension	-0.006	-0.12	0.022	0.29	-0.010	-0.13	0.040	0.49	-0.038	-0.57	0.027	0.39	-0.070	-0.76
social participation	0.049	0.62	0.024	0.21	0.036	0.35	0.100	0.88	0.029	0.26	0.045	0.46	0.005	0.04

	White-collar		Blue-collar		Job secured at wave1		Job not secured		Stressful job at wave 1		Less stressful job	
Outcomes	ATET	t-stat	ATET	t-stat	ATET	t-stat	ATET	t-stat	ATET	t-stat	ATET	t-stat
cognitive function	-0.721	-1.65	-0.012	-0.03	-0.278	-0.82	-0.522	-1.09	-0.291	-0.71	-0.521	-1.52
grip strength (kg)	-0.489	-0.43	0.662	0.66	0.327	0.35	-0.400	-0.35	0.732	0.56	-0.396	-0.44
body mass index (kg/m^2)	0.094	0.22	-0.249	-0.53	-0.235	-0.54	0.094	0.21	-0.451	-0.91	0.039	0.10
fruit intake (g/day/1000kcal)	9.833	0.87	-2.040	-0.22	-0.248	-0.03	0.687	0.06	-6.236	-0.53	4.838	0.54
income gap (ln transformed)	0.601	-1.26	-0.078	-0.16	-0.503	-1.06	0.085	0.16	0.110	0.20	-0.480	-1.14
smoking	0.011	0.16	-0.017	-0.29	-0.017	-0.25	0.032	0.54	0.003	0.05	-0.025	-0.53
mobility limitation (1 if any exists)	0.016	0.29	0.034	0.41	0.085	1.38	-0.044	-0.51	0.020	0.20	0.033	0.53
psychological distress (CESD>16)	0.066	0.75	0.048	0.56	0.108	1.47	-0.069	-0.06	0.001	0.01	0.088	1.04
hypertension	0.043	0.62	-0.046	-0.60	-0.028	-0.41	0.038	0.45	-0.143	-1.55	0.050	0.83
social participation	0.080	0.77	0.012	0.11	0.023	0.20	0.010	0.08	0.071	0.53	0.030	0.29

Propensity matched Difference-in-Difference estimation

Propensity regressed (logistic model) on conditions as of wave 1 (age, marital status, education, job characteristics (regular, white/blue collar, labor hrs, security, compulsory retirement, job stress measured in demand/control ratio), grip strength, word recall, frt intake, BMI, hypertension, mobility limitation, smoking status, income (ln transformed), city dummies, and social participation)

Table 3. Estimated Average Treatment Effect in Treated of Leaving Paid Job (Female)

	total (female)		Age less than 65		Age 65 or over		Regular employment		Non-regular		Labor >35hrs/w		Labor<=35hrs/w	
Outcomes	ATET	t-stat	ATET	t-stat	ATET	t-stat	ATET	t-stat	ATET	t-stat	ATET	t-stat	ATET	t-stat
cognitive function	-0.329	-1.14	-0.030	-0.08	-0.813	-1.90	-0.257	-0.35	-0.330	-1.05	0.021	0.04	-0.435	-1.16
grip strength (kg)	0.177	0.26	0.103	0.12	0.596	0.33	0.154	0.07	0.375	0.51	0.876	0.79	-0.066	-0.08
body mass index (kg/m^2)	0.613	0.85	0.808	0.87	-0.116	-0.19	0.441	0.66	0.337	0.75	0.721	1.24	0.529	0.51
fruit intake (g/day/1000kcal)	-8.450	-0.66	-0.250	-0.02	-27.175	-1.22	-8.665	-0.16	-9.995	-0.80	4.405	0.21	-11.886	-0.90
income gap (ln transformed)	-0.926	-2.23	-0.910	-1.61	-1.095	-1.14	-1.424	-1.71	-0.725	-1.48	-1.220	-1.72	-0.764	-1.26
smoking	0.030	0.69	0.009	0.21	0.079	0.54	NA		0.039	0.80	NA		0.050	0.88
mobility limitation (1 if any exists)	0.006	0.09	-0.018	-0.19	0.035	0.19	-0.096	-0.35	0.131	0.18	0.155	-1.18	0.057	0.64
psychological distress (CESD>16)	-0.016	-0.19	-0.002	-0.02	-0.015	-0.15	0.015	0.09	-0.016	-0.20	-0.033	-0.26	0.002	0.02
hypertension	0.011	0.20	0.055	0.83	-0.003	-0.05	0.238	0.80	0.014	0.22	-0.006	-0.07	0.032	0.53
social participation	0.085	1.09	0.055	0.55	0.079	0.62	-0.021	-0.16	0.087	0.95	0.029	0.24	0.079	0.74

	White-collar		Blue-collar		Job secured at wave1		Job not secured		Stressful job at wave 1		Less stressful job	
Outcomes	ATET	t-stat	ATET	t-stat	ATET	t-stat	ATET	t-stat	ATET	t-stat	ATET	t-stat
cognitive function	-0.232	-0.67	-0.496	-0.86	0.005	0.01	-0.878	-1.87	-0.318	-0.79	-0.287	-0.69
grip strength (kg)	-0.089	-0.11	1.105	0.90	0.393	0.51	0.355	0.32	0.277	0.25	0.337	0.41
body mass index (kg/m^2)	0.756	1.18	0.680	0.75	0.243	0.59	0.658	0.78	0.106	0.19	0.523	0.65
fruit intake (g/day/1000kcal)	4.239	0.31	-35.204	-1.32	-6.039	-0.44	-5.368	-0.36	-16.615	-1.04	0.172	0.01
income gap (ln transformed)	-0.804	-1.54	-0.978	-1.39	-0.944	-1.90	-1.486	-1.63	-0.596	-0.96	-1.074	-1.71
smoking	0.032	0.61	0.023	0.31	0.050	1.21	-0.047	-0.63	NA		0.046	0.94
mobility limitation (1 if any exists)	0.028	0.38	0.013	0.14	0.018	0.24	-0.003	-0.02	-0.047	-0.31	0.021	0.23
psychological distress (CESD>16)	-0.003	-0.04	-0.008	-0.06	0.032	0.36	0.063	0.45	-0.072	-0.78	0.023	0.25
hypertension	0.053	0.93	-0.046	-0.61	0.053	0.84	-0.051	-0.54	-0.001	-0.02	0.050	0.66
social participation	0.003	0.03	0.185	1.18	0.120	1.31	-0.082	-0.56	0.058	0.49	0.132	1.47

Propensity matched Difference-in-Difference estimation

Propensity regressed (logistic model) on conditions as of wave 1 (age, marital status, education, job characteristics (regular, white/blue collar, labor hrs, security, compulsory retirement, job stress measured in demand/control ratio), grip strength, word recall, frt intake, BMI, hypertension, mobility limitation, smoking status, income (ln transformed), city dummies, and social participation)

Appendix table; Attrition between wave1 and wave 2 by work status (N (column %))

Male	Work status at wave 1				
Wave 2 status	Full time	Non-full time	Self employed	Other work	Total
Participate	466	241	348	21	1,076
	(71.3)	(78.0)	(74.2)	(80.8)	(73.8)
Refuse to participate at wave 2	84	35	63	1	183
	(12.8)	(11.3)	(13.4)	(3.9)	(12.6)
Refuse at wave 2 due to disability/diseased	3	3	6	2	14
	(0.5)	(1.0)	(1.3)	(7.7)	(1.0)
Deceased at wave 2	2	0	5	0	7
	(0.3)	(0.0)	(1.1)	(0.0)	(0.5)
Refuse at wave 2 for family care	3	1	0	0	4
	(0.5)	(0.3)	(0.0)	(0.0)	(0.3)
Failed contact at wave 2	36	9	18	1	64
	(5.5)	(2.9)	(3.8)	(3.9)	(4.4)
Others	5	1	3	0	9
	(0.8)	(0.3)	(0.6)	(0.0)	(0.6)
Refuse at the end of wave 1	55	19	26	1	101
	(8.4)	(6.2)	(5.5)	(3.9)	(6.9)
Total	654	309	469	26	1,458
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Female	Work status at wave 1				
Wave 2 status	Full time	Non-full time	Self employed	Other work	Total
Participate	130	291	66	172	659
	(69.2)	(71.7)	(68.8)	(77.1)	(72.2)
Refuse to participate at wave 2	21	52	11	30	114
	(11.2)	(12.8)	(11.5)	(13.5)	(12.5)
Refuse at wave 2 due to disability/diseased	1	5	2	3	11
	(0.5)	(1.2)	(2.1)	(1.4)	(1.2)
Deceased at wave 2	1	0	1	1	3
	(0.5)	(0.0)	(1.0)	(0.5)	(0.3)
Refuse at wave 2 for family care	0	1	1	0	2
	(0.0)	(0.3)	(1.0)	(0.0)	(0.2)
Failed contact at wave 2	14	28	5	3	50
	(7.5)	(6.9)	(5.2)	(1.4)	(5.5)
Others	2	1	0	0	3
	(1.1)	(0.3)	(0.0)	(0.0)	(0.3)
Refuse at the end of wave 1	19	28	10	14	71
	(10.1)	(6.9)	(10.4)	(6.3)	(7.8)
Total	188	406	96	223	913
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Appendix 2. Imputed variables by Multiple Imputation with Chained Equation (m=100)

	complete	im-complete	imputed	(%)	total
ln_income at wave2	1521	192	177	10.3%	1713
word recall at wave2	1318	395	377	22.0%	1713
grip strength (kg) at wave 2	1377	336	318	18.6%	1713
fruit intake (g/day/1000kcal) at wave2	1533	180	171	10.0%	1713
body mass index (kg/m^2) at wave2	1680	33	32	1.9%	1713
psychological distress (CESD>16) at wave2	1568	145	142	8.3%	1713
smoking at wave2	1577	136	133	7.8%	1713
social participation at wave2	1596	117	114	6.7%	1713
ln_income at wave1	1620	93	88	5.1%	1713
word recall at wave1	1585	128	122	7.1%	1713
grip strength (kg) at wave 1	1644	69	66	3.9%	1713
fruit intake (g/day/1000kcal) at wave1	1539	174	170	9.9%	1713
body mass index (kg/m^2) at wave1	1539	174	170	9.9%	1713
psychological distress (CESD>16) at wave1	1638	75	73	4.3%	1713
smoking at wave1	1661	52	52	3.0%	1713
social participation at wave1	1631	82	80	4.7%	1713