What are you retiring for? Health consequences in early aging country [1]

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Abstract

Using Russia Longitudinal Monitoring Survey (RLMS-HSE) data from 1994 to 2013, this study investigates the impact of retirement on health in Russia. The Russian case is remarkable due to relatively low life expectancy and low retirement age. Assessing the effect of retirement on health is challenging because causality also runs in the opposite direction as poor health could lead to earlier retirement. The baseline identification strategy is based on the instrumental variables method that helps to overcome the endogeneity problem. To instrument retirement, I use the eligible retirement age that varies for different categories of employees. I also apply data on retirement expectations from previous waves of the panel and spouse's labor market participation as additional instrumental variables. The results show significant health-reducing effects of retirement. This effect is observed only for full retirees and does not exist for those who move into part-time retirement. The result is robust to applying different health measures and adjusting for attrition bias. The effect of retirement on health is most significant for males, highly educated, married individuals, those living in urban area, and individuals with low initial health level.

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1. Introduction

In recent years, many countries placed an increase in retirement age at the center of the discussion hoping to benefit the social security budgets. However, the prolongation of working lives could worsen the health. In such case, there would be the decline in the quality of life of the elderly and the increase of the health care expenditures that in turn could adverse the gains for social security budgets. Thus, an evaluation of the impact of retirement on health is relevant for public policy.

The theoretical models show that the direction of such impact is ambiguous. The retirement could cause a decline in health as well as an improvement in health. Retirement could lead to the fall in the health investment due to reduction in the economic return to health, but it could also lead to the increasing the health investment due to increase in the spare time (Grossman, 2000). Retirement could lead to mental problems, losses of social capital, and so on. However, it could also lead to new social contacts, increase in time for leisure (De Grip et al., 2012; Rohwedder and Willis, 2010; Sahlgren, 2012).

Even several years ago, empirical evidence of the impact of retirement on health was scarce, but recently a large body of studies has emerged. However, these studies show contradictory results. On one hand, the vast group of studies reveals the health-improving effect of retirement (Neuman, 2008; Insler, 2014; Coe and Zamaro, 2011). On the other hand, there is also the majority of studies presenting the health-decreasing effect of retirement (Lei et al., 2011; Sahlgren, 2012; Dave et al., 2008; Behncke, 2012).

The current paper contributes to the literature in several ways. This paper exploits the case of Russia, which is remarkable for several reasons. First, the longevity and official retirement age are substantially lower compared to countries analyzed in previous literature on retirement and health. In 2013, Russia with life expectancy at birth of 69 years ranked 122th place among 194 countries. The life expectancy for males is especially low and equals 63 years.[3] The official retirement age is 60 years for male workers and 55 years for female workers. Second, all retired individuals during the period of analysis were eligible only for public pensions and did not have any insurance programs. Third, individuals could not choose their official retirement age. Thus, it is exogenous to relevant personal characteristics.

This paper uses the rich dataset of the Russia Longitudinal Monitoring Survey of Higher School of Economics (RLMS-HSE). It is an annually conducted longitudinal household survey. The extensive list of household and individual characteristics allows applying different constructions of health measure and investigating different paths to retirement including switching to part-time jobs. The current study uses data from 1994 to 2013.

Estimates of retirement effect on health obtained by ordinary least squares (OLS) regression are likely to suffer from the endogeneity bias. Endogeneity of retirement arises since an individual could retire due to anticipated health problems. Furthermore, both the decision on the retirement and health changes could be caused by some non-observed factors. To address these problems, I use an instrumental variable (IV) method that accounts for the endogeneity issue. The main instrument for retirement is the eligible retirement age. As was mentioned earlier, individuals could not choose their eligible retirement age so it provides an important source of the exogeneity. Remarkably, there is a substantial variation in the eligible retirement age across workers from different industries, regions and occupations in Russia. The potential threat to the identification strategy is that the differences in the eligible retirement age could reflect health-related differences in working conditions. However, I present evidence that the eligible retirement age in Russia hardly depends on the working conditions. I also demonstrate that accounting for working conditions does not largely influence the results.

I provide further support for the claim of causality. First, I apply data on retirement expectations from previous waves of the panel and spouse's labor market participation as

[3] The life expectancy at age 60 equal to 14 years for males and 20 years for females is also significantly lower than in developed countries. *The source of data*: World Health Organization, Gavrilova and Gavrilov, 2009.

additional instrumental variables. Inclusion of additional instruments allows to perform overidentification tests. To rule out the alternative channels of the impact of retirement expectations on health, I follow the approach suggested by Insler (2014) and divide the variable of retirement expectations on the part correlated with future health shocks and the part reflecting uncorellated health shocks. Second, I show that the impact of panel attrition bias is small and does not significantly affect the results. Third, I show that the results are robust to applying different health measures. Fourth, I also apply regression discontinuity design and its results confirm the main findings.

The methodological contribution of the current study includes dealing with attrition bias. Attrition bias could arise due to different probabilities of quitting the panel among retired and non-retired individuals, as well as across individuals with different health level. If retired individuals with the worse health quit from the panel while non-retired stay in the panel independently on their health then the estimates of the effect of retirement on health would be positively biased. However, the majority of studies of retirement and health do not provide adjustment for attrition bias. The current study uses information from other members of the household about the death or illness of the individual to correct estimates for the attrition bias.

The main finding is the negative impact of retirement on health. This effect is observed only for full retirees and does not exist for those who move into part-time retirement. I also reveal the considerable heterogeneity of the impact. The effect of retirement on health is most significant for males, those living in urban area, highly educated, married, and individuals with low initial health level. To explain the evidence of the negative impact I investigate the channels of retirement impact on health. In contrast to the results obtained in previous studies of retirement impact in Western countries, I find that the retirement does not lead to the significant changes in the lifestyle. However, I discover the channels that are not described in previous literature. Specifically, I find that following the retirement the tobacco consumption shifts towards cheaper products that could be more harmful to health.

The paper is organized as follows. Section 2 reviews the main results of the previous literature and attempts to explain the contradictions in the results. Section 3 presents the main features of the pension system in Russia. Section 4 provides a description of data. Section 5 describes the methodology and discusses the validity of instruments. Section 6 presents and discusses the estimation results. Section 7 provides robustness checks including an examination of measurement issues, attrition bias, different retirement definitions, and regression discontinuity design. This section also investigates heterogeneity of effects and channels of retirement impact on health. Section 8 concludes.

2. Literature review

Previous empirical estimates of the retirement effect using OLS often show that retirement causes the substantial decline in health. The main problem of such estimation is an endogeneity of the retirement: a person could retire due to anticipated health problems. Also, the decision on the retirement could be caused by non-observed factors that could also affect the health in the future (Neuman, 2008). In the presence of endogeneity, OLS estimates are biased.

Different methods are used to deal with the endogeneity. For example, Dave et al. (2008) apply fixed effects estimation using US panel data. As a result, obtained fixed-effects estimates indicate the negative impact of retirement on health, but the size of this effect is smaller compared to the pooled OLS model. Other studies using fixed effects estimation also find negative effects (Mosca and Barrett, 2014) or weak positive effects (Kerkhofs and Lindeboom, 1997; Latif, 2012). Another solution to the endogeneity problem is the regression discontinuity design (RDD). Using this method, Johnston and Lee (2009), and Fe and Hollingsworth (2015) find the positive effects of retirement on health in the UK, while Eibich (2015) finds the positive effects in Germany. In contrast, using the same method Lei et al. (2011) and Sahlgren (2016) identify the negative effects of retirement on health in China and several European countries correspondingly. The RDD method is also applied by de Grip et al. (2012) who estimate the health effects of the pension reform in the Netherlands. The reform provided financial incentives to the workers to delay the retirement by 13 months. The discontinuity arises due to affecting only certain cohorts. Using propensity score matching estimation, Behncke (2012) reveals the negative impact of retirement on health in the UK while Hashimoto (2015) using the same technique on Japanese data does not find any effect at all. Table 1 presents the main findings of several studies. More detailed description of methodology and results of empirical studies are presented in Table A1 in Appendix.

Table 1. Main findings of previous empirical studies

Study	Country	Retirement age	Life expectancy at age of retirement		Effect	Magnitude
			Female	Male		
(Charles, 2002)	US	62 or 65	23 or 25	20 or 22	+	Moderate
(Dave et al., 2008)	US	62 or 65	23 or 25	20 or 22	-	Moderate
(Neuman, 2008)	US	62 or 65	23 or 25	20 or 22	+	Small
(Coe and Lindeboom, 2008)	US	62 or 65	n/a*	20 or 22	+	Insignificant
(Kantarci, 2013)	US	62 or 65	23 or 25	20 or 22	+	Moderate
(Coe et al., 2012)	US	62 or 65	n/a*	20 or 22	+	Small
(Bonsang et al., 2012)	US	62 or 65	23 or 25	20 or 22	-	Large
(Insler, 2014)	US	62 or 65	23 or 25	20 or 22	+	Large
(Gorry et al., 2015)	US	62 or 65	23 or 25	20 or 22	+	Moderate
(Motegi et al., 2016a)	US	62 or 65	23 or 25	20 or 22	+	Moderate
(Latif, 2012)	Canada	60 or 65	24 or 28	21 or 25	+	Insignificant
(Eibich, 2015)	Germany	60 or 65	27	20	+	Large
(Motegi et al., 2016a)	Germany	60 or 65	27	20	+	Moderate
(Bound and Waidmann, 2007)	UK	60 or 65	27	20	+	Small
(Johnston and Lee, 2009)	UK	65	n/a*	20	+	Moderate
(Behncke, 2012)	UK	63 or 65	25	20	-	Moderate
(Fe and Hollingsworth, 2015)	UK	65	n/a*	20	+	Small
(Motegi et al., 2016a)	UK	60-65	25-27	20	+	Moderate
(Mosca and Barrett, 2014)	Ireland	65	23	20	-	Moderate
(Blake and Garrouste, 2012)	France	60-65	25-30	21-25	+	Large
(Blake and Garrouste, 2013)	France	60-65	n/a*	21-25	+	Large
(Motegi et al., 2016a)	France	60 or 65	25 or 30	21 or 25	+	Moderate
(Kerkhofs and Lindeboom, 1997)	the Netherlands	65	23	20	+	Small
(Lindeboom et al., 2002)	the Netherlands	65	23	20	0	
(de Grip et al., 2012)	the Netherlands	62-65	n/a*	20-22	-	Large
(Bloemen et al., 2013)	the Netherlands	61-65	23-27	20-23	+	Large
(Motegi et al., 2016a)	Switzerland	60-65	26-29	21 or 23	+	Small
(Kuhn et al., 2010)	Austria	60 or 65	28	20	-	Large
(Lindeboom and Lindegaard, 2010)	Denmark	60 or 65	22 or 27	20 or 24	0	
(Bingley and Pedersen, 2011)	Denmark	60 or 67***	n/a*	18 or 24	+	Large
(Motegi et al., 2016a)	Denmark	60 or 65	22 or 27	20 or 24	+	Moderate
(Hallberg et al., 2015)	Sweden	55 or 60****	n/a*	25 or 30	+	Large
(Hagen, 2016)	Sweden	65	24	n/a*	-	Small
(Hernaes et al., 2013)	Norway	62-67	21-25	18-22	0	
(Coe and Zamarro, 2011)	Europe				+	Large

Study	Country	Retirement age	Life expectancy at age of retirement		Ef-fect	Magnitude
			Female	Male		
(Mazzonna and Perrachi, 2012)	Europe				-	Moderate
(Mazzonna and Perrachi, 2016)	Europe				-	Moderate
(Sahlgren, 2012)	Europe				-	Large
(Sahlgren, 2016)	Europe				-	Large
(Antonova et al., 2015)	Europe				+	Moderate
(Rohwedder and Willis, 2010)	Europe, US				_	Large
(Bingley and Martinello, 2013)	Europe, US				_	Small
(Atalay and Barrett, 2014)	Australia	60-65	24-29	n/a*	+	Moderate
(Kaijtani et al., 2014)	Japan	60	n/a*	25	0	
(Hashimoto, 2015)	Japan	60	31	25	0	
(Motegi et al., 2016a)	Japan	60	n/a*	25	+	Moderate
(Motegi et al., 2016a)	Korea	60	29	24	-	Small
(Lei et al., 2011)	China	60	n/a*	21	-	Large
(Grogan and Summerfield, 2015)	**Russia**	55 or 60	27	16	0	Insignificant

Source of data on life expectancy: World Health Organization
Notes: Life expectancy varies if the different retirement age is eligible either for females or males.
*) *n/a* – this subgroup was not investigated in the paper.
***) 60 years is an early retirement age in Denmark established as an alternative to disability pension.
****) This study concentrates on military retires that have substantially lower retirement ages.

However, the most popular tool to deal with endogeneity bias is an instrumental variable (IV) estimation. The IV variables include the spouse's retirement status (Dave et al, 2008; Sahlgren, 2012), spouses's age (Neuman, 2008; Sahlgren, 2012; Kantarci, 2013), self-reported usual retirement age on the respondent's job (Neuman, 2008), self-reported probabilities of working after retirement age (Insler, 2014), early retirement age (Coe and Lindeboom, 2008; Coe et al., 2012; Mazzonna and Perrachi, 2012, 2016), normal retirement age (Charles, 2002; Neuman, 2008; Rohwedder and Willis, 2010; Coe and Zamaro, 2011; Behncke, 2012; Mazzonna and Perrachi, 2012, 2016; Sahlgren, 2012; Bonsang et al., 2012; Latif, 2012; Bingley and Martinello, 2013; Kantarci, 2013; Kaijtani et al., 2014; Gorry et al., 2015; Antonova et al., 2015; Motegi et al., 2016a). The IV estimation is also applied to instrument retirement age using pension reforms (Charles, 2002; Kuhn et al., 2010; Lindeboom and Lindegaard, 2010; Bingley and Pedersen, 2011; Blake and Garrouste, 2012, 2013; Bloemen et al., 2013; Hernaes et al., 2013; Atalay and Barrett, 2014; Hallberg et al., 2015; Hagen, 2016).

Positive effects of retirement on health with IV estimates are found in the United States (Charles, 2002; Neuman, 2008; Coe et al., 2012; Kantarci, 2013; Insler, 2014; Gorry et al., 2015), Europe (Coe and Zamaro, 2011; Antonova et al., 2015), France (Blake and Garrouste, 2012, 2013), the Netherlands (Bloemen et al., 2013), Denmark (Bingley and Pedersen, 2011), Sweden (Hallberg et al., 2015), Australia (Atalay and Barrett, 2014). On the other hand, negative effects of retirement on health using IV estimates are revealed in the United States (Dave et al., 2008; Bonsang et al., 2012), Europe (Sahlgren, 2012; Mazzonna and Perrachi, 2012, 2016), England (Behncke, 2012), Austria (Kuhn et al., 2010), Sweden (Hagen, 2016). It seems that differences in the effect direction are caused not only by country-related differences but also by the different instruments. For example, Coe and Zamaro (2011) and Sahlgren (2012) use the same survey data for 10 European countries but present opposite conclusions.

Thus, the empirical literature provides ambiguous results. Some studies show positive effects of retirement on health while other studies show negative effects of retirement on health. The magnitude of effect also substantially differs from very small to very large values that are comparable with major health shocks in human life.

So, what could explain serious contradictions in the empirical literature? Clearly, the results are sensitive to institutional settings and the choice of the methodology but what are deeper sources of contradictions? Few authors suggest different explanations. Kuhn et al. (2010) argue that studies using self-assessed health are more likely to reveal positive health effects of the retirement compared to studies using objective health measures. Bechncke (2012) attributes contradictions to differences in methodology and claims that IV studies tend to show positive effects while negative effects are typical for studies with identification based on controlling for the selection into the retirement. As Bechncke suggests, such identification leads to an estimation of the effect on different subpopulations and, therefore, estimation results differ due to considerable effect heterogeneity. Like Bechncke, Eibich (2014) suggests that contradictions could be caused by heterogeneity of effects in different subpopulations and additionally explains it by endogeneity problem, thus, implying that reverse causality is not resolved in some studies. Dave et al. (2008) investigate a lack of consensus in early studies and suggest ignoring endogeneity as the primary cause of contradictions, and data limitations causing non-relevance of samples and lack of control variables as other causes. Bingley and Pedersen (2011) note that in spite of an increase in the number of studies in this area there are only a few studies with “adequate” data and accounting for endogeneity. Bingley and Pedersen also insist that controlling for endogeneity is not a sufficient condition to reach a consensus. Bingley and Martinello (2013) argue that the estimates based on the eligibility age as an instrumental variable are biased downward because these studies do not eliminate the alternative channel of correlation between eligibility age and health through years of schooling. Sahlgren (2016) specifies several methodological limitations of previous studies. In particular, Sahlgren raises doubts about the correct usage of the pension reform as an instrument because it could influence an individual’s behavior before retirement, thus, creating an alternative channel of the pension reform’s impact on health. He notes that some variables included in models as control variables – consumption, income and marital status – could deteriorate the estimates of impact because these variables are also the channels of retirement impact on health. According to Sahlgren, RDD studies often miss important sensitivity issues including the choice of the bandwidth, checking for non-linearity of the running variable, and allowing for different trends before and after discontinuity. He also notes that short-term and long-term effects of retirement could substantially differ. To conclude, there are suggested a lot of explanations, and different authors are at variance with the main source of the contradictions.

Note that the choice of the instrument could influence the sample size. For example, using the characteristics of a spouse as instrumental variable limits the analysis by excluding single individuals. Taking into account the substantial heterogeneity of effects, the results could largely differ from the results of analyzing (hypothetically) the whole sample.

The contradictions also could arise due to differences in the definition of main variables. The explanatory variable of interest is represented by dummy variable indicating whether individual retired or not. It is based on self-assessment of individual or on working hours data. Neuman (2008) also uses a continuous measure of retirement based on annual hours of work but reaches the same conclusions as using a model with dummy variable of retirement. Several studies apply the definition of retirement not to those who self-assessed themselves as retirees but to those elderly who are not in the labor force. However, using the both definitions in one study produces similar results (Sahlgren, 2016). Some studies count as retirees not only those who was employed prior retirement but also those who was unemployed (Sahlgren, 2016). To conclude, it is unlikely that the contradictions could be caused by different explanatory variables, but I apply different approaches to check for the robustness of the results.

Dependent variables vary across different studies. The self-assessed health is the most popular dependent variable. Also, several studies use dummies of diseases, health problems, and limitations in activities as alternative outcomes (Dave et al., 2008; Neuman, 2008; Coe and Lindeboom, 2008; Behncke, 2012; Atalay and Barrett, 2014; Fe and Hollingsworth, 2015; Hashimoto, 2015). Several authors apply health care utilization data as health outcome (Lindeboom and Lindegaard, 2010; Hallberg et al., 2015; Hagen, 2016. Bound and Waidmann (2007) use the results of physical health test, blood chemistry and anthropometric tests. Several studies concentrate on mental health indicators (Lindeboom et al., 2002; Johnston and Lee, 2009; Rohwedder and Willis, 2010; de Grip et al., 2012; Coe et al., 2012; Bonsang et al., 2012; Mazzonna and Perrachi, 2012; Bingley and Martinello, 2013; Mosca and Barrett, 2014; Kaijtani et al., 2014; Antonova et al., 2015; Sahlgren, 2016). Insler (2014) constructs composite index as a weighted sum of self-assessed health and dummies of diseases. Multidimensional indices are also used by Coe and Zamarro (2011), Blake and Garrouste (2011), Sahlgren (2012), Mazzonna and Perrachi (2016) Several studies use mortality as the primary dependent variable (Kuhn et al., 2010; Lindeboom and Lindegaard, 2010; Bingley and Pedersen, 2011; Blake and Garrouste, 2012; Bloemen et al., 2013; Hernaes et al., 2013; Hallberg et al., 2015; Hagen, 2016). Insler (2014) and Neuman (2008) use health change while other studies use health level. Neuman (2008) applies two measures of subjective health change: (i) self-assessment of health change after previous wave and (ii) change of self-assessment health. All in all, contradictions could be partially explained by different dependent variables taking into account justification bias and role bias that are considered later.

Several papers split the sample into different subgroups. Effects usually substantially differ for different subsamples indicating considerable heterogeneity of effects. However, there are some common patterns in heterogeneity. First, the effects are more pronounced for full retirees than for partial retirees. Second, involuntarily retired experience a larger decline in health than voluntary retired.

To investigate the causes of the contradictions in literature, Motegi et al. (2016a) perform an interesting quantitative exercise by replicating several previous studies. They combine studies with different results pairwise, distinguish main methodological differences between studies in each pair as potential factors of the contradictions, and then replicate studies replacing step-by-step each factor by another one from corresponding study in each pair. Their main conclusion is not of large interest because they confirm the abovementioned view of the method of analysis and country specifics as the main sources of the contradictions. More interestingly, their results indicate that the choice of control variables and the sample selection method also explain part of the differences while the definition of retirement hardly matters at all.

Our view of the literature suggests that studies using the IV method are more likely to demonstrate positive effects of health compared to studies using other methods. Moreover, almost all evidence of large positive effect comes from studies with IV estimation. Studies investigating physical health effect more often demonstrate positive influence compared to studies investigating mental health effect. In addition, there are no studies that demonstrate large positive effect on mental health. There are also some geographical patterns in the magnitude and the direction of the effect. Positive effects are more likely for Western countries and rarer for East Asia countries. The positive effect is more often for countries with medium values of the official retirement age while negative results are more likely for countries with low or high official retirement age.

The impact of retirement on physical and mental health has been also investigated in other research fields including epidemiology (Mein et al, 2003; Jokela et al., 2010; Olesen et al., 2014), gerontology (Midanik et al., 1995; Drentea, 2002; Calvo et al., 2013; Vo et al., 2014), health-related social science research (Butterworth et al., 2006; Brockmann et al., 2009; Hult et al., 2010; Moon et al., 2012; Marshall and Norman, 2013; Zhu, 2016). However, this literature also does not present consistent evidence with conclusions varying from significant negative effects (Calvo et al., 2013; Olesen et al., 2014; Vo et al., 2014) to significant positive effects (Midanik et al., 1995; Drentea, 2002; Mein et al., 2003; Jokela et al., 2010; Moon et al., 2012; Marshall and Norman, 2013; Zhu, 2016). Few studies also reveal that the direction of the effect differs across different population groups (Butterworth et al., 2006; Brockmann et al., 2009; Hult et al., 2010). Zhu (2016) find out that the channels of positive effect on health include an increase in physical activity and a reduction in smoking. The systematic review of studies in these fields is performed by van der Heide et al. (2013) who examine 22 longitudinal studies. They find strong evidence for beneficial effect of retirement on mental health and contradictory effect of retirement on physical and general health. They conclude that more research is needed with special attention to the heterogeneity of the effect.

An important question concerns possible channels of the impact of retirement on health. To my best knowledge, only five studies explicitly examine such channels including Dave et al. (2008), Kuhn et al. (2010), Lei et al. (2011), Insler (2014), Eibich (2015). Dave et al., Kuhn et al., and Lei et al. try to reveal channels of a *negative* impact on health. Dave et al. estimate the baseline model on different subsamples. The logic is that the channels are more pronounced for some subsamples than for others, e.g. married individuals compensate the loss of work-related social contacts by spouse’s support. This approach lets Dave et al. suggest that the main channels of negative impact are a decline in the number of social contacts and a decline in work-related physical activity. Dave et al. also find that the reduction in work-related stress partially compensates the negative effect of retirement. Kuhn et al. replace the baseline dependent variable – mortality – by specific causes of deaths and hospital admissions. As a result, they reveal that the retirement influences on the number of deaths due to cardiovascular diseases and the number of hospital admissions related to cardiovascular and respiratory diseases. They attribute an increase in the incidence of these specific causes to the changes in health behavior such as smoking. Kuhn et al. also try to reveal the impact of early retirement on permanent income but the estimate of this effect is small suggesting that the income channel plays little role in the negative effect of the retirement on health. To reveal the significance of different channels Lei et al. (2011) extend baseline model in several ways: by adding income as control variable or by substitution the health dummy by insurance coverage or probability of being happy as a dependent variable. They conclude that coverage by medical insurance is not a relevant channel but income has some effect and happiness seems to be the primary channel. Thus, Lei et al. attribute the negative health effect largely to psychological reasons.

In contrast, the baseline results by Insler (2014) and Eibich (2015) show the *positive* impact of retirement on health, so they look for health-improving channels. Insler (2014) reveals that two main channels of the positive impact of retirement on health are quit smoking and increase of participation in exercises. These channels are identified by estimating an impact of retirement on binary variables of health behavior. To find mechanisms, Eibich (2015) uses different indicators of health behavior as dependent variables in RDD models. Eibich also adds sleep duration and regular physical activity as control variables in baseline model and documents subsequent significant reduction of the coefficient of retirement. Overall, Eibich suggests three explanations of positive retirement impact: redemption from work-related stress, an increase in sleep duration, and an increase in physical activity.

The main conclusion is that the primary channel of influence is throughout health behavior such as exercises and smoking. However, the empirical evidence of channels of retirement's impact is still limited. Abovementioned papers do not cover all possible channels but concentrate on those which influence in the direction revealed in baseline results of a study. The only exception is the paper by Dave et al. (2008) which also investigates channels influencing in the opposite direction. But in the last case, the identification of channels is based on the strong assumption that a channel is specific for selected subsample. The interpretation of differences in results across subsamples is likely to be subjective. Dave et al. interpret larger negative effects for retired from physically demanded jobs as the result of a decline in physical activity but it also could be the result of more harmful working conditions in such jobs.[4]

Moreover, one should be careful in interpretation the coefficients in models with a variety of dependent variables as possible channels and mechanisms. The aforementioned papers mainly develop models for an identification of the causal impact of the *retirement* on health and could overlook incidental sources of endogeneity while investigating other outcomes. For example, wrong identification of direct impact of retirement on physical activities could be (wrongly) revealed when, in fact, retirement does not directly influence on such activities, but influences on health by other channels and healthier individuals tend to participate more frequently in physical activities. My concern is that the investigation of channels of the impact should be complemented by models that take into account an endogeneity between health and health behavior.

Thus, it is useful to review studies that investigate the impact of the retirement on specific health-related outcomes. Bonsang and Klein (2012) reveal positive effects of the retirement on life satisfaction, satisfaction with the free time and satisfaction with health in Germany. The positive effect of retirement on life satisfaction is also revealed by Horner (2012) who uses data for European countries and the US. Fletcher (2014) shows the small effect of the retirement on social network characteristics in Europe.

There is also a vast majority of studies documenting significant changes in lifestyle habits after retirement. However, their findings are also contradictory. For instance, Perreira et al. (2001),

[4] Also, Eibich (2014) finds some increase in body mass and alcohol consumption but do not consider it as health-deteriorating one.

Zins et al. (2011), Zhao et al. (2013) reveal an increase in alcohol consumption after retirement. In contrast, Bobo and Greek (2011) and Motegi et al. (2016b) find that retirees reduce drinking after retirement. Ayyagari (2016) reveals an increase in smoking after retirement. In contrast, Lang et al. (2007), Zhao et al. (2013), Insler (2014), and Eibich (2015) find that the retirement leads to the reduction in smoking. Motegi et al. (2016b) do not find any changes in smoking after retirement. Several studies including Zhao et al. (2013), Kampfen and Maurer (2016), Motegi et al. (2016b) find that retirees increase participation in physical exercises. However, Godard (2016) finds a significant increase in the risk of obesity for males in Europe. Motegi et al. (2016b) reveal that retired Japanese increase sleeping time on weekdays while sleeping time on holidays do not change. The review of the relevant literature is performed by Zantinge et al. (2013) who also point out contradictions in the literature. However, on the basis of their review they conclude that the impact of on alcohol consumption depends on the voluntariness of the retirement as only involuntary retirees tend to increase the alcohol consumption.

The impact of retirement on health in Russia is largely unexamined. The closest work to this study is performed by Grogan and Summerfield (2015). They investigate the impact of attaining retirement age in Russia on the labor market outcomes, life satisfaction, home production, and different measures of well-being including health. Grogan and Summerfield use the RLMS-HSE data from 2006 to 2011. Using regression discontinuity design they find that the effect on health is insignificant both for males and females. However, there are significant differences between the paper by Grogan and Summerfield and the current study. Grogan and Summerfield investigate the effect of *retirement age* on health while current study investigates the effect of *retirement* on health. The retirement age in the paper by Grogan and Summerfield is 55 years for all females and 60 years for all males but, in fact, a lot of individuals are eligible for early retirement. Also, Grogan and Summerfield investigate health among other outcomes while the current paper concentrates mainly on health effects.

Platts (2015) investigates the determinants of self-assessed health including different types of labor market status. Estimates of the Cox hazard model on the RLMS-HSE data from 2000 to 2007 indicate a negative impact of retirement on health. To address the problem of endogeneity bias the model includes the lagged values of self-rated health. However, Platts recognizes the limitation of this approach and cautiously interprets the results as evidence of the causal effects.

Some studies of retirement in Russia provide useful implications for this study. Sinyavskaya (2005) provides simulations for the impact of the possible increase in the official retirement age on disability ratio using cross-sectional nationally representative NOBUS data. Results of simulations show that the potential increase in disability ratio could be substantial and more noticeable for women.

Kolosnitsyna et al. (2014) investigate the impact of health on life satisfaction of elderly. The main finding is that the self-evaluation of health largely influences the life satisfaction. The composite indicator of health based on "objective" measures has a moderate effect on life satisfaction of females. Labor market participation is a significant determinant only for females. Kozyreva et al. (2012) show that the common for other age groups trend of health improvement in 2000s in Russia is not observed for elderly.

Gerber and Radl (2014) investigate the labor participation after official retirement age and reveal that an increase in labor participation of the elderly is caused by different factors including material hardships and new opportunities of the market economy. Cherkashina (2011) demonstrates a variety of paths from full employment to retirement in Russia including retirement before the labor pension age that is surprisingly popular.

Jensen and Richter (2004) show the strong effect of public pension delays on the health and reveal that such delays cause the return to the labor market. Kolev and Pascal (2002) find that health problems are among the primary determinants of the probability to work after retirement age. Kuzmich and Roshchin (2007) show that labor market participation depends on the health.

Lyashok and Roshchin (2015) reveal the effects of current health and health dynamics on labor supply.

3. Institutional features

The empirical literature provides significant cross-country differences in timing of retirement. These differences are mainly explained by variation in public policy (Rohwedder, Willis, 2010). Thus, it is important to exploit institutional features of the pension system in Russia.[5]

The main features of Russian pension system were introduced in the Soviet period and still preserve. The official retirement age for most employees is 60 years for males and 55 years for females. These thresholds were established in 1932 and have never changed. However, some categories of employees are eligible for early retirement.[6] As a result, the mean age of retirement is 3–5 years below the main official threshold (Maleva and Sinyavskaya, 2005).

After reaching official retirement age, almost all individuals become eligible for old-age labor pension that is a state pension. There are several types of state pensions in Russia: old-age labor pension, disability labor pension, and survivor's labor pension. Those eligible for the two or more types of state pension should choose one of it. The requirement for old-age labor pension is five years or more of labor market experience. The state pension is provided monthly as a cash transfer from the Pension Fund of the Russian Federation. The Pension Fund is financed on a basis of "pay-as-you-go" scheme through payroll taxes (Jensen and Richter, 2004). However, the current financial scheme does not allow for funding all expenditures of the Pension Fund, so the part of the expenditures are covered by the transfers from the federal budget.

[5] This section only briefly describes the main institutional features of Russian pension system. For more detailed description see (Karasyov and Lublin, 2001; Sinyavskaya, 2005; Turner and Guenther, 2005; Eich et al., 2012).

[6] The last change in the list of early retirement categories occurred in 1992.

Insurance benefits that were introduced in 2002 are eligible only for individuals born in 1967 and younger (Eich et al., 2012). Thus, such benefits do not affect individuals in the sample. The non-state pension funds appeared only after the transition to market economy and do not largely influence the pension provision of the older population.

The unique feature of Russian pension system is that the eligibility for old-age pensions does not depend on the current employment status of an individual. Thus, the pension system does not provide disincentives to work, and many pensioners keep working after official retirement age. Also, the pension amount is rather low in Russia. The amount of pension is equal to 55 percent of the average salary during the last two years of employment or any best five years of work (Nivorozhkin et al., 2013). However, the maximum amount of pension is set so the average replacement rate of income by pension is only about 30 percent (Nivorozhkin et al., 2013). Thus, many pensioners tend to keep working after reaching retirement age.

As of 2014, eleven of 15 ex-USSR countries have increased official retirement age since the collapse of the USSR (ILO, 2014). Numerous attempts to raise this age have occurred during past twenty years in Russia. Such increase could reduce the substantial deficit of the Pension Fund. However, opponents of the increase insist that retirement age increase could deepen the problem of the poor health of the elderly population.

Using the World Values Survey data, Grogan and Summerfield (2015) document an evolution of social norms regarding the status of pensioners in Russia. They show an increase over time in the prevalence of the belief that older people should leave the labor force after reaching the retirement age.

4. Data

The source of data is the Russia Longitudinal Monitoring Survey (RLMS-HSE).[7] This is a nationally representative panel household survey conducted every year. The households come from 32 different regions. This paper uses the panel part of the sample for Rounds 5 through 22 covering the years 1994 to 2013.[8] Household and individual data are merged into one sample. The number of individuals involved in this survey is about 10,000 for Rounds 5-18 and about 17,000 for Rounds 19-22. [9]

The RLMS-HSE data provide information about the month and year of leaving the last place of work and interview date. This allows determining the duration of the retirement in months. The survey data contains numerous questions about the individual health. The primary dependent variable is the self-evaluation of health. The corresponding question is "*How would you evaluate your health? It is:*

1 - very good,

2- good,

3 - average - not good, but not bad,

4 - bad,

5 - very bad."

To construct the dependent variable, the initial scale is inverted so that larger values represent better health. The rationale for this is to provide a comparison with alternative health indicators that are discussed later in the section "Robustness checks".

The retirement in this study is defined as the permanent labor market exit after the age of 50. Specifically, I use the following set of questions:

Question 1:

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[7] Source: "Russia Longitudinal Monitoring Survey, RLMS-HSE", conducted by HSE and ZAO "Demoscope" together with Carolina Population Center, University of North Carolina at Chapel Hill and the Institute of Sociology RAS. (RLMS-HSE sites: http://www.cpc.unc.edu/projects/rlms-hse, http://www.hse.ru/org/hse/rlms)

[8] The first rounds of the RLMS-HSE are not representative and rarely used in recent studies.

[9] For the detailed description of the RLMS-HSE design and data collection see (Kozyreva et al., 2016)

- *"Let's talk about your primary work at present. Tell me, please:*
  - *You are currently working*
  - *You are on paid leave (maternity leave or taking care of a child under 3 years of age)*
  - *You are on another kind of paid leave*
  - *You are on unpaid leave*
  - ***You are not working.**"*

Question 2:

- *"Tell me, please: In the last 30 days did you engage in some additional kind of work for which you were paid or will be paid? Maybe you sewed someone a dress, gave someone a ride in a car, assisted someone with apartment or car repairs, purchased and delivered food, looked after a sick person, sold purchased food or goods in a market or on the street, or did something else that you were paid for?"*

Question 3:

- *" Would you like to find job?"*

The retired in the current paper are those who choose the last answer to Question 1 and also give negative answers to Questions 2 and 3. The samples include females aged 50-75 and males aged 55-75. Table 2 presents the details regarding the data selection procedure.

To become eligible for state old-age labor pension, individuals should have at least five years of labor market experience. Thus, I exclude individuals with labor market experience fewer than the five years from the sample. I also exclude those who plan to return to the labor market and those who retired less than 12 months before the interview. I also exclude observations with missing values for health, income and education.

Table 2. Data selection

	Number of observations
All females 50-75 years old and males 55-75 years old	61,152
Excluded because labor market experience < 5 years	83
Excluded because missing health level information	308
Excluded because missing individual income information	859
Excluded because missing education information	173
Excluded because planning to return to the labor market	3,231
Excluded because length of retirement < 1 year	1,837
Excluded because receive disability pension	4,313
Sample size	50,348
Retirees	28,812
Non-retirees	21,536
Recently retired (between 1 and 2 years)	1,836

Source: calculated by the author using the RLMS-HSE data for years 1994-2013

Another large group excluded from the sample is those receiving disability pensions. This group could receive disability pensions before their official retirement age. However, my strategy for identification causality is based on the attainment of retirement age. Taking into account that the sum of the disability pension is comparable with the sum of the old-age pension and that these pensions are alternative to each other, it seems that financial incentives for this group experience little change after retirement age.

After exclusion, the sample size includes 50,348 observations. Among retirees, there are 1,836 observations for recently retired. Recently retired are those who retired between 12 and 24 months prior the interview date. This group is of particular interest because the effect of retirement in this group reflects short-term impact. Mean values of main variables among retirees, non-retirees and recently retired are presented in Table 3. Table 3 indicates that retirees have a low level of subjective health compared to non-retirees. The health of recently retired is better than the health of those who retired more than 24 months before the survey. The retired individuals also have the substantially low level of individual income. Real income is presented in 1994 prices. To compare, the real income of 187 roubles in 1994 prices corresponds to 6,603 roubles in 2013 prices that in turn corresponds to USD 208 on the basis of the 2013 average currency exchange rate.

Table 3. Mean values

	All retirees (including recently retired)	Recently retired	Non-retirees
Health (1 – very bad, 5 – very good)	2.65	2.85	3.02
Age	66.0	60.9	57.5
Education	9.7	11.1	12.1
Married	0.53	0.61	0.61
Urban location	0.68	0.75	0.79
Female	0.72	0.64	0.68
Number of children in the household	0.24	0.26	0.23
Number of adults in the household	2.38	2.50	2.53
Real income (in 1994 prices) / 1000	187	222	464
Number of observations	28,812	1,836	21,536

Source: calculated by the author using the RLMS-HSE data for years 1994-2013
Notes: the initial scale of health variable is inverted so that larger values represent better health (1 – very bad, 5 – very good). Real income in 1994-1996 is divided by 1000 due to the denomination of Russian currency in 1998.

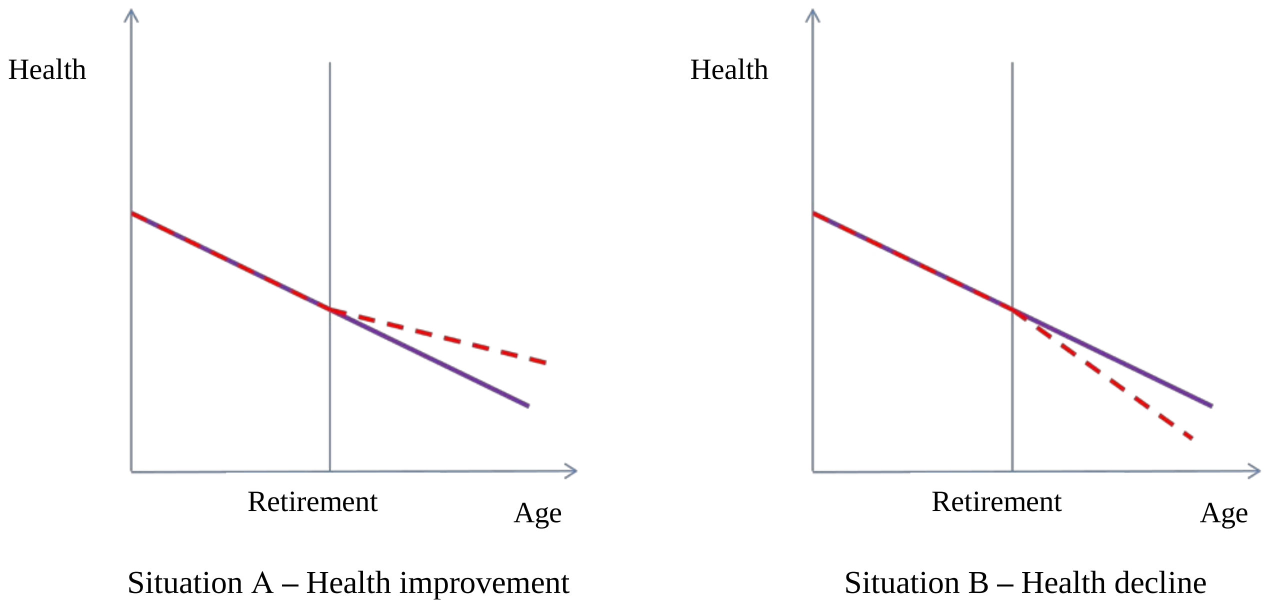
Table 3 indicates that retirees have a low level of subjective health compared to non-retirees. The health of recently retired is better than the health of those who retired more than 24 months before the survey. The retired individuals also have the substantially low level of individual income. Real income is presented in 1994 prices. To compare, the real income of 187 roubles in 1994 prices corresponds to 6,603 roubles in 2013 prices that in turn corresponds to USD 208 on the basis of the 2013 average currency exchange rate.

5. Methodology

5.1. Identification of the causal effect of retirement on health

Health improvement in this study is defined as relative health improvement, i.e. the slower health decline of retired compared to health decline of non-retired. Thus, health decline is defined as relative health decline, i.e. the faster health decline of retired compared to health decline of non-retired. Graphically both situations are illustrated in Figure 1.

Figure 1. Definition of health improvement and health decline



Notes: the dash line indicates health dynamics for retired immediately after retirement age, the solid line shows health dynamics for non-retired after retirement age.

The primary approach contains an estimation of two equations:

$$H_{it} = \alpha + \gamma R_{it} + X_{it}\beta + \varepsilon_{it}, \quad (1)$$

$$R_{it} = \varphi + \theta IV_{it} + X_{it}\pi + u_{it}, \quad (2)$$

where H_{it} is the health indicator of individual *i* in year *t*; R_{it} is a dummy equal to 1 if an individual is retired, and zero for working individuals; X_{it} is a vector of control variables; IV_{it} is an instrumental variable; ε_{it} and u_{it} are error terms; *i* denotes individual, and *t* denotes year. Control variables include age, cohort dummies, adjusted years of education, number of children in the household, number of adults in the household, dummy for marital status, and location dummies.

Using OLS for an estimation of the parameters of the model (1) is likely to provide biased estimates due to the correlation between the variable of interest R_{it} and the error term ε_{it}. This error term could include unobserved characteristics of an individual that are correlated with both health dynamics and retirement.[10] Moreover, it is difficult to predict the direction of the bias.

The primary tool in this study to deal with the endogeneity bias is the instrumental variables (IV) method. The estimates are obtained by the two-stage approach. In the first stage, I estimate the model (2) where the variable R_{it} is a function of an IV variable. In the second stage, the model (1) is estimated. Models (1) and (2) have the same list of control variables.

The choice of an instrumental variable is crucial for the validity of results. Three different instrumental variables are considered:

1) *IV1* – the eligibility for old-age labor pension.[11] Though the most frequent labor pension age is 55 for females and 60 for males, it is varied for the broad range of occupations and industries. *IV1* is a dummy equal to 1 if an individual is eligible for old-age labor pension, and zero otherwise.

2) *IV2* – retirement expectations after the labor pension age.[12] From Round 12 until Round 20, an individual was asked about her expected sources of income after the labor pension age. *IV2* is a dummy equal to 1 if an individual in previous waves of the RLMS-HSE expected to obtain labor income after her labor pension age and zero if an individual in previous waves of the RLMS-HSE did not expect to obtain labor income after her labor pension age. If there are several answers to this question in different waves, than the earlier data are used to minimize the possibility of anticipating future health problems. For the same reason, I use information for at least three years before retirement age. If the retired individual was not asked in previous waves or was asked only in two consequent years before retirement than such individual is not included in the sample when estimating the model with IV2.

3) *IV3* – spouse's employment. The decision of retirement could be taken jointly. Thus, the decision of an individual to retire could depend on the retirement status of individual's wife or

[10] There is also a reverse causality because not only retirement affects health but health also affects retirement. The causal effect of health on retirement was demonstrated in numerous empirical studies for Russia (Kuzmich and Roshchin, 2007; Lyashok and Roshchin, 2015) and other countries (McGarry, 2004).

[11] It is empirically confirmed that an eligibility of social security benefits largely influences the time of the retirement (French, 2005; French, Jones, 2011).

[12] Insler (2014) use information of retirement expectations to construct an IV for identification the causal effect of retirement on health using data for the US.

husband. Several previous studies successfully apply this variable to instrument the retirement decision (Dave et al., 2008; Neuman, 2008; Sahlgren, 2012). It is a binary variable equal to 1 if the spouse is not retired. However, using this variable as an instrument has some limitations. First, this instrument could be applied only to the subsample of married individuals. However, the effect of retirement on health in this group is likely to differ from the effect in the group of single individuals. Second, in contrast to previous instruments, there is no evident effect of this variable on retirement decision in the case of Russia. On one hand, an individual could retire after the spouse's retirement due to increasing in a value of leisure. On the other hand, an individual could choose prolongation of the working life after the spouse's retirement if their nonlabor household income is insufficient. Given the small amount of state pension in Russia, the second scenario is also likely to occur.

The inclusion of several instruments in one model allows performing overidentification tests. Such tests are used to check for the absence of the direct effect of instruments on the dependent variable in the second stage. It should be mentioned that the identification of causal effects using these instrumental variables relies on the strong assumptions. More detailed discussion of instrument validity is presented in the next subsection.

Since the dependent variable is an ordinal variable, an ordered probit approach is chosen as the main model. In ordered probit model framework the latent health variable H_{it}^{*} is modeled as:

$$H_{it}^{*} = \alpha + \gamma R_{it} + X_{it}\beta + \varepsilon_{it}, \quad (3)$$

However, this latent variable is not observed. The observed health variable H_{it} is represented by five categories (j = 1, 2, 3, 4, 5):

$$H_{it} = j \text{ if } \mu_{j-1} < H_{it}^{*} < \mu_{j}, \quad (4)$$

where μ_j are cut points estimated together with the parameters of the model.

To incorporate instrumental variables into ordered probit model, *cmp* command for Stata is used (Roodman, 2011). This command applies maximum likelihood estimation.

5.2. Validity of instruments

The ability of IV model to detect causal effect depends on specific assumptions. The first assumption is *monotonicity*. The assumption of monotonicity is failed in the presence of *defiers*, i.e. individuals who always do the opposite of their assignment (Imbens, Rubin, 2015). It is unlikely that there are individuals who at given age will stay at labor market if they receive a pension and will exit from labor market if they do not receive a pension. Thus, the first instrument, the eligibility for old-age labor pension, fulfills the assumption of monotonicity. It is also unlikely that the retirement expectations violate the monotonicity assumption. In the case of the third instrument, spouse's employment, the monotonicity assumption could fail because, as described in the previous subsection, some people could retire after spouse's retirement and other people could choose prolongation of working life. Thus, I use the model with the third instrument only as robustness check and do not consider its results as baseline results.

The second assumption requires that *instruments are not weak*. An instrument is weak if the correlation between an instrument and an endogenous variable is low. The problem of weak instruments is checked by the first-stage F-statistics using a critical value of 10 (Staiger, Stock, 1997).

The last assumption, *exclusion restriction*, requires much more attention. This assumption implies that the instruments should not have any direct effect on health but influence on it only indirectly, and only through the retirement channel. Technically instruments should not be correlated with error term, ε_{it}, in model (1). Thus, it is important to discuss whether instruments could have any other channels of influence.

The first instrument, the eligibility for old-age labor pension, could fail the assumption of the exclusion restriction if the eligible retirement age depends on the health consequences of work. For example, if employees in industries with unhealthy working conditions receive an opportunity for early retirement, then the health status of individuals with early retirement age tend to be lower than the health status of other individuals. In such case, the characteristics of working place are correlated both with retirement age and health, thus, providing another channel of correlation between the instrument and a health variable.

However, I argue that this alternative channel is unlikely to exist. Recall that the variation in the eligibility of the old-age pension is mainly aroused by the options of the early retirement age that were established in Soviet times with last changes in the early 1990s. Sinyavskaya (2005) argues that special surveys of working conditions were performed many years ago and do not reflect the current situation due to improvement of working conditions in many jobs. Furthermore, the early retirement age depends not only on working conditions but many other factors. Sinyavskaya (2005) claims that the list of jobs with harmful working conditions mainly reflects the result of lobbyists' efforts but not the real assessment of working conditions. Turner and Guenther (2005) notice that the option of the early retirement age in the USSR was one of the major mechanisms for rewarding favored occupations because wage differentiation in a centralized wage-setting system could not perform such function.

I also perform calculations to check whether there are substantial differences in health-related working conditions across workers with different labor pension age. The physical and mental strains of jobs are estimated on the basis of job exposure matrices developed by Kroll (2011) for all jobs mentioned in the International Standard Classification of Occupation (ISCO-88). These matrices are based on data of the large survey on working conditions conducted in Germany. Specifically, these matrices cover all 2-digit codes, 94.8 percent of 3-digit codes and 78.5 percent of 4-digit codes. Kroll develops several indexes including Overall Job Index (OJI), Physical Job Index (PJI) and Psycho-Social Index (PSI). All indexes vary from 1 to 10 where higher values indicate higher strain.[13]

Correlation analysis shows only weak association between the Kroll indexes and pension age. For example, Spearman's rho between OJI and pension age is -0.18 for females (p=0.36) and -

[13] For additional information on the usage of Kroll indexes see Santi et al. (2013).

0.19 for males (p=0.41).[14] As demonstrated in Table A2 in Appendix some occupations with medium values of the Kroll indexes have remarkably early pension age. For instance, female school teachers represented by ISCO-88 groups 2320 and 2331 have an average pension age 52.0 and 48.5 years in our sample.[15] Yet, the overall job index for these groups equals only 4 and 5 respectively. Such groups as other department managers (ISCO group 1239) and other general managers (ISCO group 1319) also have relatively low pension age that equals 52.8 for females in the first group and 50 for females and 54.7 for males in the second group; however, overall job index is not high equaling 3 for the first group and 4 for the second. Values of the psycho-social index for all abovementioned groups are slightly higher but do not exceed 7 for any group.

Meanwhile, many occupations with high values of Kroll indexes do not have preferential pension age. Farm-hands and labourers (ISCO group 9211) have high value of the overall job index (OJI = 8) and the highest value of the physical index (PJI = 10), but their mean pension age for females equals 54.2 years that is negligibly lower than the baseline pension age for females. Motor vehicle mechanics and fitters (ISCO group 7231) have the highest values of the overall job index and the physical job index but the average pension age for males is 58.3 years that is higher than for many other occupations with more favorable working conditions.

One could argue that Kroll indexes were developed from German data while working conditions in Russia could be significantly different. I confirm the validity of Kroll indexes for Russia by comparison its values with the satisfaction of working conditions. Employees are asked to rate their working conditions on a five-point scale ranging from 1 (absolutely satisfied) to 5 (absolutely unsatisfied). Satisfaction with working conditions has a Spearman's rank correlation coefficient of 0.68 (p<0.001) with OJI, 0.69 (p<0.001) with PJI, and 0.42 (p=0.01) with PSI.[16] The

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[14] The units of the observation are 4-digit occupations. Occupations with few or zero observations are excluded. The negative sign of the coefficient indicates the lower pension age for the higher values of the index. Spearman’s rho between PJI and pension age is -0.08 for females (p=0.69) and -0.21 for males (p=0.37). The only significant correlation is revealed between PSI and pension age for females with Spearman’s rho of -0.53 (p=0.01). The corresponding Spearman’s rho for males is 0.24 (p=0.29).

[15] Recall that the baseline pension age in Russia is 55 years for females and 60 years for males.

[16] The units of the observation are 4-digit occupations. Occupations with few or zero observations are excluded. The positive sign of the coefficient indicates the lower degree of satisfaction for the higher values of the index.

share of employees unsatisfied with work conditions grows almost steadily when Kroll index increases: it equals 11.8 for those with low values of index (1-2), 22.1 for those with medium values of index (3-8) and 28.5 for those with high value of index (9-10). The correlation between Kroll indexes and satisfaction with working conditions confirms that these indexes properly reflect the working conditions in Russia.[17]

Additionally, I also perform a robustness test to check whether the correlation between the first instrument and health based on working conditions could significantly bias the results. I split the whole sample into those who was employed in jobs with harmful working conditions and those who was employed in jobs without harmful working conditions. If the coefficients in two subsamples are close to each other, then I conclude that the consequences of possible violation of this assumption are not severe.[18] The results of this robustness check are presented in Section 7.3.

The second instrument, retirement expectations, is even more suspected to have a direct channel of influence. An individual could have some knowledge that helps her to predict future health decline and use it for retirement plans. This problem is realized by Insler (2014) who provides a modification of such instrument.[19] Following Insler, I decompose the error term, ε_{it}, in the following way:

$$\varepsilon_{it} = \omega_{it} + \rho_{it}, \tag{5}$$

where ω_{it} reflects the (unmeasured) factors of health that are anticipated by an individual, and ρ_{it} reflects unanticipated health factors that an individual could not predict.[20] Thus, retirement expectations are correlated only with ω_{it} and orthogonal to ρ_{it}. To eliminate the correlation

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[17] The lack of correlation between Kroll indexes and pension age could also be caused by possible misclassification of ISCO-88 groups. Indeed, Sabirianova (2002) reveals the significant misclassification in Rounds 5-8 of the RLMS-HSE. However, as was shown earlier, the highest share of the benefits among the medium-strain jobs and the lowest share of the benefits among the high-strain jobs are observed for clearly distinct groups such as school teachers in the former case and elementary occupations (ISCO group 9) in the latter case. Workers in these groups are unlikely to be misclassified, so the lack of correlation is not caused by misclassification.

[18] The question about working conditions exists only in Round 13 and all later rounds. I calculate that an eligible retirement age for those employed in jobs with harmful working conditions is on average 2.5 years less than for those who not. Thus, there is a concern to apply robustness checks.

[19] The baseline model by Insler (2014) includes modified instrument. However, using the Health and Retirement Survey data Insler obtains the results in the model with modified expectations close to results based on the unmodified expectations.

[20] Insler (2014) also includes fixed effects in ε_{it}.

between expectations and ω_{it}, I regress the variable of retirement expectations on age, education, marital status, number of children, dummy of land usage, health variables, health behavior variables, location variables, year dummies.[21] I assume that residuals from this equation ("*expectations residuals*") are not correlated with ω_{it}. Therefore, expectations residuals are not correlated with ε_{it} and assumption of exclusion restriction is satisfied.

The third instrument, spouse's retirement, could also have other indirect influence on outcome variable in the second stage. The retirement of the spouse could change the incentives of an individual to invest in health, thus, creating another channel of instrument's impact.

The assumption of exclusion restrictions could be checked by overidentification tests. Overidentification tests compare results of estimating models with a different number of instruments. Thus, to perform overidentification tests, one needs to estimate a model with at least two instrumental variables. If the model does not pass overidentification test, then at least one instrument has a direct effect on the dependent variable in the second stage.

Taking into account the lack of data and sample's reduction for some instruments I use four different lists of instruments. Table 4 describes all instrument sets.

Table 4. Sets of instrumental variables

IV1	IV set 1	IV set 2	IV set 3
• eligibility for pension (**IV1**)	• eligibility for pension (**IV1**) • retirement expectations (**IV2**) • interaction (eligibility * expectations – **IV1*IV2**)	• eligibility for pension (**IV1**) • expectation residuals (**modified IV2**) • interaction (eligibility * expectation residuals – **IV1*modified IV2**)	• eligibility for pension (**IV1**) • expectation residuals (**modified IV2**) • interaction (eligibility * expectation residuals – **IV1*modified IV2**) • spouse's retirement (**IV3**)
50,348 observations	6,234 observations	5,348 observations	2,307 observations

[21] Health variables include self-evaluation of health, dummy for health problems in last 30 days, dummies for different diseases (heart disease, high arterial blood pressure, stroke, diabetes, lung disease, liver disease, kidney disease, gastrointestinal disease, spinal problems, other chronic diseases), and dummy for disability. Health behavior variables include dummies for smoking, frequent alcohol consumptions and sports activities. Location variables include dummies for federal districts and set of dummies for the size of residence area.

The advantage of using IV1 is the sample size because I keep all observations from the initial sample of 50,348 observations. Thus, firstly, I present the results from estimating the model with IV1 only. Secondly, I instrument retirement applying IV set 1 that includes two instrumental variables, IV1 and IV2, and its interaction term. Due to a lack of data on retirement expectations in several rounds and non-participation of some individuals in the survey three or more years before retirement, the number of observations substantially decreases.[22] In the case of IV set 1, an estimate of retirement coefficient could be severely biased as a result of the probably high correlation between retirement expectations and the error term in the second stage equation. Thirdly, I apply IV set 2 that use expectation residuals instead of retirement expectations. The number of observations for this set is fewer than for the previous set because some data on independent variables are missing when calculating expectation residuals. Last, I apply IV set 3 that includes all three instruments and interactions of expectation residuals with IV1. In this case, the number of observations is even lower than in the third case because only those living with the spouses remain in the sample.

6. Results

The results are presented in Table 5. The results show statistically significant health reducing effects of retirement. Third and fourth column present the results when the dependent variable is considered as a continuous variable, other columns present results when the dependent variable is considered as an ordinal variable.

Estimates from models without control variables indicate the substantial negative impact of the retirement on health. Such result is presented in the second column for ordered probit model. Adding control variables reduces the magnitude of the effect, but it remains large and statistically significant. Comparisons of results from the pooled OLS model and model with fixed effects

[22] The question about retirement expectations was asked only in Rounds 12–20 (2003–2011).

which controls for time-invariant unobservable factors show the reduction of the coefficient in the latter case.

The negative effect remains after controlling for the endogeneity of the retirement. The estimates from models with different instruments show similar results. In all cases, the coefficients are statistically significant. The magnitude of retirement coefficient is larger for IV set 1 and IV set 3. However, as was mentioned in the previous section, the coefficient in the case of IV set 1 could be biased. The coefficient of IV set 3 could be larger due to more pronounced negative effect for married individuals. Heterogeneity of effects among individuals with different marital status is examined in the next section.

Table 5. The effect of retirement on health

Dependent variable: subjective health (1 – very bad, 5 – very good)

	Ordered probit (2)	OLS (3)	FE (4)	Ordered probit (5)	IV1 (6)	IV set 1 (7)	IV set 2 (8)	IV set 3 (9)
R_{it}	-0.677***	-0.169***	-0.042***	-0.331***	-0.243***	-0.406***	-0.340***	-0.489***
	(0.011)	(0.007)	(0.011)	(0.014)	(0.040)	(0.096)	(0.106)	(0.136)
Female		-0.159***		-0.310***	-0.322***	-0.289***	-0.269***	-0.128
		(0.007)		(0.013)	(0.013)	(0.058)	(0.065)	(0.090)
Adjusted years of education		0.016***	0.006*	0.029***	0.030***	0.023***	0.023***	0.015
		(0.001)	(0.004)	(0.002)	(0.002)	(0.007)	(0.008)	(0.012)
Married		-0.012**	0.001	-0.026**	-0.030**	0.040	0.030	-0.012
		(0.006)	(0.014)	(0.012)	(0.012)	(0.035)	(0.038)	(0.080)
Number of children in the household		0.014***	0.005	0.028***	0.026***	0.012	-0.014	-0.052
		(0.006)	(0.009)	(0.011)	(0.010)	(0.029)	(0.032)	(0.055)
Number of adults in the household		0.030***	0.007	0.057***	0.057***	0.067***	0.079***	0.130***
		(0.003)	(0.005)	(0.005)	(0.005)	(0.014)	(0.015)	(0.026)
Urban location		-0.031***	0.044	-0.062***	-0.059***	-0.026	-0.034	-0.165***
		(0.007)	(0.072)	(0.012)	(0.012)	(0.036)	(0.038)	(0.057)
Logarithm of real household income		0.016***	0.009***	0.030***	0.040***	0.025*	0.027*	0.039*
		(0.003)	(0.003)	(0.005)	(0.006)	(0.015)	(0.016)	(0.023)
Cohort dummies		yes	yes	yes	yes	yes	yes	yes
Year dummies		yes	yes	yes	yes	yes	yes	yes
Number of observations	50,348	50,348	50,348	50,348	50,348	6,234	5,348	2,307

Notes: Coefficients are reported; robust standard errors are in parentheses. The second column presents results from ordered probit model without control variables, the third column presents results from the pooled OLS model, the fourth column presents results from model with fixed effects, the fifth column presents results from ordered probit model, the sixth column presents results from ordered probit model where retirement is instrumented by the eligibility for old-age labor pension, the columns (7)-(9) present results from ordered probit models where retirement is instrumented by IV set 1, IV set 2, and IV set 3 correspondingly.
(***) Significant at the 1 percent level; (**) significant at the 5 percent level; (*) significant at the 10 percent level.

Marginal effects of coefficients from the ordered probit models with control variables are presented in Table 6. The results in Table 6 correspond to columns (5) – (9) in Table 5. In overall, marginal effects indicate that the retirement decreases the probability to be in good health and increases the probability to be in bad health. There are some differences in effects on probability to be in average health. Model with one instrument, IV1, shows a decrease in probability to be in average health while models using different sets of instrumental variables show a slight increase in probability to be in average health. Marginal effects of coefficients from the model with IV1 indicate that retirement raises the probability to be in bad health by 5.6 percent and to be in very bad health by 1.5 percent. According to the results from this model, retirement also reduces the probability to be in average health by 3.3 percent, to be in good health by 3.6 percent and to be in very good health by 0.3 percent.

Table 6. Marginal effects in probit models

Dependent variable: subjective health

	Ordered probit	IV1	IV set 1	IV set 2	IV set 3
	(2)	(3)	(4)	(5)	(6)
Very bad	0.021***	0.015***	0.008***	0.006***	0.008**
	(0.001)	(0.003)	(0.002)	(0.002)	(0.003)
Bad	0.076***	0.056***	0.069**	0.057***	0.078***
	(0.003)	(0.009)	(0.016)	(0.018)	(0.022)
Average	-0.044***	-0.033***	0.015***	0.016***	0.032***
	(0.002)	(0.005)	(0.005)	(0.006)	(0.010)
Good	-0.049***	-0.036***	-0.086***	-0.074***	-0.109***
	(0.002)	(0.006)	(0.021)	(0.023)	(0.031)
Very good	-0.004***	-0.003***	-0.006***	-0.005***	-0.009***
	(0.000)	(0.000)	(0.002)	(0.002)	(0.003)
Number of observations	50,348	50,348	6,234	5,348	2,307

Notes: Marginal effects are reported; standard errors are in parentheses. The results correspond to column (5) – (9) in Table 5.
(***) Significant at the 1 percent level; (**) significant at the 5 percent level; (*) significant at the 10 percent level.

Table 7 demonstrates first stage estimates for IV models. The first row of Table 7 shows that, as expected, the pension eligibility substantially increases the probability of retirement.

Column (3) indicates that retirement expectations decrease the possibility of retirement. Recall that IV2 is a dummy variable that equals 1 if an individual was planning to continue working after retirement age. Thus, the negative sign of the coefficient implies that individuals who plan to work are substantially less likely to retire after retirement age. Column (4) confirms the results in column (3). Column (5) presents that the retirement of an individual is more likely after the spouse's retirement.

Table 7. First stage results

Dependent variable: retirement

	IV1 (2)	IV set 1 (3)	IV set 2 (4)	IV set 3 (5)
IV1 – eligibility for pension	1.272*** (0.026)	1.341*** (0.095)	1.349*** (0.086)	1.657*** (0.148)
IV2 – retirement expectations		-0.585*** (0.092)		
interaction (eligibility * expectations)		-0.064*** (0.024)		
modified IV2 – expectation residuals			-0.450*** (0.098)	-0.763*** (0.172)
interaction (eligibility * expectation residuals)			-0.051*** (0.023)	-0.052 (0.043)
IV3 – spouse's retirement				0.377*** (0.086)
Female	0.386*** (0.018)	0.716*** (0.086)	0.800*** (0.099)	1.084*** (0.137)
Adjusted years of education	-0.066*** (0.003)	-0.073*** (0.011)	-0.085*** (0.013)	-0.037* (0.019)
Married	0.154*** (0.017)	-0.004 (0.055)	0.030 (0.060)	0.065 (0.130)
Number of children in the household	0.082*** (0.015)	0.038 (0.045)	0.023 (0.050)	0.092 (0.088)
Number of adults in the household	0.004 (0.007)	0.138*** (0.022)	0.109*** (0.024)	0.046 (0.040)
Urban location	-0.148*** (0.018)	-0.206*** (0.054)	-0.205*** (0.058)	-0.036 (0.090)
Logarithm of real household income	-0.546*** (0.008)	-0.590*** (0.019)	-0.580*** (0.020)	-0.652*** (0.034)
Cohort dummies	yes	yes	yes	yes
Year dummies	yes	yes	yes	yes
F-statistics	2961.2	136.7	108.7	51.6
Sargan overidentification test		20.88	0.77	3.36
p-value (Sargan test)		0.00	0.68	0.34
Anderson-Rubin overidentification test		20.64	0.82	3.54
p-value (Anderson-Rubin test)		0.00	0.66	0.32

Notes: Robust standard errors are in parentheses. The results correspond to columns (6) – (9) in Table 5.
(***) Significant at the 1 percent level; (**) significant at the 5 percent level; (*) significant at the 10 percent level.

Determination of the interaction effect in nonlinear models is complicated. Moreover, the sign for the interaction effect can differ from the sign for the interaction term (Ai, Norton, 2003). Therefore, I use *inteff* command for Stata to compute the interaction effects and standard errors for the interaction between two variables in the probit models (Norton et al., 2004).[23]

The results of the first stage are used to check the validity of instruments. In all cases, the F-statistics shows that the instruments are not weak. To investigate the validity of exclusion restrictions I perform two overidentification tests: the usual Sargan test and the Anderson-Rubin chi-square test. In the case of IV set 1, the null hypothesis of the validity of instruments is rejected. Thus, unmodified retirement expectations are am improper instrument for retirement, and using expectations residuals instead of expectations is justified by the fail of overidentification test. Two sets of instruments, IV set 2 and IV set 3, confirm to be valid because the null hypothesis of the validity of instruments is not rejected.

To summarize, the results obtained by IV methods confirm the substantial negative impact of retirement on health. The results differ from those in Grogan and Summerfield (2015) who do not find any significant effect of retirement on health. I conduct a replication of the model in Grogan and Summerfield (2015) to reveal the causes of the contradictions. Table 8 compares replication results and those reported in Grogan and Summerfield (2015). Note that Grogan and Summerfield do not invert initial health scale. Thus, the positive sign of the coefficient indicates the negative impact of retirement on health.

Grogan and Summerfield use RLMS-HSE data for 2006-2011 years. Their sample includes women aged 46-59 and men aged 51-64 in 2006. They use only one threshold in the official retirement age for women and only one – for men. Thus, dummy for retirement age takes value 1 for women aged 55 and older, and 0 for women younger than 55. As for men, dummy for

[23] Alternative estimates of the first stage based on linear models show results similar to the results of *inteff* command.

retirement age takes value for men aged 60 and older, and 0 otherwise. They report results separately for women and men.

Table 8. Replication of (Grogan and Summerfield, 2015) results

Dependent variable: subjective health (1 – very good, 5 – very bad)

	Grogan and Summerfield, 2015		Replication		Different retirement age	
	Women	Men	Women	Men	Women	Men
	(2)	(3)	(4)	(5)	(6)	(7)
Dummy for retirement age	-0.0824	0.1433	0.0249	0.0856	0.248***	0.396***
	(0.107)	(0.142)	(0.048)	(0.061)	(0.046)	(0.058)
Age	0.0136	0.0824	0.0194	0.0205	-0.0625	-0.0867
	(0.173)	(0.250)	(0.085)	(0.129)	(0.086)	(0.130)
Age squared	0.0006	-0.0000	0.0002	0.0002	0.0008	0.0009
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Number of observations	8,032	4,120	10,998	5,474	10,973	5,282

Notes: clustered standard errors are in parentheses, additional control variables include dummies for year, month, and their interactions, location dummies.
Source: coefficients and standard errors in columns (2)-(3) are from (Grogan and Summerfield, 2015); coefficients and standard errors in columns (4)-(7) are calculated by author.
(***) Significant at the 1 percent level; (**) significant at the 5 percent level; (*) significant at the 10 percent level.

Results of replication are presented in columns (4) and (5) of Table 8. The results in some degree differ from those reported by Grogan and Summerfield. In columns (4)-(5) the number of observations is higher, and estimates of coefficients are more precise than in columns (2)-(3). However, we get estimates of coefficients close to Grogan and Summerfield.

To reveal the causes of contradictions, I apply different changes in the model. Changes in list of control variables or extending the period of analysis do not lead to significant changes in results reported in columns (4)-(5).[24] The only modification that significantly changes the results is applying a different approach to eligible retirement age. I use the information provided by respondents about their individual eligible retirement age instead of 55 for females and 60 for males. These results are presented in columns (6) and (7) of Table 8. Note that the health scale is not inverted as in other tables of the paper. So, the positive and statistically significant coefficients in both columns do not contradict with my baseline results. Thus, I attribute the differences in my

[24] These results are not presented in Table 8 and are available upon request.

results and results by Grogan and Summerfield (2015) to the different approach to retirement definition.

7. Robustness checks

There are several potential threats to the identification strategy described in the previous section. They include measurement errors and attrition bias. This section discusses these problems and applies some robustness checks.

7.1. Measurement error

Measurement error occurs if an individual gives the wrong information about her health. The common problem in health economics is the so-called "justification bias". An individual understates her health to justify the retirement (McGarry, 2004). The justification bias leads to the downward bias of self-evaluated health. However, there is some evidence that the problem of justification bias is not so widespread in Russia (Lyashok and Roshchin, 2015). Another type of bias is "role bias". It appears when an individual feels herself healthier after retirement because she does not face with physical limitations in the job. In fact, she could experience no change in health or even health decline, but she evaluates herself as healthier (Neuman, 2008). The role bias leads to the upward bias of self-evaluated health. Therefore, this paper also uses alternative health indices that apply additional "objective" information about the health. These indices aggregate the following variables:

1) self-evaluation of health,
2) dummy for heart disease, myocardial infarction,
3) dummy for high arterial blood pressure,
4) dummy for stroke-blood hemorrhage in the brain,

5) dummy for diabetes,

6) dummy for lung disease, bronchus,

7) dummy for liver disease,

8) dummy for kidney disease,

9) dummy for gastrointestinal disease,

10) dummy for spinal problems,

11) dummy for other chronic illness.

The first composite index, *PCA health index*, is constructed using the principal component analysis (PCA) method. This method is used to transform several correlated variables into a single measure. This measure is the first principle component that explains the largest share of the total variation of all variables (Lindelow, 2006).

The second composite index, *composite health index*, is constructed using the method suggested by Insler (2014) by four stages:

- First, eleven probit models including only eleven health variables are estimated separately. Each health variable is a dependent variable in one equation and independent variable in other equations. For the self-evaluation of health, the ordered probit model is used. Health variables are the same as in the previous index.
- Second, the predicted values of each dependent variable are calculated using the estimates of probit models.
- Third, each predicted values are normalized between zero and one, where the larger values indicate better health.
- Fourth, the mean of all normalized predicted values is calculated for each observation.

The descriptive statistics for composite indices in comparison with the self-evaluation of health is presented in Table 9. Number of observations for composite indices is less than for self-evaluated health because the data for some diseases are not presented in the early rounds. Note that health indices have different scales. PCA health index varies from -10.21 to 1.98 while composite health index varies from 0.35 to 0.92.

Table 9. Descriptive statistics for health indicators

	Self-assessed health (1 – very bad, 5 – very good)	PCA health index	Composite health index
Mean	2.81	-1.26	0.78
Standard deviation	0.65	1.95	0.10
Minimum	1.00	-10.21	0.35
Maximum	5.00	1.98	0.92
1st quartile	2.00	-2.39	0.72
Median	3.00	-0.85	0.81
3rd quartile	3.00	0.06	0.84
Skewness	-0.39	-0.89	-1.29
Number of observations	50,348	42,301	42,301

Source: calculated by the author using the RLMS-HSE data for years 1994-2013
Notes: the initial scale of health variable is inverted so that larger values represent better health (1 – very bad, 5 – very good). Real income in 1994-1996 is divided by 1000 due to the denomination of Russian currency in 1998.

The results obtained by using health indices are presented in columns (3) and (4) in Table 10. The results are from models with retirement variable instrumented by the first instrument IV1. Results with these indices confirm the results obtained in the previous section. The magnitudes of the effects are similar to each other taking into account different scales of health indicators.

Table 10. Robustness checks: health measurement and attrition

	Main model	PCA health index	Composite health index			
			Main sample	Reduced sample	Corrected for death	Excluding those living without other adults
	(2)	(3)	(4)	(5)	(6)	(7)
R_{it}	-0.331***	-0.464***	-0.016***	-0.021***	-0.055***	-0.056***
	(0.014)	(0.101)	(0.005)	(0.006)	(0.012)	(0.012)
Controls	yes	yes	yes	yes	yes	yes
Number of observations	50,348	42,301	42,301	28,572	29,075	28,330

Notes: Coefficients are reported, standard errors are in parentheses. All results are obtained by using IV1 as an instrumental variable. The dependent variable in column (2) is self-assessed health (1 – very bad, 5 – very good), the dependent variable in column (3) is index obtained by principal component analysis, the dependent variable in columns (4)–(7) is second composite index described in Section 7.1. The dependent variable in columns (6), (7) is adjusted for attrition. The results for columns (5), (6) are based on the sample excluding those living alone or from household without data on future attrition cause. The results for column (7) are based on the sample additionally excluding those living in households without other adult members.
(***) Significant at the 1 percent level; (**) significant at the 5 percent level; (*) significant at the 10 percent level.

7.2. Attrition bias

The problem of attrition bias could arise due to selection effects in the next panel wave. A person with severe health problems has a higher probability to drop out of the sample than a healthy individual. A sick person could go into the hospital, migrate to relatives, or even die. Moreover, the probability of drop out could correlate with the retirement status of an individual. Ignoring such differences in sample selection could lead to biased estimates. For example, if a retired person with health problems has a lower probability to drop out than an employed person than the effect of retirement on health is overestimated. In fact, attrition bias could be so substantial that it could even change the sign of the impact.

Unfortunately, the information about the death is not provided for all diseased individuals in the sample. Denisova (2010) in the study devoted to the mortality adduces the results of an additional survey that uses the administrative data to exploit the reasons for the RLMS-HSE attrition. This survey reveals that 1-2 percent of the drop-out households quit due to the death of one or two members, and other 1-2 percent quit due to the moving to other location after the death of one of the household members. It is a minor rate, and Denisova concludes that the attrition bias is limited. However, in the case of the retirement impact on health, the even minor degree of attrition due to death could significantly affect the estimates of coefficients. Therefore, I devote particular attention to deal with the attrition bias.

Gerry and Papadopoulos (2015) investigate the extent of attrition in the RLMS-HSE. They reveal that attrition is non-random and related to several personal characteristics including health and labor market activity. Gerry and Papadopoulos suggest using inverse probability weighting (IPW) to correct for attrition bias. However, applying this method to our sample is complicated for several reasons. For example, the sample includes a large share of temporary attritors who return to the survey after one or more years of absence.[25] Furthermore, the survey had several major replenishments. Thus, I use another approach to estimate the consequences of attrition based on the mortality data.

The household questionnaire in the RLMS-HSE includes a question about causes of person's attrition.[26] This question is asked if the person observed in the previous round is not living in the household in the current round. Since 2001, the causes of death include different illnesses. Therefore, it is possible to incorporate data on death into health measure.

Unfortunately, such approach has some limitations. The most serious limitation is that the household must have at least two persons to provide information about someone's death. The death of a single person could not be told by anyone to the interviewer next year. Thus, the sensitivity of results to attrition is checked only for individuals living in households with at least two persons.[27] But, to generalize the results to the overall sample, it is necessary to assume the homogeneity of effects among single person's households and households of bigger size. The impact of the retirement on health could differ for single individuals and those living with others (see the effects for individuals in different households by size *in Section 7.5*). Thus, this robustness check does not allow to get the conclusions for the overall sample. However, it could provide additional information about the direction and magnitude of the attrition bias.

The next limitation concerns the case of a household of the older individual and young children. After his death children could move to other household and, therefore, they would not be covered by the survey. Thus, an additional robustness check is provided for the sample of individuals living in households with at least two persons one of whom is 18 years, or older.[28]

[25] The dynamic version of IPW used by Gerry and Papadopoulos (2015) implies exclusion all observations for temporary attritors after their return.
[26] The household questionnaire is answered by the household head.
[27] Brainerd and Cutler (2005) study of the mortality on the RLMS-HSE data also uses the same approach to construct the sample.
[28] Such approach was used earlier in the study of mortality on the RLMS-HSE data by Furmanov and Chernysheva (2014).

One more limitation is that some households miss one or more rounds. But I not only compare consecutive rounds but also use the information from the first appearance of the household after the absence.

The dependent variable in the analysis of attrition bias is the composite health index. A continuous variable is more appropriate for incorporating death into the health measure. The estimation differs from the main model by using future value of health variable instead of contemporaneous value. The future value of health index is also adjusted for attrition by adding a zero value to individuals who die from diseases.

To estimate the sensitivity of the results to the attrition caused by death from diseases, I exclude from the sample those who live alone and those who live in households where all members exit from the survey. Firstly, to provide comparability of results I estimate the model with the future value of health index on reduced sample without any correction for attrition. The estimates obtained by using future value of health index on reduced sample are similar to baseline estimates (see column (5) in Table 10). Next, I correct health index by adding zero values to those who die from a disease. The sample, thus, increases by 503 observations. The model corrected for the attrition bias produces significantly higher negative effects compared to the model without correction as presented in column (6).[29] Last, I exclude from the reduced sample those who live in households without other adults among household members. The obtained results shown in column (7) are similar to results in the previous column.

Thus, correction for attrition bias does not significantly change the main conclusion. Results from models corrected for attrition do not contradict with the main conclusion of negative retirement impact on health. Moreover, these results indicate that the effect obtained by the main model is even underestimated. Retired individuals tend to have higher mortality rates compared to non-retirees.

[29] Given the scale of probit health index from 0.35 to 0.92, it could seem arbitrary to assign zero value to death. But even if death is assigned to the minimum index value of living person (0.35), the coefficient is still significantly larger (namely, -0.039).

7.3. Alternative retirement definition

The main results are based on a narrow retirement definition. I examine only full retirees; thus, I ignore different retirement paths. An individual could choose part-time retirement after reaching retirement age, and this type of retirement also needs an investigation.

I examine the impact of part-time retirement by two different ways. The first is based on the determination of dummy variable of part-time retirement. This variable is equal to 1 if an individual becomes partially retired in this round compared to previous wave and equal to 0 if she is a full-time employee. An individual is considered as partially retired if she works less than 20 hours per week. This threshold is chosen by the examination of different retirement paths of the elderly. Those who work 20 to 30 hours per week have a high probability of increasing working time in future. Those who work less than 20 hours per week have much less probability to increase substantially working time and return to full employment. The second approach uses the logarithm of working hours as a continuous measure instead of retirement variable.

In both cases, I use the same approach to determine working hours. Its determination is mainly based on the following question about the first job of an individual: "*On average, how many hours is your usual work week*?" However, there are missing observations, and this question was not asked in early rounds. If there are no observations, I use another question "*How many hours did you actually work at your primary job in the last 30 days*?" If there are no observations even for the second question I use questions "*On average, how long is your normal workday at this job*?" and "*How many workdays in all have you worked in the last 30 days*?" The same algorithm is applied to determine the number of working hours in the second job. I also add the number of working hours in the incidental job during last 30 days but only if an individual is often engaged in this job on a regular basis. If the total monthly number of hours exceeds 360, it is replaced by missing value.

The results for the alternative definitions of the retirement are presented in Table 11. The coefficient of part-time retirement is positive, thus, indicating that the transition to part-time retirement from full-time employment benefits health. However, this effect is moderate and statistically insignificant. On the contrary, the impact of the logarithm of working hours on health is positive and statistically significant indicating that increase in working hours leads to health improvement. These findings suggest that the negative impact of retirement on health is caused by the transition from work to retirement but not by the decrease in working time.

Table 11. Robustness checks: retirement definition and working conditions

Dependent variable: subjective health (1 – very bad, 5 – very good)

	Main model	Partially retired	Logarithm of working hours	Harmless working conditions
	(2)	(3)	(4)	(5)
R_{it}	-0.331***			-0.287***
	(0.014)			(0.019)
Part-time retirement		0.217		
		(0.216)		
Logarithm of working hours			0.066***	
			(0.012)	
Controls	yes	yes	yes	yes
Number of observations	50,348	21,536	49,685	30,036

Notes: Coefficients are reported, standard errors are in parentheses. All results are obtained by using IV1 as an instrumental variable.
(***) Significant at the 1 percent level; (**) significant at the 5 percent level; (*) significant at the 10 percent level.

Another robustness check is performed to test the validity of IV1. The eligible pension age could differ due to differences in working conditions. Harmful working conditions could not only influence pension age and decision to retire but also lead to long-term health effects. To check whether it could deteriorate the estimates I do calculations only for those who were previously employed at jobs without harmful working conditions. For this group variation in pension age is not caused by working conditions, so the impact of pension age on health is explained only by retirement channel. Results of estimation are presented in column (5) of Table 11. The sample is substantially lower compared to the main sample due to excluding those who was employed at jobs with harmful working conditions and those with missing data on working conditions. The estimates are slightly lower compared to the main sample, but the effect is still large and statistically significant.

I also examine the divergence of health between retires and non-retires when retirement length increases. Results are presented in Table 12. Each column presents coefficients from model estimated on the sample of non-retirees and those who retired in the corresponding period before an interview. For example, the number of individuals in column (2) includes non-retirees and retired between 12 and 24 months before an interview; the number of individuals in column (3) includes non-retirees and retired between 24 and 36 months before an interview, and so on.

Table 12. Effect of retirement on health by the length of retirement

Dependent variable: subjective health (1 – very bad, 5 – very good)

	1-2 years	2-3 years	3-5 years	5-10 years	10-20 years
	(2)	(3)	(4)	(5)	(6)
R_{it}	-0.209**	-0.309***	-0.301***	-0.339***	-0.435***
	(0.087)	(0.085)	(0.068)	(0.054)	(0.055)
Number of observations	23,221	23,385	25,007	29,398	32,893

Notes: Coefficients are reported; standard errors are in parentheses. The results are obtained using IV1. The results correspond to column (6) in Table 5.
(***) Significant at the 1 percent level; (**) significant at the 5 percent level; (*) significant at the 10 percent level

The results indicate that the negative impact of the retirement enlarges as the length of retirement increases. However, the most substantial health decline is observed soon after retirement.

7.4. Alternative instruments

I also consider several different instrumental variables that could influence the decision of retirement but do not influence the health:

- The presence of grandchildren in the household. Many households in Russia have a complicated structure and include not only children and their parents but also grandparent or grandparents. When both parents have full-time jobs, grandparents take care of their grandchildren. To find the grandchildren of respondents I use information about relatives from household files of the RLMS-HSE. The presence of grandchildren is a binary variable indicating 1 if there is at least one grandchild in the household.
- The ratio between old-age labor pension and wage. Substantial disparities between labor pension and wage could force an individual to delay her retirement. It is a continuous variable which is calculated by division of the labor pension after reaching eligible retirement age to the wage two years earlier. The sum of wage is determined as the average monthly wage in previous 12 months. If these data are missing then wage in last 30 days is used. Non-cash payments and wage arrears are also included in the wage.
- The presence of dacha. Dacha is the wide-spread second house which often requires substantial efforts for gardening. The crop from dacha could be consumed in the household or sold in the market. Dacha provides the additional possibility to increase the well-being of pensioners so they could give up the job for engagement in dacha's activities.

First-stage statistics of the instruments is presented in Table 13.

Table 13. First stage results for alternative instruments

Dependent variable: retirement

	Grandchildren	Pension-wage ratio	Dacha
Coefficient	-0.016**	-0.002	-0.002
Standard error	(0.007)	(0.002)	(0.004)
F-statistics	4.93	1.00	0.29
Number of observations	23,885	7,678	23,867

Notes: Robust standard errors are in parentheses.
(***) Significant at the 1 percent level; (**) significant at the 5 percent level; (*) significant at the 10 percent level.

All alternative instruments are weak and could not be used to identifying the effect of retirement on health.

7.5. Heterogeneity of effects

The review of the empirical literature shows that the impact of retirement on health could substantially differ among different subgroups. So, I investigate differences in impact by gender, urban location, education (using ten years of education as a threshold between high level and low level), marital status, and initial health level.

The most popular tool to investigate heterogeneity is the inclusion of interaction terms in the model. However, the determination of the interaction effect in nonlinear models is complicated. Moreover, the sign for the interaction effect can differ from the sign for the interaction term (Ai, Norton, 2003). Thus, I investigate the heterogeneity by simple division the main sample into subgroups. The results are presented in Table 14. All results are obtained by using the ordered probit model with IV1.

In almost all subgroups, the effect is negative and statistically significant which is mostly pronounced for males, urban dwellers, highly educated, married, and individuals with initially low health level. Impact of retirement on health of those with good health is slightly positive but statistically insignificant.

Table 14. Effect of retirement on health by different subgroups

Dependent variable: subjective health (1 – very bad, 5 – very good)

	All sample	Females	Males	Urban location	Rural location	High education	Low education
	(2)	(3)	(4)	(5)	(6)	(7)	(8)
R_{it}	-0.243***	-0.150***	-0.405***	-0.310***	-0.106	-0.331***	-0.165***
	(0.040)	(0.049)	(0.069)	(0.048)	(0.070)	(0.056)	(0.056)
Number of observations	50,348	35,408	14,940	36,663	13,685	27,086	23,262

Notes: Coefficients are reported; standard errors are in parentheses. The results are obtained using IV1. The results correspond to column (6) in Table 5.
(***) Significant at the 1 percent level; (**) significant at the 5 percent level; (*) significant at the 10 percent level

Table 14. Effect of retirement on health by different subgroups (cont.)

Dependent variable: subjective health (1 – very bad, 5 – very good)

	Initial good health	Initial average health	Initial bad health	Married	Single
	(9)	(10)	(11)	(12)	(13)
R_{it}	0.101	-0.323***	-0.432***	-0.275***	-0.188***
	(0.158)	(0.064)	(0.118)	(0.050)	(0.063)
Number of observations	3,652	24,724	7,871	28,522	21,826

Notes: Coefficients are reported; standard errors are in parentheses. The results are obtained using IV1. The results correspond to column (6) in Table 5.
(***) Significant at the 1 percent level; (**) significant at the 5 percent level; (*) significant at the 10 percent level

7.6. Channels of retirement impact on health

The channels of impact of retirement on health are investigated by estimating the short-term effect of retirement on different choices of lifestyle. By focusing on recent retirees we reveal the main changes of health behavior immediately after retirement.

The channels are investigated by changing the dependent variable to the corresponding variable of health behavior. The results are presented in Table 15. I use the following binary variables as dependent variables: smoking, smoking cessation, beginning smoking, drinking alcohol more than three times per week, drinking alcohol one time per week or more, regular sports activity. I also use number of cigarettes per day, the logarithm of average cigarette price, the logarithm of household expenditures on tobacco in last seven days. For comparison, I also present results for the logarithm of household expenditure on medical drugs in last month. The question on the cigarette price has appeared in individual questionnaire only recently, thus, the sample in this case as shown in column (6) is very low. Thus, I also use data on cigarette prices from household questionnaire.

Alcohol and smoking are among the main causes of low life expectancy and large male-female life expectancy gap in Russia. The retirement does not lead to the significant decline in the probability of smoking or alcohol consumption. It even raises the probability of smoking and excessive alcohol consumption (more than three times per week). However, an impact of retirement on smoking and alcohol consumption is not substantial. Moreover, retirement does not lead to an increase in the number of cigarettes per day. There is also a positive effect of retirement on participation in sports activities. But this effect could be compensated by a reduction in on-the-job physical activity. Overall, the retirement does not lead to the significant changes in the lifestyle. However, I find that unhealthy lifestyle that could be the result of hard work does not disappear after retirement.

Table 15. Effect of retirement on different outcomes

	Smoking	Smoking cessation	Beginning smoking	Number of cigarettes per day	Logarithm of average cigarette price (individual data)	Logarithm of average cigarette price (household data)
	(2)	(3)	(4)	(5)	(6)	(7)
R_{it}	0.162^{**}	0.062	-0.020	-0.961	-0.114^{**}	-0.233^{***}
	(0.067)	(0.156)	(0.148)	(0.725)	(0.052)	(0.036)
Number of observations	50,348	9,941	30,372	9,172	2,564	18,250

Notes: Coefficients are reported; standard errors are in parentheses. The results are obtained using IV1. Each column presents the results of estimation an impact of retirement on the corresponding dependent variable.
(***) Significant at the 1 percent level; (**) significant at the 5 percent level; (*) significant at the 10 percent level

Table 15. Effect of retirement on different outcomes (cont.)

	Alcohol (more than 3 times per week)	Alcohol (one time per week or more)	Logarithm of household expenditures on tobacco	Logarithm of household expenditures on medicaments	Sports activity
	(8)	(9)	(10)	(11)	(12)
R_{it}	0.153^{*}	-0.005	-0.105^{*}	-0.193^{**}	0.172^{***}
	(0.090)	(0.057)	(0.056)	(0.078)	(0.063)
Number of observations	50,348	50,348	18,354	33,241	45,643

Notes: Coefficients are reported; standard errors are in parentheses. The results are obtained using IV1. Each column presents the results of estimation an impact of retirement on the corresponding dependent variable.

(***) Significant at the 1 percent level; (**) significant at the 5 percent level; (*) significant at the 10 percent level

Alcohol and smoking also have a significant share in expenditures of many households, and the reduction in income due to retirement could lead to raising this share. However, I reveal a reduction in household expenditures on tobacco. Given the persistence in cigarette consumption, it could indicate the reduction in prices of purchased cigarettes. Indeed, the effect of retirement on cigarette prices is negative and substantial. So, the retirement results in a purchase of cigarettes by lower prices. Taking into account that cheaper cigarettes could be more harmful to health the reduction in prices could be a channel of the negative health impact of retirement.

7.7. Regression discontinuity design

This subsection applies regression discontinuity design as an alternative method for the causal investigation to provide yet another robustness check. Regression discontinuity design (RDD) is another popular method of investigating the causal impact of retirement on health. In this case, regression discontinuity design uses the fact that the eligible retirement age is a threshold which divides all individuals into those in the left side of the threshold (non-treated) and those in the right side of the threshold (treated). RDD applies the assumption that individuals which are near the threshold on both sides should be similar by many characteristics including health. Thus, all differences in health between individuals from different sides are attributed to the causal impact of the intervention, i.e. retirement. In retirement and health studies the running variable – the variable that determines treatment – is individual's age.

I already applied this method in replication of Grogan and Summerfield (2015) study in Section 6. However, in Section 6 I used their approach determining the sample and list of controls. In this section, I apply RDD to my sample. Another difference is using fuzzy RDD instead of sharp RDD.

First, I investigate an evidence of the discontinuity near the retirement age. Figures 2 and 3 show the share of retirement for males. The threshold in Figure 2 is determined on the basis of the most popular retirement age for males – 60 years. The threshold in Figure 3 is determined on the basis of the individual-specific retirement age. Thus, the horizontal axis in Figure 3 reflects the years before and after individual's retirement age.

Figure 2. Share of retired males by age

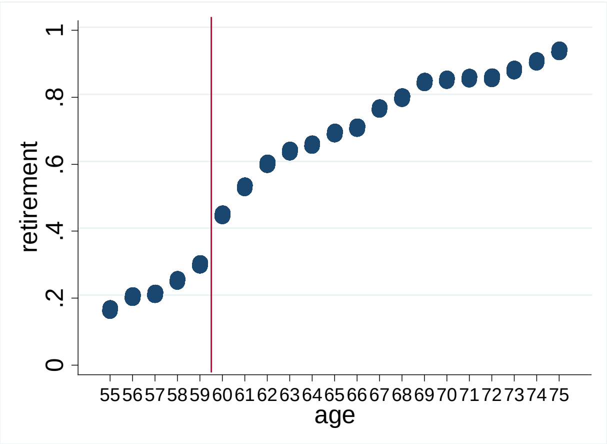
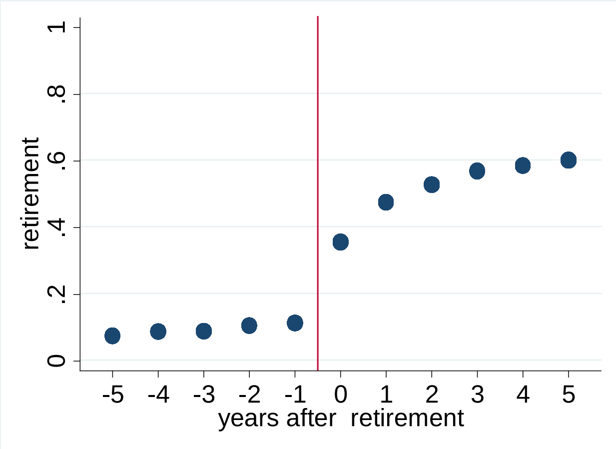


Figure 3. Share of retired males by number of years after retirement



The share of retirees increases noticeably after reaching retirement age. Only 29.6 percent of males are retired at age 59 while 44.5 percent are retired at age 60, and 52.8 percent are retired at age 61. The threshold in Figure 3 indicates a more substantial increase in the share of retirees among males. The percentage of retirees rises from 11.2 percent before specific retirement age to 35.5 percent at retirement age and 47.5 percent one year after retirement age. Figure 3 indicates that during two years the share of retirees increases by 36.3 percentage points compared to the increase by 24.3 percentage points in Figure 2.

Figures 4 and 5 show the share of retirement for females. The threshold in Figure 4 is determined on the basis of the most popular retirement age for females – 55 years. The threshold in Figure 5 is determined on the basis of the individual-specific retirement age.

Figure 4. Share of retired females by age

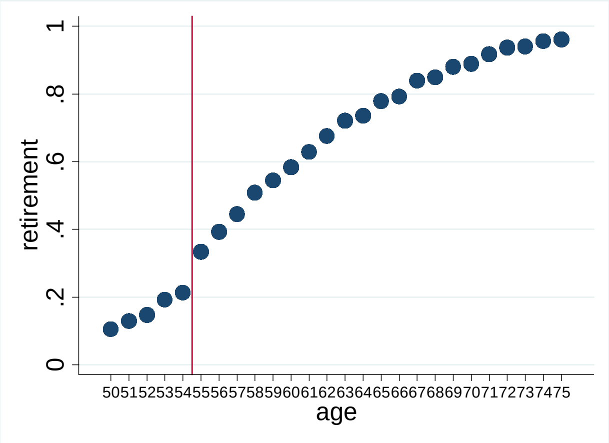
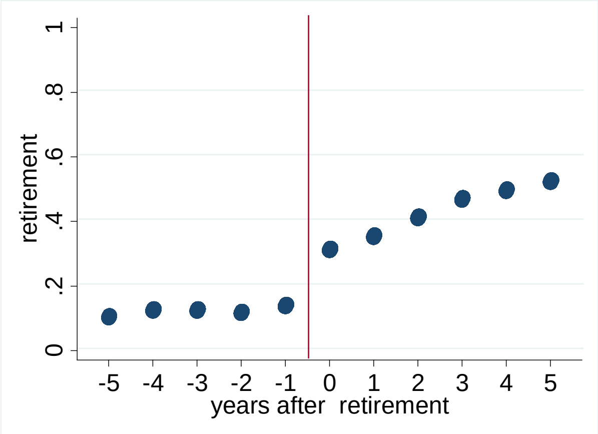


Figure 5. Share of retired females by number of years after retirement



After crossing the threshold of 55 years the share of retired females changes from 21.2 percent to 33.4 percent. The share of retired females is 39.2 percent at age 56. The alternative threshold presented in Figure 5 indicates more significant discontinuity. The share of retirees rises from 13.5 percent before specific retirement age to 30.9 percent at retirement age and 35.1 percent one year after retirement age. The two-year increase in Figure 5 is 21.6 percentage points compared to 18.0 percentage points in Figure 4.

So, the discontinuity near individual-specific official retirement age is sharper than the discontinuity near baseline official retirement age. Figures 2-5 also show that the increase in the share of retired follows different trends before and after retirement age. Thus, I modify the specification of running variable *age* in regression discontinuity model to take into account different trends.

There is also a graphical evidence of discontinuity in health while crossing the threshold. Figures 6 and 7 demonstrate a substantial health decline after reaching individual-specific retirement age. The decline is noticeable both for females and males.

Figure 6. Subjective health of males around the threshold

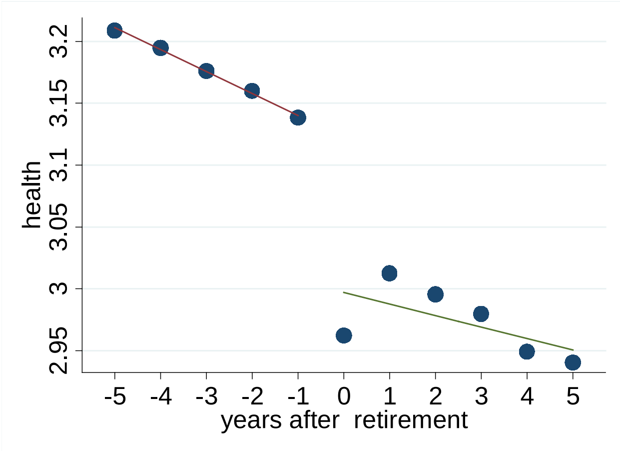
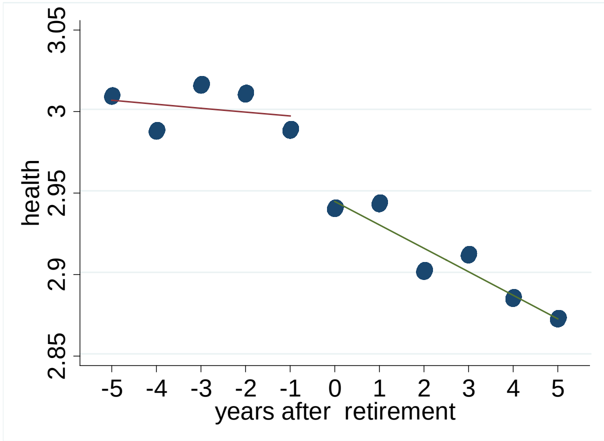


Figure 7. Subjective health of females around the threshold



Notes: 1 – very bad, 5 – very good

There are two main types of RDD: sharp RDD and fuzzy RDD. In sharp RDD, all individuals from the left side of the threshold are not treated, and all individuals from the right side are treated. Fuzzy RDD is applied when crossing the threshold significantly increases the possibility of treatment but does not raise it to one. I use fuzzy regression discontinuity design because many individuals in the sample do not retire after reaching their official retirement age.

The estimation in fuzzy RDD is based on the two-stage least squares approach. The first stage models the retirement decision:

$$R_{it} = \varphi + \rho D_{it} + \beta_1 age_{it} + \beta_2 age_{it} * D_{it} + u_{it}, \quad (6)$$

where D_{it} is a binary variable that takes value 1 if an individual is on the right side of the threshold, and value 0 if an individual is on the left side of the threshold. To allow for different trends before and after retirement age, I add interaction of variables age_{it} and D_{it}. The second stage models the effect of retirement on health:

$$H_{it} = \alpha + \delta \hat{R}_{it} + \gamma_1 age_{it} + \gamma_2 age_{it} * D_{it} + \varepsilon_{it}. \quad (7)$$

The results of estimation are presented in Table 16. Due to retirement delay I use two different thresholds: the first is set at the year of the individual-specific eligible retirement age, and the second is set at one year after the individual-specific eligible retirement age.

Table 16. Estimates of regression discontinuity models

Dependent variable: subjective health (1 – very bad, 5 – very good)

	Year at retirement (2)
Retirement	-0.280***
	(0.037)
Age	0.011***
	(0.003)
Age * D_{it}	-0.024***
	(0.003)
Number of observations	49,662

Notes: standard errors are in parentheses.
(***) Significant at the 1 percent level; (**) significant at the 5 percent level; (*) significant at the 10 percent level.

The results of the RDD confirm the results of the baseline model. Retirement leads to considerable health decline in Russia.

8. Conclusions

The life expectancy, as well as health indicators of the elderly in Russia, remains low compared to countries with a similar level of economic development. This paper investigates the causal impact of retirement on health. The estimation is complicated by several methodological problems including an endogeneity of retirement, panel attrition bias and health measurement. The paper uses instrumental variable estimation to overcome the endogeneity problem. I exploit the variation in the eligible retirement age that is caused by the possibility of receiving state pension earlier for broad categories of employees. Remarkably, this earlier pension is not lower than the baseline pension for remaining categories of employees. Several robustness checks are performed to estimate the vulnerability of results to methodological challenges.

All in all, the results show the substantial negative impact of retirement on health. These results differ from those reported by Grogan and Summerfield (2015) who do not find any significant effect of retirement on health. Unlike Grogan and Summerfield, I use a different approach to determine the eligible retirement age taking into account its variation across occupations and regions.

To evaluate the magnitude of the effect, I estimate the same models on the same samples but change the retirement variable to the variable indicating the stroke between interview and previous wave. The effect of the retirement is comparable to one-quarter of the effect of the stroke, thus, presenting a very substantial impact on health.

The evidence of negative effect persists after several robustness checks. Different approaches to health measurement show similar results. The estimates are likely biased by non-random panel attrition, but this bias leads to an underestimation of effect rather than an overestimation. Accounting for attrition bias shows an even larger effect compared to baseline estimates.

There is also a remarkable heterogeneity in the magnitude of the effect but not in the effect direction. The more substantial effect is observed for males, highly educated individuals, urban citizens, married, and individuals with low initial health. To explain the observed effect, several possible channels were examined. The retirement leads to the reduction in prices of purchased cigarettes, and I interpret it as a shift toward more harmful cigarette consumption. I also reveal that the individuals keep unhealthy lifestyle associated with hard work after retirement, so they do not switch to the healthier lifestyle.

Future research in this area could include the further investigation of the channels of retirement impact on health. The results of channels investigation do not entirely explain the large impact of retirement on health. For example, it is promising to study more thoroughly patterns in alcohol consumption. Another branch of further research could be addressed to the estimation of monetary loss of health decline due to retirement. Such estimates would be helpful in the determination of possible grounds for pension reform.

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Appendix

Table A1. Main findings of previous empirical studies

Study	Country	Retire-ment age	Life expectancy at age of retirement: Female	Life expectancy at age of retirement: Male	Effect	Magnitude	Method	IV	Retirement definition	Dependent variables	Heterogeneity of effects	Other outcomes	Problems trying to solve
(Grogan and Summerfield, 2015)	**Russia**	55 or 60	24	14	0	Insigni-ficant	RDD		Threshold of official retirement age	Self-assessed health	No substantial differences between males and females		
(Dave et al., 2008)	US	62 or 65	21 or 24	19 or 21	-	Moderate	Fixed effects, IV	Spouse's retirement status	Self-assessment as “retired” or “partially retired”	Dummies of self-assessed health (1 – “poor health”), health problems and diseases	Smaller but significant effects for individuals who were physically and mentally healthy before retirement. Larger effects on physical health for males. Larger effects on mental health for females. Larger effects for unmarried, retirees from non-stressful jobs, retirees from physically demanding jobs, non-participated in physical activities after retirement, involuntarily retired. Smaller effects for partially retired.	No effect on cancer. Significant effect on probabilities of different other diseases.	Endogeneity, selective changes in insurance coverage, unobserved shocks between waves
(Neuman, 2008)	US	62 or 65	21 or 24	19 or 21	+	Small	IV	Eligibility age, spouse’s age, dummy of age older than eligibility age and self-reported usual retirement age on the job	Dummy of working less than 1,200 annual hours per year	Dummies of self-assessed health change (1 – “improved or non-changed health”), changes in health problems and diseases (1 – improvement or no changes)	Larger effects for females.	No statistically significant effect on health problems. Decline in the probability of problems with daily living activities for females.	Endogeneity of instruments, subjective sample selection due to different definitions of retirement
(Coe and Lindeboom, 2008)	US	62 or 65	21 or 24	19 or 21	+	Insignifica nt	IV	Offer of early retirement window	Early retirement window		No substantial heterogeneity for different types of jobs including stressful and nonstressful jobs, job satisfaction, blue-collar and	No significant effect on mental health, heart attack, high blood pressure, diabetes, cancer,	

Study	Country	Retire-ment age	Life expectancy at age of retirement		Effect	Magnitude	Method	IV	Retirement definition	Dependent variables	Heterogeneity of effects	Other outcomes	Problems trying to solve
			Female	Male									
											white-collar workers, higher and lower educated workers.	and ADL test score.	
(Bonsang et al., 2012)	US	62 or 65	21 or 24	19 or 21	-	Large	IV	Eligibility age	Self-assessment as "retired"	Result of episodic memory test		Decrease in results of working memory test	Selection bias
(Insler, 2014)	US	62 or 65	21 or 24	19 or 21	+	Large ("one-quarter of arthritis")	IV	Retirement expectations after eligibility age	Self-assessment as "retired" or "partially retired" and (in the second case) less than 20 working hours per week	The change of composite index constructed as weighted sum of dummies of diseases and self-assessed health	Larger effect for "full retirees". Similar effects for younger and healthier subsamples.	Increase in participation in exercises and decrease in smoking.	Correlation between IV and error term, measurement error, justification bias
(Gorry et al., 2015)	US	62 or 65	21 or 24	19 or 21	+	Moderate	Fixed effects, IV	Eligibility age	Retired and partially retired	Self-assessed health, composite index of diseases, mental health score	No substantial heterogeneity. Relatively larger effects for less-educated, nonwhites and Hispanic, single persons, retirees from physically demanding jobs/	Increase in life satisfaction, no effect on number of functional limitations, no effect on health care utilization	Attrition bias, selection bias
(Eibich, 2015)	Germany	60 or 65	25	18	+	Large	RDD		Self-assessment as "retired"	Dummies of self-assessed health (1 – "satisfactory health"), physical health index, mental health index	Little heterogeneity by gender. Larger effect on mental health for highly educated. Larger effect on physical health for less educated. Larger effects for retirees from physically demanding jobs. No heterogeneity by retirement status of the partner. Larger effects for retirees with grandchildren.	Decrease in smoking. Increase in participation in exercises. Small decrease in body mass. Large increase in sleep duration. No significant effect on the number of close friends. Increase in time for an active lifestyle. Decrease in the probability of hospitalization and number of doctor visits.	
(Behncke, 2012)	UK	63 or 65	25	18	-	Moderate	IV, matchin g	Eligibility age	Self-assessment as "retired" and "not in paid work" activity	Self-assessed health. Dummy of chronic disease.	Larger effect for retired because of reaching state pension age	Increase of cardiovascular diseases and cancer. Increase of difficulties in activities of daily living. Higher risk to develop the	Attrition, measurement error, justification bias

Study	Country	Retire-ment age	Life expectancy at age of retirement Female	Male	Effect	Magnitude	Method	IV	Retirement definition	Dependent variables	Heterogeneity of effects	Other outcomes	Problems trying to solve
									in last month			metabolic syndrome and high fibrinogen concentration.	
(Blake and Garrouste, 2012)	France	60-65	n/e* (23-27)	19-23	+	Large	IV	Based on pension reform change	Dummy of retirement	Multidimensiona l index of health	No substantial differences for males and females. Larger effect for low-educated individuals.	The largest effect on social health. Large effect on physical health. No effect on mental health.	
(Blake and Garrouste, 2013)	France	60-65	n/e* (23-27)	19-23	+	Large (one-year delay of retirement leads to a decrease in life expectanc y of 0.22 years)	IV	Based on pension reform change	Dummy of retirement	Mortality	Different effects for income groups	-	
(Bingley and Pedersen, 2011)	Denmark	60 or 67**	20 or 26	18 or 23	+	Large	IV	Based on pension reform change	Age of retirement	Mortality	-	Large effects for deaths of bronchitis and strokes especially in younger years. Small effects for other causes of death.	Instrumenting income
(Bingley and Pedersen, 2011)	Denmark	60 or 67**	20 or 26	18 or 23	+	Large	IV	Based on pension reform change	Age of retirement	Mortality	-	Large effects for deaths of bronchitis and strokes especially in younger years. Small effects for other causes of death.	Instrumenting income
(Antonova et al., 2015)	Europe				+	Moderate	IV	Eligibility age	Self-assessment as "retired"	Composite indicator of mental health	The effect is observed only for males. The effect is stronger for blue-collars working in regions that are severely hit by economic crisis.	-	Attrition
(Atalay and Barrett, 2014)	Australia	60-65	23-27	n/e*	+	Moderate	IV	Eligibility age	Self-assessment as "not in the labor force"	Dummies of self-assessed health (1 – "bad health"), mental health problems,	The same effect for single individuals, low-income group	Mental health improves due to a decrease in mood disorders, physical health – due to a decrease in hypertension, migraine,	

Study	Country	Retire-ment age	Life expectancy at age of retirement		Effect	Magnitude	Method	IV	Retirement definition	Dependent variables	Heterogeneity of effects	Other outcomes	Problems trying to solve
			Female	Male									
										physical health problems		back pain and disc disorders. No effect on healthy behavior: smoking, participation in exercises. No effect on overweight.	
(Lei et al., 2011)	China	60	n/e*	18	-	Large	RDD		Both not working and not looking for the job	Dummy of self-assessed health (1 – "good health")	Smaller effects for better educated.	No significant effect on probability of functional limitations (self-assessed)	

Source of data on life expectancy: World Health Organization

Notes: Life expectancy varies if the different retirement age is eligible either for females or males. The last column "Problems" describe the problems that subsequent papers try to solve by adjusting methodology. A problem is added to this column if a paper explicitly names this problem and (i) tries to adjust somehow methodology or (ii) provides any statistical test to check for it.

*) *n/e* – this subgroup was not investigated in the paper.

**) 60 years is an early retirement age in Denmark established as an alternative to disability pension.