Heterogeneous impact of retirement on health in Japan: A fuzzy regression discontinuity design with individual fixed effects

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Abstract

This study examines the impact of retirement on health and health-related behavior, focusing on differences in educational background and gender across groups. We employed a regression discontinuity design, using the unique practice of an age-based mandatory retirement scheme prevalent in Japan, to identify causal effects; we exploited discontinuity in the working status of individuals, considering the mandatory retirement age of 60 in Japan, to identify the effect of retirement. We observe that retirement has a statistically significant effect on psychological distress among men. Retirement improves men's mental health; however, the magnitude of such an improvement is greater among retirees with tertiary education than those with secondary or primary education. An important gender difference is that men are less likely to undertake medical checkups after retirement while women are more likely to do so. The effect of retirement on health is disproportionate to gender and socioeconomic status. Therefore, policymakers should consider the different consequences of late retirement based on workers' attributes.

Keywords: retirement; regression discontinuity; self-rated health; health behavior; physical activity; smoking; drinking; psychological distress

JEL Classification: I12; I14; J14; J26

Source of Funding: Grants-in-Aid for Scientific Research [KAKENHI: 18K01657, 20K01592]

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1. INTRODUCTION

The aging population in developed countries exerts massive pressure on the public spending of a nation because of the corresponding huge burden exerted on public pension schemes (Gruber & Wise, 1999); accordingly, the cost of health and long-term care for the elderly is expected to increase (De la Maisonneuve & Oliveira Martins, 2013). A major policy option is to extend the working life and delay the pension-eligible age. The effects of retirement on health have attracted the interest of policymakers and researchers in economics and other fields. Retirement is a big life event, following which individuals experience a drastic change in their lifestyle, economic situation, time allocation, and interpersonal relationships. These changes are considered to be associated with health and health behaviors. If extending the working years deteriorates the health of elderly workers, it may increase the nation's healthcare costs instead of minimizing its public spending. Therefore, the impact of retirement on health should be carefully examined.

Great number of studies has examined the effect of retirement on various health outcomes. Early studies using observational data have obtained mixed results. Using panel data obtained from the Health and Retirement Study, Dave, Rashad, and Spasojevic (2008) observed that retirement increases difficulty in the mobility and daily activity of individuals and induces morbidity and mental illness among them. Other studies that have reported negative effects of retirement on health are Rohwedder & Willis, 2010; Kuhn, Wuellrich, & Zweimüller, 2010; Sahlgren, 2012; Behncke, 2012; and Calvo, Sarkisian, & Tamborini, 2013. In contrast, there are other studies that have reported the positive effects of retirement on various health-related behaviors, such as quitting smoking (Celidoni & Rebba, 2016; Ding *et al.*, 2016; Lang *et al.*, 2007), reducing alcohol consumption (Brennan *et al*., 2010; Celidoni & Rebba, 2016; Ding *et al*., 2016), and participating in physical activities (Chung, Domino, Stearns, & Popkin, 2009; Ding *et al*., 2016; Feng, Croteau, Kolt, & Astell-Burt, 2016; Slingerland *et al*., 2007; Stenholm *et al*., 2016). In addition, it was observed that retirement favorably influences physical health, as measured by self-rated health and mental health studies (Behncke, 2012; Coe & Zamarro, 2011; Hessel, 2016; Neuman, 2008; Westerlund *et al*., 2009; Westerlund *et al*., 2010; Zhu, 2016).

The reason for these contradictory results is the endogeneity of the retirement decision. It is reasonable to argue that healthy people are more likely to work in their fifties or sixties, and health condition is a major determinant of retirement (Dwyer & Mitchell, 1999).

To overcome this problem, later studies have utilized the instrumental variable (IV) method using the eligibility for public pension benefits as an IV (Coe & Zamarro, 2011; Hessel, 2016; Neuman, 2008; Oshio & Kan, 2017). Bonsang, Adam, and Perelman (2012); Godard (2016); Zhu (2016); and Motegi, Nishimura, and Oikawa (2020) combined the fixed-effect model and the IV method to cope with the biases caused by individual time-invariant attributes and the endogeneity of retirement. Other studies have employed natural experimental opportunities. Shai (2018) exploited the increase in the full retirement age for men in Israel from 65 to 67 as an exogenous source of variation in the employment status and concluded that employment at old age impairs health. Similarly, Bertoni *et al*. (2018) investigated Italian pension reforms that increased the minimum retirement age and observed that middle-aged Italian males affected by the reform reacted to the extended working horizon by increasing regular exercise, with positive improvements against obesity and self-reported satisfaction with health.

Following the developments in the econometrics of program evaluation, recent studies have attempted to use regression discontinuity (RD) design for causal inference. Fitzpatrick et al. (2018) focused on Social Security eligibility age at 62, and found a robust two percent increase in male mortality immediately after that age. Eibich (2015) exploits financial incentives in the German pension system in fuzzy RD design and found that retirement improves subjective health status and mental health. Muller and Shaikh (2017) also apply a fuzzy RD design to identify partner’s and own retirement effects by using retirement eligibility as exogenous instruments for spousal and own retirement status. This study follows this line.

The second reason for the contradictory results is that the results reflect the average effect for those with different socioeconomic backgrounds. The impact of retirement differs across groups with different socioeconomic statuses (SESs) (Platts, Webb, Zins, Goldberg, & Netuveli, 2015; Schuring, Robroek, Lingsma, & Burdorf, 2015; Wang & Shultz, 2010), which are determined by occupation, education, and income (Mackenbach & Kunst, 1997; Shavers, 2007). Previous studies have demonstrated that people with a high SES experience a larger decline in general health after retirement, compared to people with a low SES (Rijs, Cozijnsen, & Deeg, 2012).

Conversely, other studies have demonstrated that people with a high SES experience improvement in mental and physical health, compared to people with a low SES (Berchick, Gallo, Maralani,& Kasl, 2012; Chung *et al*., 2009). Thus, evidence regarding the relationship between health and retirement among different socioeconomic groups remains inconclusive.

Recently, Schaap, de Wind, Coenen, Proper, and Boot (2018) conducted a systematic review of the available evidence regarding the effects of retirement on health in high and low socioeconomic groups. Their review of 22 studies revealed that improvements in health after retirement were mainly present in employees with a high SES, compared to employees with a low SES.

This study contributes to the existing literature in three ways. First, we exploited a fuzzy RD approach to avoid the bias arising from workers' endogenous retirement decisions. In previous studies using IV methods to control for the endogeneity of retirement decisions, authors mostly established the IV to identify the working status using the variation in the pension-eligible age (Fletcher, 2014; Coe & Zamarro, 2011). Although these IVs were valid in estimation, it remained possible for workers to consider their retirement timing, based on their health conditions.

Eibich (2015) ,and Müller and Shaikh (2017) utilized discontinuity in retirement by pension eligible age and retirement eligible age respectively in a fuzzy RD design frame work. We utilize similar discontinuity in retirement, but by mandatory retirement age, which is unique to Japanese labor market.

This study exploited a discontinuity in the working status at the mandatory retirement age of 60 set by employers in Japan. The RD approach is a method of estimating the treatment effect in a non-experimental setting, where treatment is determined based on if an observed assignment variable exceeds a known cut-off point (Lee & Lemieux, 2010). In Japan, the Elderly Employment Stabilization Law prohibits employers from establishing a mandatory retirement age below 60 years. At the time of the survey, Japanese companies (with a few exceptions) had a uniform mandatory retirement age of 60. Overall, 86 and 81.2% of male and female employees, respectively, who were surveyed responded that they faced a mandatory retirement age of 60 (if mandatory retirement applied to them). Therefore, the discontinuous jump to non-working status occurred at approximately age 60, as indicated in the age–retirement profile. We took advantage of this discontinuity at age 60 to identify the effect of retirement on health and health-related behaviors among the elderly.

Second, we examined the effect of retirement by different SES and gender. We focused on the role of educational attainment in the effects of retirement. We assumed that educational attainment pertained to job content and the health production function (Grossman, 1972). Gender was considered to be a factor that influences the impact of mandatory retirement. Men and women have different job attachments, particularly among workers who obtained their jobs before the establishment of the gender equality law, which was enacted in 1985. Until recently, life-long employment focused on male workers in Japanese companies offered assured job security and age-based salary in exchange for a life-long commitment from employees. Therefore, the effect of mandatory retirement can significantly differ between the two groups with different levels of job attachment.

Third, following Oshio and Kan (2017), we differentiated the immediate impact of retirement and the change in the trend after retirement in the five-year range. Zhu (2016) considers that retirement consists of two processes: first process is a discrete change from employment to retirement; the second is a cumulative process of exposure to being out of the labor force. Thus they construct the variable "retirement duration," which measures the time between the self-reported retirement age and age at the time of survey. In this study, we instead construct variable indicating age minus mandatory retirement age, which is intuitively captured by the "kink" while immediate change at retirement is considered to be the "jump" in the RD framework. Positive sign of coefficient for the kink indicates that changes by age in outcome variables are accelerated after mandatory retirement age.

2. MANDATORY RETIREMENT SYSTEM

An age-defined mandatory retirement system is applied to employees at most private companies and public offices in Japan. It is a system in which an employment contract is automatically terminated when an employee reaches a certain age. In the past, many companies tended to set a retirement age of 55; however, an amendment to the Act on Stabilization of Employment of Elderly Persons in 1994 (enforced April 1, 1998) legally prohibited companies from setting a retirement age below 60. Most Japanese companies are based on a mandatory retirement system; the percentage of companies that employ this system is 93.3% for companies of all sizes and 99.8% for companies with 1,000 or more employees (data source: 2013 General Survey on Working Conditions conducted by the Ministry of Health, Labour and Welfare (MHLW)). They are likely to set a mandatory retirement age of 60 years after the amendment.

In circumstances where extremely rapid aging occurs because of the combination of low birthrate and extending life expectancy, the Japanese government amended the Act on Stabilization of Employment of Elderly Persons in 2012, and it was enforced on April 1, 2013. The newly amended Article 9 stipulated that in cases where employers set the retirement age (limited to those under 65 years old), the employer shall execute any of the following measures to secure stable employment for their employees until the age of 65.

1. Raise the mandatory retirement age.

2. Introduce a continuous employment system (a system that requires the continuous employment of elderly employees beyond their retirement age if they desire).
3. Abolish the mandatory retirement age.

After this amendment, mandatory retirement practice at the age of 60 was no longer a norm after April 2013, although it was quite rigid until 2012. Therefore, the analyses were based on panel data from 2005 to 2012.

3. METHODS

3.1. Study sample

We used data from the Longitudinal Survey of Middle-aged and Elderly Persons (LSMEP) conducted by Japan's MHLW from 2005 to 2012. LSMEP is a nationally representative panel survey. The respondents, comprising 34,240 middle-aged individuals aged 50–59 at baseline, were randomly chosen through stratified two-stage sampling.

This study used data from the first wave (2005) through the eighth wave (2012) of the LSMEP. We excluded observations with missing variables in the analytical model. The sample included 133,896 person-year observations: 89,997 and 83,107 observations for men and women, respectively.

Japan's Statistics Law required the survey to be reviewed from statistical, legal, ethical, and other viewpoints. We obtained the survey data from the MHLW with its official permission; therefore, this study did not require further ethical approval.

3.2. Measures

Health behaviors

Health-related behaviors of interest included the following four variables: smoking, heavy alcohol consumption, physical leisure activity, and regular medical check-up. We generated a binary variable for each of them. We designated a respondent who answered “yes” to the question “do you smoke currently?” as a current smoker. We defined heavy alcohol consumption as an intake of more than three *go* (540 mL) of Japanese *sake* or an equivalent amount of alcohol every day, which corresponds to approximately 60 g of pure alcohol. This threshold was based on a study that revealed that maintaining alcohol consumption below 46 g/day appeared to minimize the risk of mortality in a Japanese population (Inoue *et al*., 2012). We assumed that respondents engaged in physical leisure activity if they reported that they were involved in moderate or vigorous aerobic activity at least two days per week. This threshold was approximately consistent with the guidelines suggested by the MHLW (2013). We allocated 1 to each binary variable when applicable. Lastly, we allocated 1 to the variable that indicated that a respondent has had a regular medical check-up in the last 12 months.

Health

We examined two health measures, which are poor self-rated health and psychological distress, and generated a binary variable for each of them. Self-rated health was assessed using a questionnaire, which required respondents to choose their current health condition from levels 1 to 6: 1 (*very good*), 2 (*good*), 3 (s*omewhat good*), 4 (*somewhat poor*), 5 (*poor*), and 6 (*very poor*). Considering that the number of levels had no meaning, we constructed a binary variable, indicating poor self-rated health. We allocated 1 to those who chose 4, 5, or 6 and 0 to those who chose 1, 2, or 3.

The survey used the Kessler Psychological Distress Scale (K6; Kessler *et al*., 2002; Kessler *et al*., 2010) to assess the mental health of the respondents. The respondents were asked to answer a six-item questionnaire, which was, “During the past 30 days, about how often did you feel a) nervous, b) hopeless, c) restless or fidgety, d) so depressed that nothing could cheer you up, e) that everything was an effort, and f) worthless?” The questions were rated on a 5-level scale: 0 = *none of the time* to 4 = *all of the time*. Thereafter, the sum of the reported scores, which ranged from 0 to 24, was calculated and defined as the K6 score. High K6 scores reflected high levels of psychological distress. A K6 score greater than or equal to 5 indicated a mood/anxiety disorder in a Japanese population sample, as confirmed by previous studies (Furukawa *et al*., 2008; Sakurai, Nishi, Kondo, Yanagida, & Kawakami, 2011). A binary variable for psychological distress was constructed by allocating the value, 1, to those with K6 scores greater than or equal to 5 and the value, 0, to those with K6 scores below 5.

3.3. Explanatory variables

Retirement

It is necessary to define the meaning of retirement before we examine the effect of retirement on various outcomes. The definitions vary depending on the literature (Coe & Zamarro, 2011; Eibich, 2015). We defined retirement as a state in which individuals are out of the labor force. The LSMEP did not directly ask respondents if they had retired; therefore, we contracted the variable based on several questions. If a respondent answered "no" to the question, "do you work for earning money," and they do not want to work, we classified them as "retired." People who want to work, although not working were classified as "unemployed," while in the labor force.

Educational attainment

The respondents were divided into two groups based on their educational attainment. Individuals who had completed secondary education or less were classified as "high school," and those that had completed more than secondary education were classified as "college."

Covariates

As covariates, we constructed three binary variables to indicate if the respondent had a spouse, lived with family in addition to the spouse, and provided informal care to any family member. Notably, these covariates were potentially endogenous and affected by retirement and health; however, we confirmed that the estimation results remained virtually intact even if omitted from the regressions. In addition, we used the indicator variables for each wave to control wave-specific factors.

3.4. Econometric specification

The RD was designed to determine the assignment to the treatment, either completely or partly, by the value of a predictor being on either side of a fixed threshold (Imbens & Lemieux, 2008). Although the mandatory retirement scheme automatically terminates employment contracts in the year when employees turn 60, they can continue to work at a different company, under a different contract, or with different work hours if they want. Therefore, we considered this setting a fuzzy RD framework. It was estimated a two-stage least square model with individual fixed effects (FEs). We set up the model with the main specification as a discontinuity at the age of 60.

First, y_{it} and s_{it} were designated as the outcome and dummy for the treatment status of individual i at period t. The outcome variables included two indicators for physical and mental health and four indicators for health-related behaviors. The treatment was binary and given by the employment status, such that s_{it} was 1, if the respondent was out of the labor force, and 0, otherwise. Our purpose was to evaluate the causal impact of retirement s_{it} on the outcome y_{it}.

For the treatment (out of labor force) status, we adopted a first stage RD regression in the following form: for $i = 1,2,\ldots,N$ and $t = 1,2,\ldots,T$,

$$s_{it} = \rho d_{it} + \alpha_1 z_{it} + \alpha_2 (d_{it} z_{it}) + x'_{it}\alpha_3 + q_i + v_{it}, \quad (1),$$

where z_{it} is the forcing variable, which is the value of the age minus 60, and x_{it} is the vector of the covariates, including marital status, if there is any cohabiter other than a spouse, whether caring for a family member, and year dummy variables. Time-invariant q_i denotes the unobserved individual effects. The dummy variable d_{it} on the right-hand side was determined as follows:

$$d_{it} = 1[z_{it} \geq 0], \quad (2),$$

which captured the possible abrupt jump of retirement s_{it} at $z_{it} = 0$ (or equivalently at age 60). The coefficient ρ measured the jump of s_{it} at the threshold. Conversely, the interaction term $d_{it}z_{it}$ modeled the change in the association between s_{it} and z_{it} after the age passed the threshold. For example, if $\alpha_2 < 0$, the effect of aging on retirement decreased after the mandatory retirement age. The main second stage regression for the outcome was given as follows:

$$y_{it} = \delta s_{it} + \beta_1 z_{it} + \beta_2 (d_{it} z_{it}) + x_{it}' \beta_3 + a_i + u_{it} \quad (3),$$

with individual effects a_i, where δ was the key parameter to estimate. Generally, even after controlling the individual effects, s_{it} remained correlated with the error term, u_{it}, which caused an endogeneity bias on regular FE estimators for δ. However, the abrupt jump, which occurred on s_{it} by d_{it} was exogenous for equation (3). Thus, the fuzzy RD employed an instrumental variable estimation using d_{it} as an instrument for s_{it}, transmitting exogenous shocks from equations (1) to (3). Specifically, we operated an FE two-stage least square (FE2SLS) model.

As the RD design identified the treatment (retirement) effect on the outcomes only around the discontinuous point, we applied a panel 2SLS version of local linear regression regarding z_{it} (Imbens & Lemieux, 2008). Specifically, we constructed a rectangular kernel as follows:

$$w_{it} = 1[-c < z_{it} < c], \quad (4),$$

where c is the bandwidth parameter. Afterward, we implemented the FE2SLS model using w_{it} as weight. We set $c = 5$, implying that we limited the age of the observations to a range of 55–65. The graphical inspection indicated below denoted that around the range of $-5 < z_{it} < 5$, the association of s_{it} and z_{it} was well approximated by a linear regression. Instead of local regression, certain studies use higher-order polynomials of z_{it} to create a flexible regression equation for the whole sample. However, Gelman and Imbens (2019) recently argued that polynomial regressions may cause additional variability in the estimation. Therefore, we avoided polynomials and adopted linear regression in the neighborhood of $z_{it} = 0$.

4. RESULTS

We nonparametrically checked for discontinuity in working statuses by age. Figures 1 and 2 present[†] the rate of retirement by educational attainment at every age from 55 to 65 for men and women. We observed the discontinuity at the age of 60 years for both genders. Regarding the difference in educational attainment, two lines ran in parallel before and after the discontinuous jump at the age of 60. More educated men were more likely to stay in the labor force within the range of 55–65 years old than their counterparts, while more educated women were more likely to retire earlier than their counterparts were. In addition, we checked for the discontinuity of the six health-related outcomes by age. We depicted the average rate of each outcome at each age and drew regression lines in Figures 3 and 4 for men and women, respectively. Men demonstrated discontinuity in depression, physical exercise and medical checkups in Figure 3. Women showed discontinuity in depression and medical checkups, but medical checkup showed opposite direction from men's.

Table 1 presents the summary statistics of men and women in the sample by educational attainment. The first row indicates the average retirement rates for men and women. As presented in Figures 1 and 2, the average retirement rate was lower among more educated men than their counterparts were, and vice versa for women. For health outcomes, more educated men are less likely to report poor health and psychological distress and less likely to smoke and drink. They were more likely to have medical checkups. These tendencies were observed among female respondents; however, the gap by educational attainment was wider among men.

The results from the regression of retirement probability on discontinuity at the mandatory retirement age and other covariates are presented in Table 2. Although similar regressions were run in a

[†] Solid lines indicate those who received tertiary education and dashed lines indicate those who with secondary or primary education as the note in Figure 1 shows.

two-stage estimation procedure for each regression for the six health-related outcomes, it was independently run. We focused on the significance of the coefficients of *d* in equation (1), which denotes the vertical jump at the age of 60 in Figure 1 because it was indispensable for the RD design. The coefficients were statistically significant at the 1% significance level for all subsample groups for the estimation. It was the largest at 0.031 among male high school graduates and the smallest at 0.021 among female high school graduates. . The coefficient of z indicated the effect of aging within the range of 55–65 years old, while the coefficient of *zd* implied a change in the slope after the mandatory retirement age. The coefficients for these two variables were also statistically significant at the 1% significance level for all subsample groups for the estimation.

Finally, Tables 3 and 4 present the results from the FE2SLS modeling of six health-related outcomes with groups of two different educational attainments for men and women. Comparing Tables 3 and 4, it was noticeable that the effects of retirement differed between men and women. First, looking at the results for men, retirement affected physical and mental health. Both groups with different educational attainments improved their mental health, although only male high school graduates improved their physical health. The magnitude of improvement in mental health was considerably larger among college-educated men. The coefficients were −0.336 and −1.062 for high school and college graduates, respectively. For the health-related behaviors, college-educated men were more likely to quit smoking, and high school educated men were more likely to engage in physical exercise. Both groups of men were less likely to have medical checkups after retirement.

Contrarily, among female respondents, retirement effects differed across the two groups with different educational attainments. Female high school graduates were more likely to consume more alcohol, exercise more, and have medical checkups, all of which were attributed to the availability of time after retirement. However, they tended to become averse to those behaviors with time. Women with a college education were more likely to stop smoking after retirement. Retirement did not affect physical and mental health among both subsets of female respondents.

The influence of aging seemed greater for men than for women. Both groups of men tended to feel more depression as they aged after their retirement age. Men with high school education were more likely to report poor health and depression as they age. They consumed less alcohol, exercised less. College educated men slightly increased the probability to take medical checkup after their retirement age. Women with high school education, however, gradually decreased the likelihood to take medical checkup after the retirement age.

5. ROBUSTNESS CHECKS

We implemented three additional procedures to check the robustness of our results, and they are shown in Appendix Table 1 and Appendix Table 2 for men and women respectively. First, we estimated the regression model using limited samples. We excluded those who never worked, had not worked for a long time or were self-employed since they were not affected by mandatory retirement. Although the discontinuity in the working status at retirement age, which is 60, was statistically significant even if we included those, we surmised that it could be more convincing to exclude them. The results obtained from this analysis were static.

Second, we used different definitions of retirement. We originally defined retirement as being out of the labor force since the survey did not directly ask respondents if they were retired. An alternative definition of retirement is not working for pay; which was commonly used in literature. This definition was wider and included the unemployed, homemakers, and volunteers. Although the significance became a little bit small, the results were still stable.

Finally, we estimated the regression model with different bandwidths. Although we did not aim to argue the optimal bandwidth of the RD design in this study, the choice of bandwidth was key to RD. We set the bandwidth to 3, and the sample included narrower age brackets, which ranged from 57 to 63.

Although the sign of each coefficient was unchanged, the effects weakened for women, except for the effect of physical exercise on women with lower educational attainment.

6. CONCLUSION

We examined the impact of retirement on six health-related outcomes with an emphasis on heterogeneity by gender and SES. Comparing the effects on smoking, heavy alcohol consumption, physical leisure activity, regular medical check-up, poor self-rated health, and psychological distress across different genders and educational backgrounds, we observed the heterogeneous influence of retirement. A comparison between the men and women of Japan revealed that the former are more likely to improve their mental health after retirement. This has been attributed to social or cultural aspects, analyzing which is beyond the scope of this study. It was thought that men born between 1946 and 1955 (age 50 to 59 in 2005) had worked for companies that offered job security and age-based salary in exchange for a life-long commitment, which might have stressed them. It had been difficult for them to switch companies even if they were not comfortable at work. Moreover, men in these generations had played a role as a sole wage earner in their family, and they could not quit or change jobs until they retired. Therefore, they improved their mental health after retirement. In different words, job attachment was different between men and women, and it could explain the gender differences.

Another difference observed between the two genders is that men are less likely to undertake medical checkups after retirement while women are more likely to do so. Both sexes faced increased free time after the retirement, which explains more opportunity to take medical checkup. What explains this gender difference? A possible reason for this is men tended to take medical checkup at their workplace, thus they lost an opportunity to do so after retirement. Some approach to encourage them to take medical check could be beneficial for society because the morbidity from serious illnesses increases with age.

In terms of the heterogeneous effects of retirement between different educational backgrounds, the association between educational attainment and effects of retirement was found to be greater in the case of men than women. In particular, men improved their mental health after retirement, and the effects were greater for men with tertiary education. Only men with secondary or primary education improved their physical health after retirement. This was possible because the less educated men mostly worked for the jobs that required more physical labor, while highly educated men worked for more complex tasks at offices.

In conclusion, the effects of retirement on health-related outcomes varied depending on gender and socioeconomic characteristics. Postponing retirement may have adverse impact on health of older workers, and the effects are different across different background. When policy options are discussed in the future, such as the extension of working life, these factors should be considered.

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Table 1: Characteristics of respondents by gender and educational attainment (55-65 years old)

	Men				Women			
	Highschool or less		College		Highschool or less		College	
Variables	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean
Out of labor force	59,293	0.073	28,645	0.061	68,573	0.254	27,749	0.289
Poor health	58,770	0.220	28,467	0.160	68,048	0.194	27,584	0.164
Psychological distress	55,953	0.270	28,046	0.249	64,761	0.307	26,863	0.302
Current smoker	59,052	0.430	28,587	0.322	68,060	0.109	27,616	0.084
Heavy drinking	58,960	0.333	28,579	0.290	67,826	0.037	27,604	0.038
Physical activity	57,559	0.134	28,421	0.169	66,687	0.164	27,365	0.174
Took medical chechup	58,697	0.716	28,509	0.774	67,690	0.649	27,553	0.684
Age	69,564	59.383	33,117	59.071	78,040	59.394	31,343	58.988
Years after 60	69,564	-0.617	33,117	-0.929	78,040	-0.606	31,343	-1.012
Married	59,265	0.861	28,628	0.907	68,507	0.829	27,760	0.845
Living with family	59,236	0.639	28,638	0.664	68,511	0.599	27,751	0.620
Caring family member	55,536	0.088	27,780	0.112	63,881	0.135	26,541	0.186

Table 2: Estimated effects of mandatory retirement age on exit from labor force by education

	Exit from labor force			
	Men		Women	
	Highschool (obs=55374)	College (obs.=27733)	Highschool (obs=63526)	College (obs.=26471)
	coeff.	coeff.	coeff.	coeff.
Retired (d)	0.031 ***	0.022 ***	0.021 ***	0.027 ***
	(0.003)	(0.004)	(0.004)	(0.007)
Years after 60 (z)	0.006 ***	0.007 ***	0.023 ***	0.02 ***
	(0.001)	(0.001)	(0.001)	(0.002)
d*z	0.025 ***	0.028 ***	0.011 ***	0.013 ***
	(0.002)	(0.002)	(0.002)	(0.003)
Married	-0.013	0.005	0.016	-0.005
	(0.015)	(0.021)	(0.012)	(0.024)
Living with family	-0.003	0.007	-0.002	-0.003
	(0.004)	(0.005)	(0.005)	(0.008)
Caring family member	0.009 *	0.015 **	0.01 *	0.016 **
	(0.005)	(0.006)	(0.005)	(0.008)

Notes:

1) *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

2) Standard errors in parentheses are adjusted for cluster (individuals)

Table 3: Estimated effects of exit from labor force on health outcomes by educational attainment: men

		Poor health	Psychological distress	Current smoker	Heavy drinking	Physical activity	Took medical chechup
		coeff.	coeff.	coeff.	coeff.	coeff.	coeff.
Retired (d)	Highschool	-0.324 *	-0.336 *	-0.1	0.239	0.851 ***	-0.687 ***
		(0.168)	(0.179)	(0.114)	(0.146)	(0.185)	(0.187)
	College	-0.096	-1.062 ***	-0.452 *	0.311	-0.39	-1.012 ***
		(0.304)	(0.399)	(0.235)	(0.282)	(0.395)	(0.369)
Years after 60 (z)	Highschool	0.01 ***	0.007 ***	-0.019 ***	-0.006 ***	-0.024 ***	-0.007 ***
		(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)
	College	0.002	0.011 **	-0.012 ***	-0.004	-0.015 ***	-0.002
		(0.004)	(0.005)	(0.003)	(0.003)	(0.004)	(0.004)
Changes in annual rate after retirement age (d*Z)	Highschool	0.007	0.009 *	-0.003	-0.01 **	-0.034 ***	0.006
		(0.004)	(0.005)	(0.003)	(0.004)	(0.005)	(0.005)
	College	0.003	0.027 **	0.011	-0.012	-0.006	0.019 *
		(0.008)	(0.011)	(0.007)	(0.008)	(0.011)	(0.011)

Notes:

1) *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

2) Standard errors in parentheses are adjusted for cluster (individuals)

Table 4: Estimated effects of exit from labor force on health outcomes by educational attainment: women

		Poor health	Psychological distress	Current smoker	Heavy drinking	Physical activity	Took medical chechup
		coeff.	coeff.	coeff.	coeff.	coeff.	coeff.
Retired (d)	Highschool	-0.146	-0.156	-0.143	0.239 **	0.492 *	0.545 *
		(0.216)	(0.245)	(0.095)	(0.101)	(0.269)	(0.293)
	College	-0.3	-0.557	-0.199 *	0.124	0.346	0.161
		(0.263)	(0.359)	(0.114)	(0.103)	(0.318)	(0.315)
Years after 60 (z)	Highschool	0.008	0.011 *	-0.001	-0.006 **	-0.037 ***	-0.026 ***
		(0.006)	(0.007)	(0.003)	(0.003)	(0.007)	(0.008)
	College	0.011 *	0.017 *	0.001	-0.005 *	-0.034 ***	-0.012
		(0.007)	(0.009)	(0.003)	(0.003)	(0.008)	(0.008)
Changes in annual rate after retirement age (d*Z)	Highschool	0.003	0.002	0.002 *	-0.003 **	-0.019 ***	-0.008 **
		(0.003)	(0.003)	(0.001)	(0.001)	(0.004)	(0.004)
	College	0	0.009 *	0.002	0.002	-0.018 ***	-0.004
		(0.004)	(0.005)	(0.002)	(0.002)	(0.005)	(0.005)

Notes:

1) *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

2) Standard errors in parentheses are adjusted for cluster (individuals)

Appendix Table 1: Estimated effects of exit from labor force on health outcomes with different samples/models: men

		Poor health	Psychological distress	Current smoker	Heavy drinking	Physical activity	Took medical chechup
		coeff.	coeff.	coeff.	coeff.	coeff.	coeff.
Excludes those who never worked, haven't worked for long time, or are self-employed	Highschool	-0.316 *	-0.348 *	-0.066	0.23 +	0.763 ***	-0.717 ***
		(0.157)	(0.164)	(0.105)	(0.136)	(0.174)	(0.174)
	College	-0.095	-0.886 *	-0.298	0.265	-0.344	-1.136 **
		(0.29)	(0.364)	(0.215)	(0.27)	(0.382)	(0.36)
Different definitin of retirment (not working)	Highschool	-0.164 +	-0.171 +	-0.051	0.121 +	0.435 ***	-0.351 ***
		(0.084)	(0.09)	(0.058)	(0.074)	(0.089)	(0.091)
	College	-0.047	-0.511 **	-0.221 *	0.152	-0.188	-0.496 **
		(0.147)	(0.181)	(0.111)	(0.137)	(0.19)	(0.168)
Bandwidth = 3	Highschool	-0.333	-0.219	-0.024	0.286	1.044 ***	-0.71 ***
		(0.223)	(0.236)	(0.127)	(0.191)	(0.237)	(0.239)
	College	0.37	-1.045 *	-0.294	0.3	0.004	-1.073 *
		(0.352)	(0.465)	(0.228)	(0.33)	(0.439)	(0.432)

Notes:

1) +,*, ** and *** indicate statistical significance at the 15%, 10%, 5% and 1% levels, respectively.

2) Standard errors in parentheses are adjusted for cluster (individuals)

Appendix Table 2: Estimated effects of exit from labor force on health outcomes with different samples/models: women

		Poor health	Psychological distress	Current smoker	Heavy drinking	Physical activity	Took medical chechup
		coeff.	coeff.	coeff.	coeff.	coeff.	coeff.
Excludes those who never worked, haven't worked for long time, or are self-employed	Highschool	-0.139	-0.145	-0.099	0.237 **	0.479 *	0.352
		(0.191)	(0.223)	(0.085)	(0.09)	(0.238)	(0.246)
	College	-0.113	-0.455 +	-0.172 +	0.114	0.327	0.175
		(0.195)	(0.26)	(0.086)	(0.075)	(0.24)	(0.244)
Different definitin of retirment (not working)	Highschool	-0.099	-0.112	-0.097	0.161 *	0.321 +	0.361 +
		(0.147)	(0.175)	(0.063)	(0.064)	(0.168)	(0.19)
	College	-0.252	-0.417	-0.16 +	0.102	0.292	0.132
		(0.219)	(0.262)	(0.088)	(0.084)	(0.263)	(0.259)
Bandwidth = 3	Highschool	-0.33	0.003	-0.187	0.103	1.072 *	0.705
		(0.33)	(0.357)	(0.125)	(0.135)	(0.427)	(0.415)
	College	-0.632	-1.515	-0.161	0.29	0.358	0.232
		(0.485)	(0.914)	(0.169)	(0.192)	(0.48)	(0.511)

Notes:

1) +,*, ** and *** indicate statistical significance at the 15%, 10%, 5% and 1% levels, respectively.

2) Standard errors in parentheses are adjusted for cluster (individuals)

Figure 1: Rate of retirement among men between the age of 55 and 65.

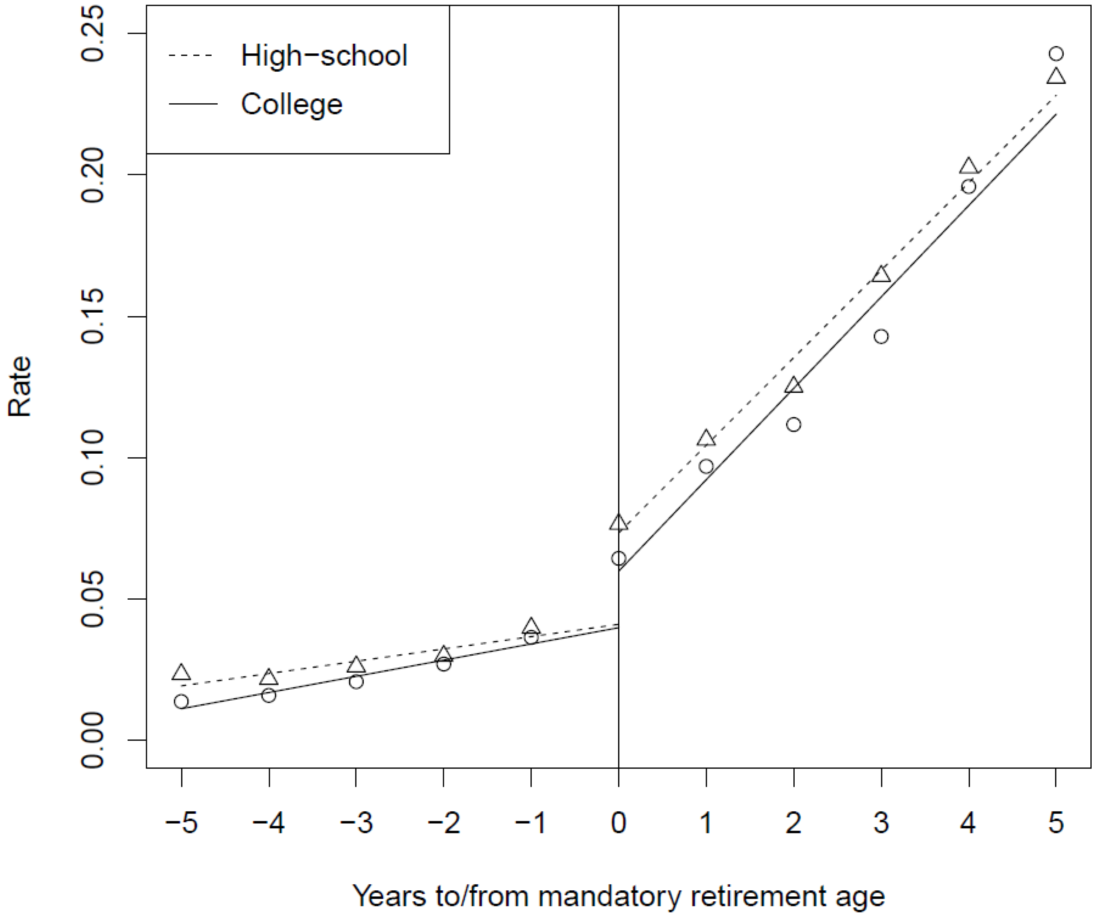

Figure 2: Rate of retirement among women between the age of 55 and 65.

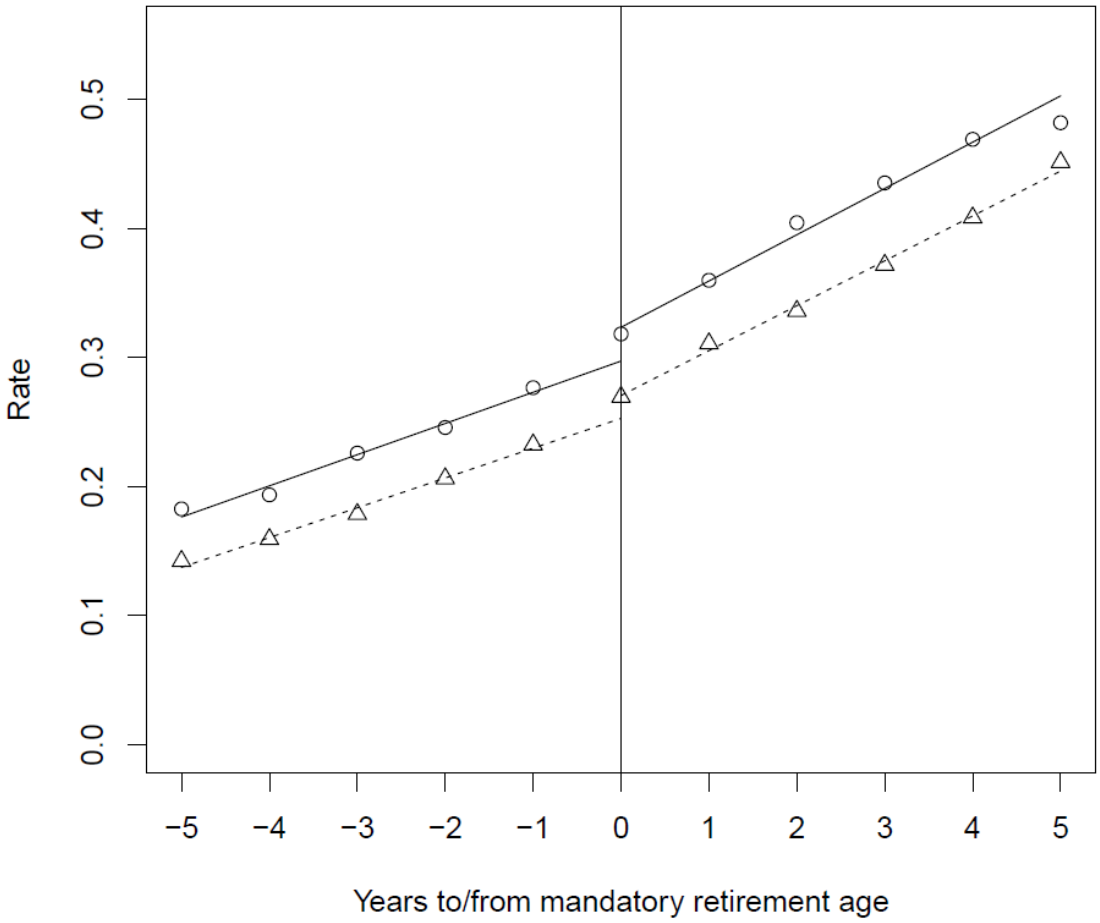

Figure 3: Average rate of outcomes at each age for men.

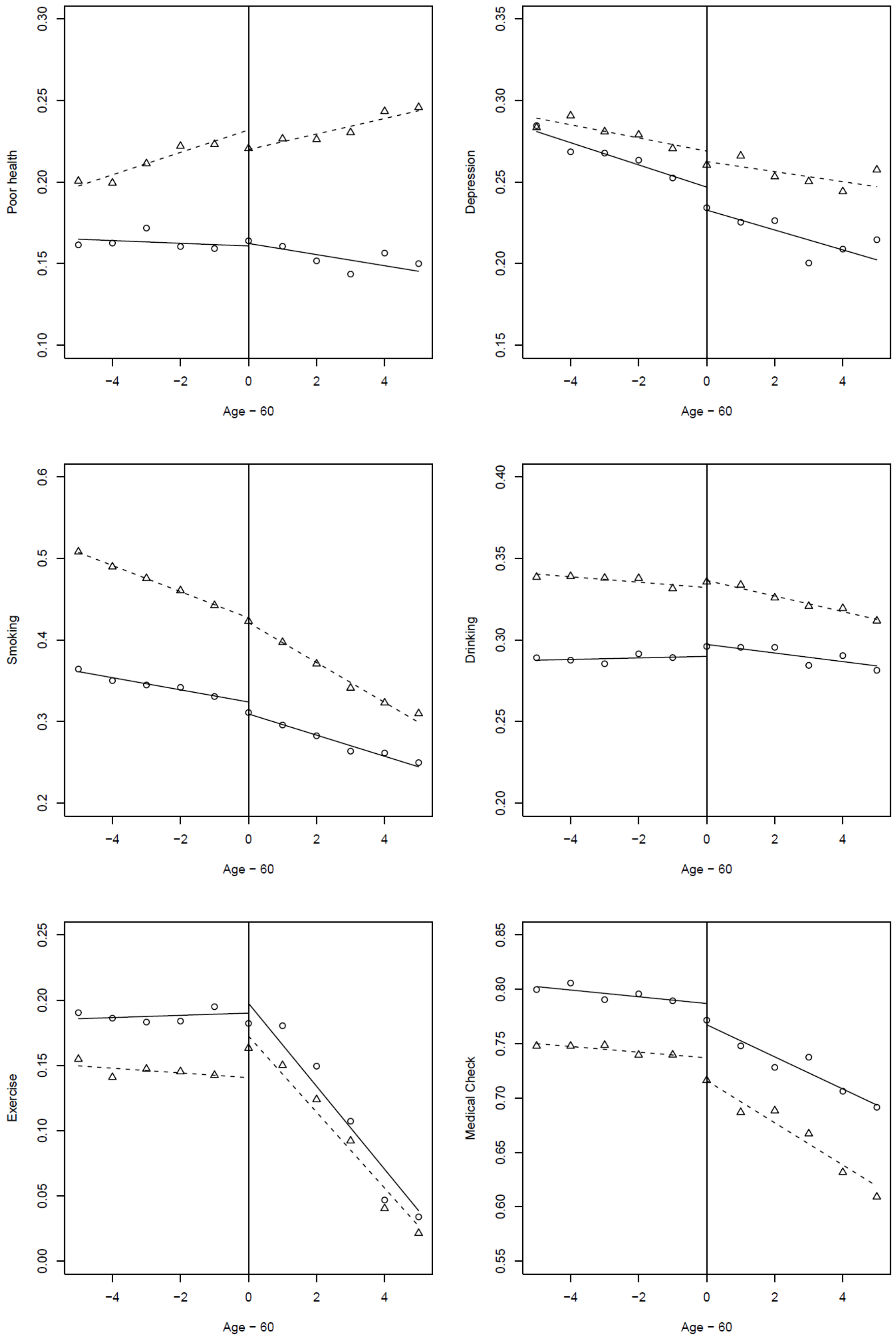

Figure 4: Average rate of outcomes at each age for women.