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Health and labor force participation of elderly Russians

The effect of health on labor force participation is an established fact. This research hypothesizes the endogeneity of health stemming from the reverse effect, reporting bias and unobserved factors. The relationship between health and labor force participation of elderly Russians is modeled with simultaneous equations using data from World Health Organization Study on Global Ageing and Adult Health, Wave 1 (WHO SAGE, 2007–2010). A strong and non-linear effect of health on labor force participation is confirmed. Unlike for a complex health measure, endogeneity, confirmed by the correlation of unobserved shocks in the system of equations, is found for single-question health measures. The results show that the official retirement age has a moderate effect on labor force participation for women and a weaker or no effect for men. Nevertheless, the health of elderly Russians does not impose strong limitations on the increase of the retirement age.

Keywords: health; labor force participation; retirement; elderly.
JEL classification: I10; J14; J26.

1. Introduction

Increases in healthy life expectancy in developed countries in recent decades have resulted in increases in the retirement age and discussions concerning pension reforms. This problem has become especially pronounced in the Russian Federation, which led many experts to suggest raising the retirement age to increase overall labor force participation. However, such measures may be inefficient or infeasible if the poor health of older Russians constrains their decision regarding retirement. It is possible that other factors, such as health, provide a more effective mechanism to stimulate labor force participation among the elderly.

Although a lot of research has been done on data from developed countries showing strong interconnections between health and the retirement decision, little has focused on Russia. Therefore, it is unclear whether all of these results hold for the Russian case. The answer to this question will be crucial to understanding the possible effects of proposed retirement reforms and opportunities to increase labor force participation through other mechanisms.

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The main objective of this research is to simultaneously model labor force participation and the health of elderly[2] Russians. To avoid confusion, we define the retirement decision as a labor force participation choice: a person is either in the labor force or retired. In particular, the following hypotheses are tested.

1. Health is a significant factor in the retirement decision.
2. The effect of health is nonlinear with respect to age and health level.
3. Labor force participation affects health.
4. Reaching the official pension eligibility age does not affect the retirement decision.

A simultaneous equations approach is chosen to model retirement and health jointly to account for possible endogeneity (Cai, 2010; Stern, 1989; Van Gameren, 2008). The system of equations is estimated with the maximum likelihood method, which allows for correlation between the errors of the two equations. We use data from the World Health Organization Study on Global Ageing and Adult Health, Wave 1 (WHO SAGE, 2007–2010). The survey was conducted in Russia in 2007–2010, and it collected unique objective health indicators, which distinguish this dataset from others.

Four aggregate health measures are used in alternative specifications to represent health. Three of them are single-question measures: self-assessed health, severity of difficulties with work and household activities, self-reported comparison of health to people of the same age in the same location. The fourth is a complex index based on questions concerning individuals' difficulties in undertaking certain activities (World Health Organization Disability Assessment Schedule 2.0, WHODAS[3]). Independent variables in the health equation include objective health indicators, which are grouped into 5 categories: self-reported conditions, symptom-based conditions, anthropometrics, behavior and risk factors, and health care utilization.

Hypotheses 1 and 2 are confirmed. Health strongly affects labor force participation: better health leads to postponed retirement. Marginal effects of health are highly non-linear, being strongest at moderate health levels and depending on age.

Evidence regarding Hypothesis 3 is mixed and subject to ambiguous interpretation: the direct effect of labor force participation may be present or not together with reporting bias. Nevertheless, there is strong evidence of health endogeneity with single-question health measures, which is confirmed by error correlation.

Hypothesis 4 is confirmed for men and rejected for women, which results from the difference in their retirement patterns. The official retirement age seems to have a moderate effect on labor force participation for women and weaker or no effect for men. Nevertheless, health does not impose limitations to a possible retirement age reform.

Section 2 describes the Russian context, Section 3 presents the theoretical framework, Section 4 reviews the literature, Section 5 describes the methodology, Section 6 presents the data and the model, Section 7 presents the results, Section 8 discusses them, and Section 9 concludes.

[2] For ease of exposition, in this paper we use the term «elderly» to refer to the population aged 50+.

[3] See http://www.who.int/classifications/icf/whodasii/en/.

2. Russian context

There are several features of the Russian pension system that distinguish it from those in other countries. The official retirement age is 55 for women and 60 for men, and it has not been changed since the Soviet period. Moreover, there are numerous groups that are eligible for early pension, including, but not limited to, people who live or work under hazardous conditions or have certain disabilities. Thus, Russians become eligible for pensions at a relatively early age, compared to developed countries (Pensions at a glance…, 2013).

Actual retirement behavior, however, is different. The effective retirement age in Russia is 60 among women and 63 among men (Society at a glance…, 2014). These figures suggest that people do not retire after they become eligible for pension and keep working for at least several years. It implies that people are both able and willing to stay in the labor force after reaching retirement age. This pattern contrasts with most other countries: generally, the effective retirement age tends to be lower than the official one because people have various options to ensure sufficient income apart from the state pension; such as through disability, unemployment and early retirement schemes (Society at a glance…, 2014).

However, it is not clear whether this prolonged labor force participation in Russia is a truly voluntary choice or whether people are forced to postpone actual retirement for as long as they can. The latter option seems to be more likely: average life expectancy and expected years in retirement in Russia are lower than in developed countries (Society at a glance…, 2014). It suggests that Russians postpone their retirement beyond what would be optimal if they were not limited by other factors that keep them in the labor force.

Income is likely to be the main factor. Accounting for the cost of living, the pension in Russia is quite low and relying solely on it means a significant drop in the quality of life (Pensions at a glance…, 2013). To smooth this transition into retirement people may decide to keep working extra years to make savings that would compensate for a small pension income and increase subsequent pension benefits. In this sense, people are forced to remain in the labor force by current economic conditions.

Small pension income results from the design of the pension system, demographic trends and the mass concealment of income. Most current pensioners rely solely on the state pension that is provided by the Pension Fund of the Russian Federation (Bank of Russia, 2016). While subsequent pensioners will receive a part of their pension from non-state funds that manage their contributions, in the near future the biggest share of pension benefits will remain financed through obligatory contributions from current income of the working population to the state Pension Fund.

This scheme is vulnerable to at least two features characterizing contemporary Russia. First, the population is aging: the ratio of working age people to retirement age people is declining and is projected to decrease from the current value of 4 to 2 (Pensions at a glance…, 2013), which means that it will be necessary to increase contributions from the working population to sustain pension benefits at the current level. Second, a big share of income is earned in the informal sector and remains undeclared as well as a part of income in the formal sector (Gurvich, Sonina, 2012). This leads to a smaller effective rate of contribution to the state Pension Fund than is implied by the official figure.

These two sources of vulnerability within the pension system correspond to possible ways of improving it. One way is to increase the amount of pension contributions by changing the rate

of contributions or the amount of declared income. The second way is to limit the increasing ratio of pensioners to workers by encouraging higher labor force participation and postponed retirement. This approach has been widely discussed and is gaining approval from experts (Gurvich, Sonina, 2012; Nazarov et al., 2014).

3. Theoretical framework

The standard framework in economics for explaining health choices over the life-course is the Grossman model (Grossman, 1972). Although it has a different focus, the intuitive logic of this framework extends naturally into the domain of the retirement decision, particularly in the context of increases in healthy life expectancy. Grossman conceived of health as both a consumption and an investment good that is produced and managed over the life-course through rational use of time and other resources. According to this approach, an individual's health yields both direct utility, stemming from the pleasure of being healthy, and indirect utility, from the improved quality of work and leisure time that good health facilitates.

In terms of retirement therefore, *ceteris paribus*, the model predicts a negative relationship between health and the decision to retire. First, better health increases the number of healthy days that a person can devote to work and/or remain in the labour force; and second, better health leads to higher productivity, which provides extra incentives for remaining in the labor force. The model is more ambiguous regarding the impact that retirement itself will have on health: on the one hand, other things being equal, retired people have more time to devote to health production; but on the other hand, retired people may be more likely to have lower incomes and face constraints in their health investments.

While, in this paper, we don't propose to formally test the Grossman model or derivatives of it, we do draw on its insights: that health is an endogenously evolving stock variable which is partly determined by demographic factors, socio-economic status and employment history (Sickles, Taubman, 1986); that current labor force participation affects the current (and future) level of health through physical and mental activities, work conditions and reduced investment in health; and that the decision to participate in the labor force (and therefore to retire or not) is influenced by current and future expected health status, among other utility-maximizing factors (Dwyer, Mitchell, 1999). Following the spirit of this conceptual approach, in this paper, we provide an empirical characterization of the health-retirement relationship using an econometric specification which allows us to attenuate the effects of the endogeneity.

4. Literature review

4.1. International data

The relationship between health and retirement has been extensively studied in the international context, especially with the US data. Models, estimation methods and available data have been developing since the 1980s but the core result concerning the importance of health remains unrefuted.

Poor health leads to earlier retirement, and this effect is non-linear (Cai, Kalb, 2007; Sickles, Taubman, 1986). Regarding its relative magnitude, the results vary: depending on the data and methods, the effect of health was found to be relatively weak compared to economic factors (Bazzoli, 1985) or, on the contrary, health was declared the strongest factor (Dwyer, Mitchell, 1999; Jones et al., 2010).

Health seems to be a multidimensional factor, and different health indicators as well as different health conditions have different and independent effects on retirement (Au et al., 2005; Bound, 1991; Dwyer, Mitchell, 1999; Kalwij, Vermeulen, 2008).

Bound et al. (1999) explore the relationship from a dynamic perspective and show that the earlier the health shock occurs, the less likely it is to effect retirement. Lagged health level, in contrast with lagged health shock, was found to be significant in the decision to retire (Au et al., 2005).

Retirement may also be modeled in a household context to account for possible correlation between decisions of spouses and added worker effect: when women experience a health shock, their husbands were found to increase their labor supply (Coile, 2004).

Results regarding the endogeneity of health with respect to retirement are less conclusive. Most articles claim no direct effect of labor force participation on health (Cai, Kalb, 2007; Sickles, Taubman, 1986; Stern, 1989). However, agreement is not universal and the results leave room for interpretation, because an insignificant coefficient does not necessarily mean the absence of a direct effect if it is offset by other factors. Cai (2010) discovers a significant effect of labor force status on health, which, however, is different for men and women and works in the opposite direction. Previous work history also influences current health (Cai, Kalb, 2007; Lindeboom, Kerkhofs, 2009).

Another source of endogeneity is the unobserved factors that affect both health and retirement (Bound et al., 1999; Cai, Kalb, 2007; Campolieti, 2002; Kalwij, Vermeulen, 2008). In this case, the imposition of the independence assumption between the two equations leads to an underestimation of the effect of health (Cai, Kalb, 2007).

The third source of endogeneity is justification bias: for social, psychological and economic reasons retired people may exaggerate their health problems as a way of justifying their retirement. There is evidence both in favor (Au et al., 2005; Jones et al., 2010; Lindeboom, Kerkhofs, 2009) and against (Dwyer, Mitchell, 1999) the presence of justification bias.

4.2. Russian data

Research regarding Russia, and emerging countries in general, is quite scarce, and the findings from articles based on developed countries may be different due to differences in settings. For instance, health may be more important in less developed countries (Currie, Madrian, 1999).

The main result of the significant influence of health on retirement is found for the Russian elderly (Gurvich, Sonina, 2012; Lyashok, Roshchin, 2015; Nazarov et al., 2014; Goryakin et al., 2014; Goryakin, Suhrcke, 2017). It is stronger for men, urban residents, less educated and near retirement age people (Goryakin et al., 2014; Goryakin, Suhrcke, 2017), and the influence of a health shock accumulates over time (Lyashok, Roshchin, 2015).

5. Methodology

5.1. Review of alternative methods

Methodological concerns result from the possible endogeneity of health, and ignoring this may lead to biased estimates. The main potential problems, which were discussed in previous research, are justification bias, the multidimensional nature of health, the reverse effect of labor force participation and unobserved factors that affect health and retirement. To obtain consistent estimates these features need to be accounted for.

The general idea of most approaches is to exploit the variety of health-related information available in the data. Most datasets contain information of two types: subjective health measures (e. g. self-assessed health) and objective health indicators (e. g. presence of specific conditions). Bound (1991) provides an extensive discussion about using them in the retirement equation. The main problem with subjective measures is that they may be prone to justification bias. If people retire for other reasons but justify their decision with poor health, then the effect of health is exaggerated and other variables' influence is underestimated. Moreover, different people may perceive and report the same level of health differently depending on their characteristics or randomly, and a single reported measure of health may not capture all the aspects of true health. On the other hand, objective measures may be only weakly correlated with health or work capacity. As a result, they may bias estimates downward.

As a solution, most articles use a so-called latent health stock approach. The idea is to take a single aggregate measure of health, usually self-assessed health, and instrument it using objective health indicators, usually specific conditions. It allows for the estimation of a latent health stock, which is supposed to be exogenous to labor force participation. This health stock is used to estimate the effect of health in the retirement equation. This approach has been widely implemented (e.g. Lyashok, Roshchin, 2015; Au et al., 2005; Bound et al., 1999; Cai, Kalb, 2007; Campolieti, 2002; Dwyer, Mitchell, 1999; Goryakin et al., 2014) but it assumes that there is no direct effect of labor force status on health.

An alternative method models the retirement decision and health as a system of simultaneous equations and allows for the effects between health and retirement to run in both directions. This approach, although more difficult to implement and interpret, relies on weaker assumptions (Cai, 2010; Stern, 1989; Van Gameren, 2008).

5.2. Description of methodology

This research uses the latter approach of estimating a system of simultaneous equations and follows the model outlined in (Stern, 1989)[4]. The conceptual model consists of three equations: labor force participation as a function of true health; true health as a function of labor force participation; reported health as a function of true health and labor force participation.

$$p^* = \alpha_p h^{**} + \beta_p X_p + u_p, \quad (1)$$

[4] A detailed discussion of the methodology and its economic rationale can be found in (Cai, 2010).

where p^* is the latent value of being in the labor force, h^{**} is the latent true measure of health, X_p is a vector of exogenous variables.

$$h^{**} = \alpha_h p^* + \beta_h X_h + u_h, \tag{2}$$

where X_h is a vector of exogenous variables, including health indicators[5].

$$h^* = h^{**} + \alpha_r p^* + u_r, \tag{3}$$

where h^* is the latent measure corresponding to reported health.

These three equations account for simultaneous effects between health and labor force participation and for biased reporting of health that may result from psychological or economic factors.

Substituting equation (2) into (1) and (3) we obtain the following system:

$$p^* = \tilde{\alpha}_p h^* + \tilde{\beta}_p X_p + e_p, \tag{4}$$

$$h^* = \tilde{\alpha}_h p^* + \beta_h X_h + e_h, \tag{5}$$

where $\tilde{\alpha}_p = \alpha_p / (1 + \alpha_p \alpha_r)$, $\tilde{\beta}_p = \beta_p / (1 + \alpha_p \alpha_r)$, $e_p = (u_p - \alpha_p u_r) / (1 + \alpha_p \alpha_r)$, $\tilde{\alpha}_h = \alpha_h + \alpha_r$, $e_h = u_h + u_r$.

Values of latent p^* and h^* are not directly observed. Instead, we observe indices p and h:

$p = \begin{cases} 1, & if\ p^* > 0, \\ 0, & if\ p^* \le 0, \end{cases}$ $h = i$ if $h_i < h^* \le h_{i+1}$ for $i = \overline{1, m}$, where h_i are unobserved cut-offs.

Thus, p is a dummy variable for labor force participation, and h is an ordinal health measure. Equations (4) and (5) constitute a simultaneous probit — ordered probit system. Our data also contains a continuous health measure — in this case, equation (5) becomes linear.

There are two methods to estimate this system. A two-step procedure estimates reduced-form equations at the first step and uses predicted values at the second step to obtain consistent estimates (Stern, 1989).

The second method is a full information maximum likelihood approach. Contrary to the two-step procedure, it allows for correlation between error terms in the equations and gives estimates that are both consistent and efficient (Cai, 2010). We use the maximum likelihood approach.

This method also allows us to conduct an exogeneity of health test: $\mathbf{H}_0 : \tilde{\alpha}_h = 0$ and $\rho = 0$; $\mathbf{H}_1 : \tilde{\alpha}_h \neq 0$ and/or $\rho \neq 0$, where ρ is the correlation between the error terms. Note, however, that $\tilde{\alpha}_h = 0$ does not necessarily imply exogeneity because it is the sum of a direct effect of labor force participation and reporting bias, which may offset each other and result in an insignificant coefficient. It is impossible to distinguish between these two effects without making further assumptions.

[5] This equation (2) includes p^* because p would potentially over or underestimate the real (latent) p^* and therefore in the model we want to specify true p^* rather than observed p.

6. Data and model specification

6.1. Data

Data for this research comes from the World Health Organization Study on Global Ageing and Adult Health, Wave 1 (WHO SAGE, 2007–2010). The SAGE database includes household data primarily on persons aged 50 years and older in China, Ghana, India, Mexico, the Russian Federation and South Africa, plus a data set for the adult population aged 18 to 49 years.

Three waves of data are available for Russia (Wave 0, Wave 1 and Wave 2). In this research, we use only Wave 1 because the sample and questionnaire were modified substantially compared to Wave 0. Wave 2 was not available at the time of research. Wave 1 is a cross-section, which was collected in 2007–2010 in all federal districts of Russia. The data consists of 4511 individual observations supplemented with household information, however only 3882 observations have the minimum required data for this research.

The individual questionnaire consists of the following instruments: socio-demographic characteristics; work history and benefits; health state descriptions; anthropometrics, performance tests and biomarkers; risk factors and preventive health behaviors; chronic conditions and health service coverage; health care utilization; social cohesion; subjective well-being and quality of life. One of the major benefits of SAGE is the availability of numerous health indicators that characterize objective and subjective health from various perspectives. For example, interviews are conducted with a medical professional, who assists in collecting health-related information and measures such as vision, breath and blood tests, grip strength, specific diagnostic questions, etc.

To the best of our knowledge, there has been no research on these topics using Russian SAGE. SAGE offers a unique variety of objective health indicators that enable us to exploit the full potential of the methodology. Therefore, despite its modest sample size and cross-sectional nature, SAGE may be the best candidate for this research.

6.2. Descriptive statistics

Table 1 provides descriptive statistics. 38% of the sample are men, 75% live in urban areas, 60% are married or cohabiting. Half of the sample finished only high school, with 30% having lower education and 20% having higher education. Almost all respondents report having obligatory health insurance, and only 1% have voluntary health insurance. 34% are currently working and 36% are in the labor force, while 53% left the labor force for retirement and 8% due to disability. 73% have reached the state pension eligibility age — 55 for women and 60 for men. Household heads constitute 68% of the sample, and 60% are the main household income earners. With very rare exceptions, respondents have a regular source of income. 88% work or worked at the last place in the public sector, while only 9% are/were in a private company, 2% are/were self-employed and 1% are/were in the informal sector. 9% and 7% have a child aged 0–5 and 6–15 respectively as a household member, 4% provide financial care to someone in the household and 12% provide other types of care.

The age of respondents in the sample ranges from 50 to 100 years with a mean of 65 (Appendix 2). On average, respondents started to work for pay at the age of 18 and stopped at 57 with a relatively low standard deviation. Most respondents report a traditional work schedule

of 5 days per week, 8 hours each, and a total of 40 hours per week. However, there are some extreme figures that seem to be a property of certain occupations: for instance, concierges' often report a 24/7 schedule. Most households consist of 2–3 members with the biggest having 13 members. Mean reported annual income is about 187000 rubles with a great variation from 1800 to 6 million and standard deviation bigger than the mean. Median income (120000 rubles) is lower than mean which results from a preponderance of large extreme values. Per household member income has the same pattern, which reflects significant heterogeneity even after correcting for household size. On average respondents studied for 11 years which is consistent with the high school education level being the most common. However, there are people who report no formal education or, on the contrary, 25 years of education.

Table 1. Variable definitions and descriptive statistics

			Mean value		
Variable name	Definition of variables	N	All	Male	Female
	A. Endogenous variables				
Labour force status	0 non-participation, 1 participation	3670	0.37	0.45	0.32
Health variables:					
Self-assessed health	Self-reported health status in general (1 = Very good, 2 = Good, 3 = Moderate, 4 = Bad, 5 = Very bad)	3670	3.16	3.04	3.23
Difficulty	Severity of difficulties with work and household activities, last 30 days (1 = None, 2 = Mild, 3 = Moderate, 4 = Severe, 5 = Extreme / Cannot do)	3660	2.48	2.31	2.57
Compared health	Self-reported comparison of health to people of the same age in the same location (1 = More healthy, 2 = Same level of health, 3 = Less healthy)	3591	2.14	2.08	2.18
WHODAS 2.0	Index based on 12 questions about difficulties in daily activities, from 0 (best health) to 100 (worst health)	3368	16.37	13.96	17.73
	B. Variables appearing in both equations				
Age	Age of respondent, *years*	3670	64.89	63.69	65.57
Age at first job	Age when started working for pay, *years*	3670	18.09	18.04	18.12
Spouse	1 if married or cohabiting	3665	0.57	0.80	0.43
Urban	1 if lives in urban setting	3670	0.77	0.71	0.80
Income	Normalized permanent household income	3665	0.03	0.09	–0.01
Household size	Number of household members, *persons*	3665	2.45	2.77	2.27
Secondary school	1 if finished secondary school	3641	0.19	0.17	0.20
High school	1 if finished high school	3641	0.51	0.52	0.50
Higher education	1 if finished college or higher	3641	0.21	0.23	0.19
Public employer	1 if current or last job was in a public company	3649	0.88	0.84	0.91
Self-employed	1 if current or last job was self-employment	3649	0.02	0.03	0.02
Informal employment	1 if current or last job was informal	3649	0.01	0.01	0.01
Regional dummies	See Appendix 3a, federal districts	3670			
Occupation group dummies	See Appendix 3a, ISCO-88 classification	3670			

End of the Table 1

Variable name	Definition of variables	N	Mean value All	Male	Female
	C. Additional variables in the LFP equation				
State pension eligibility	1 if female and 55+, or male and 60+	3670	0.73	0.57	0.82
Hours worked per week	Hours per week worked at current or last job, *hours*	3654	43.97	45.65	43.03
Seasonal work	1 if current or last job was seasonal	3670	0.03	0.05	0.02
Irregular work	1 if current or last job was irregular	3670	0.02	0.03	0.01
Financial support provider	1 if provides financial care to someone in household	3670	0.04	0.05	0.03
Other care provider	1 if provides other type of care to someone in household	3670	0.11	0.12	0.11
Child member in household	1 if there is a 6–15 year-old household member	3670	0.07	0.07	0.06
Preschool member in household	1 if there is a 0–5 year-old household member	3670	0.08	0.09	0.08
	D. Additional variables in the health equation				
Voluntary health insurance	1 if has voluntary health insurance	3661	0.01	0.01	0.01
Objective health measures	See Appendix 3				

See Appendix 3 for symptom-based model; anthropometrics model; behavior and risk factors model; healthcare utilization model; self-reported conditions model; and the combined health indicators model.

Most respondents report moderate Self-assessed health and difficulties, however, Self-assessed health is more often worse than moderate while difficulties are more often less than moderate (Table 2). Most people say that they have similar health to others, but the «Less healthy» answer appears twice as often as «More healthy». WHODAS index has an average of 16.7 with a standard deviation of 15.3. Although 75% scored less than 23, there are extremely disabled people with a score of 100. Appendix 1 shows that older people report worse health but, up to 80 years old, at least half of respondents report moderate or better health.

Table 2 shows a strong association between health measures and labor force participation. In all cases, respondents outside of the labor force report poor health states more often while those in the labor force perceive their health as generally better. Higher WHODAS is associated with not participating in the labor force: mean value of 21.35 (sd = 16.5) for respondents out of the labor force compared to 8.67 (sd = 8.6) for those within the labor force.

The main advantage of the SAGE survey is the inclusion of many questions that allow for the construction of health indicators that are ‘objective’. They can be grouped into 5 categories: self-reported conditions; symptom-based conditions (see (Arokiasamy et al., 2015) for the algorithm of diagnosing conditions); anthropometrics; behavior and risk factors; health care utilization. The composition of each category together with descriptive statistics is presented in Appendix 3.

The most common conditions are hypertension and backpain: more than half of respondents suffer from them. According to body-mass index, 42% are overweight and another 35% are obese. Over the previous year 61% used outpatient healthcare and 16% used inpatient care. Regarding risk factors, 18% smoke and 26% consume alcohol, while only 11% do sports.

Table 2. Frequency of health levels by labor force (LF) participation

	Not in LF	In LF		Not in LF	In LF		Not in LF	In LF
SAH	Freq (%)	Freq (%)	Difficulty	Freq (%)	Freq (%)	Compared health	Freq (%)	Freq (%)
Very good	6 (0.24)	11 (0.80)	None	297 (11.92)	507 (36.85)	More healthy	222 (9.238)	259 (19.36)
Good	150 (6.01)	323 (23.39)	Mild	593 (23.80)	484 (35.17)	Same health	1330 (55.35)	921 (68.83)
Moderate	1353 (54.19)	948 (68.65)	Moderate	1021 (40.97)	346 (25.15)	Less healthy	851 (35.41)	158 (11.81)
Bad	912 (36.52)	94 (6.81)	Severe	493 (19.78)	38 (2.76)			
Very bad	76 (3.04)	5 (0.36)	Extreme	88 (3.53)	1 (0.07)			
Total	2497	1381	Total	2492	1376	Total	2403	1338

6.3. Model Specification

The model consists of two equations estimated simultaneously: one of them models labor force participation, the other — the level of health. They are separately estimated for male and female subsamples. The detailed specification of the model is presented in Table 1.

The dependent variable in the first equation is a dummy variable with 1 for labor force participation and 0 for retirement. The dependent variable in the second equation is one of four aggregate health measures (self-assessed health, difficulty, comparative health, or WHODAS), higher values correspond to worse health.

Demographic, socio-economic and labor market characteristics, such as age, marital status and work experience are included in both equations as independent variables and are traditional for both labor supply and health models.

The following variables are excluded from the health equation: eligibility for state pension, hours worked per week, seasonality and irregularity of work, provision of financial and other care, presence of a child in the household. Presence of children in the household is likely to affect labor force withdrawal, especially among elderly women, who take care of their grandchildren, while there is no evidence of the effect of a child in a household on individuals' health that we are aware of. The same effect results from the need to provide time-consuming care for other household members. On the other hand, provision of financial care is associated with higher demand for earnings, which induces labor force participation. Hours worked per week and seasonal or irregular types of work directly affect labor force participation as employment characteristics, but they may influence health only indirectly through working conditions. State pension eligibility may be a significant factor for labor force participation, but it is not likely to affect health as it is just an exogenously determined age threshold.

Variables excluded from the labor force equation are the presence of voluntary health insurance and various objective health measures. Voluntary health insurance provides easier access to health care services of higher quality, which may lead to better health outcomes. Taking into account features of the Russian health insurance market, it is more likely that employment

affects access to voluntary health insurance and not vice versa[6]. Objective health measures, as mentioned earlier, are present in SAGE in full variety, reflecting health from different perspectives. This allows us to group these objective health measures according to questionnaire sections and use them as separate models. The use of such objective health measures in the health equation stems from their specific and unambiguous nature, which makes them less prone to justification bias (Bound et al., 1996). Objective health measures, however, are excluded from the labor force equation because they are used as instruments for self-reported health (Cai, 2010). It should be noted that the objective health measures used in the health equation could have additional value for predicting participation if the health index is incomplete, violating the exclusion restrictions. However, the health indicators used are based on the traditional measurement methods in health economics.

Although the data were collected in different years, dummies for each year are not included in both equations because the general patterns of the variables of interest are similar over the whole period and inclusion of year dummies does not qualitatively change the parameter estimate.

7. Results

Appendix 4 presents estimates of key parameters, correlation coefficients and tests of exogeneity of health for all 48 models. These estimates show that health indeed plays a significant role in the retirement decision: the health variable has a significant coefficient in all specifications, except for those with healthcare utilization for women. These coefficients, however, say nothing about the magnitude of the effect. To get a sense of it, Tables 3–4 present marginal effects of moving from one health level to another on the probability of labor force participation for an average female and male.

The specification chosen for estimation of marginal effects uses a combination of health indicators from all categories, except for self-reported symptoms (Appendix 3). Although marginal effects differ across health measures, health changes clearly have a strong effect on the probability of labor force participation. Comparison between specifications with separate categories of objective health indicators shows that in general the estimated effect is the weakest when using healthcare utilization characteristics, it is stronger with self-reported conditions, even stronger with symptom-based conditions, and the strongest in the specifications with anthropometrics and behavioral characteristics.

The marginal effect of health on labor force participation was also estimated across the age distribution (Figures 1, 2). The impact of health changes is shown to depend on the initial level of health. Reductions in health from very good or good health have the strongest negative impact on labour force participation for both men and women, in all specifications.

Regarding the effect of labor force participation on health, the results are less clear. The coefficient is significantly negative for females in all but one specification using Self-assessed health. However, it is insignificant in all other specifications.

Estimates of the correlation coefficient vary across specifications and show a significant correlation only in a half of all cases with Self-assessed health, Difficulty and Compared health,

[6] Nevertheless, presence of voluntary health insurance is not a definite indicator of labor force status: 43% of voluntary health insurance holders are not participating in labor force.

Table 3. Marginal effects of Self-assessed health and Difficulty on labor force participation

Self-assessed health	Female		Male		Difficulty	Female		Male	
Very good	89%		100%		None	57%		82%	
Marginal effect		*–22%*		*–7%*	*Marginal effect*		*–17%*		*–25%*
Good	67%		92%		Mild	39%		57%	
Marginal effect		*–34%*		*–41%*	*Marginal effect*		*–18%*		*–33%*
Moderate	33%		51%		Moderate	21%		23%	
Marginal effect		*–24%*		*–45%*	*Marginal effect*		*–13%*		*–20%*
Bad	9%		6%		Severe	8%		4%	
Marginal effect		*–7%*		*–6%*	*Marginal effect*		*–6%*		*–3%*
Very bad	2%		0%		Extreme	2%		0%	

Calculated at respective means.

Table 4. Marginal effects of Compared health and WHODAS on labor force participation

Compared health	Female		Male		WHODAS	Female		Male	
More healthy	60%		97%		Mean–sd	46%		85%	
Marginal effect		*–32%*		*–36%*	*Marginal effect*		*–19%*		*–39%*
Same health	28%		60%		Mean	27%		46%	
Marginal effect		*–20%*		*–51%*	*Marginal effect*		*–14%*		*–35%*
Less healthy	8%		10%		Mean + sd	13%		11%	

Calculated at respective means.

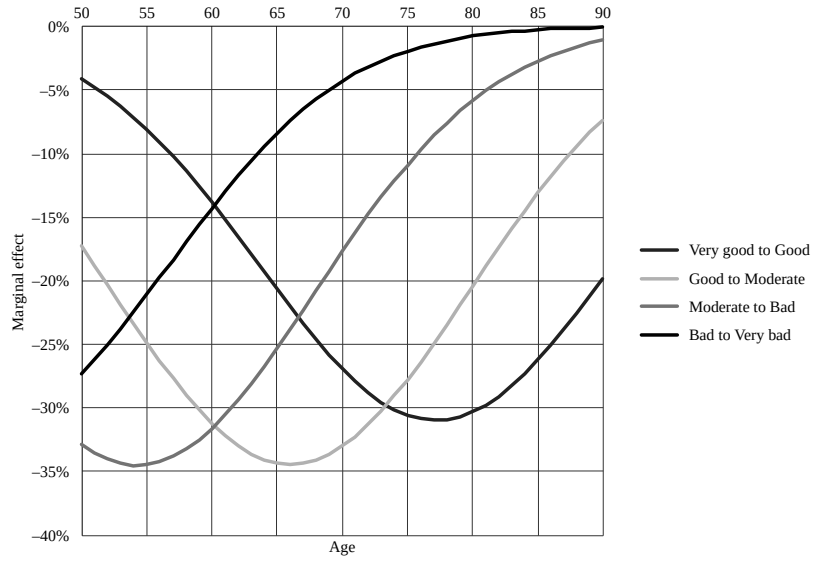

Fig. 1. Marginal effects of self-assessed health by age, female

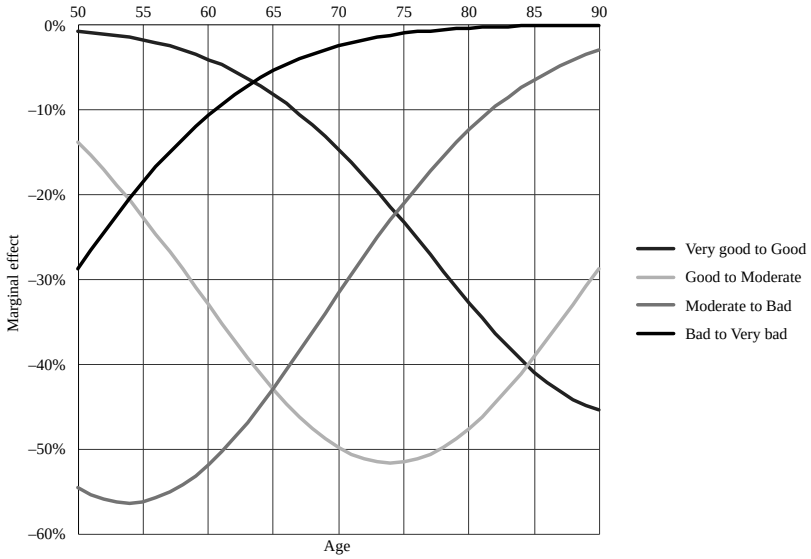

Fig. 2. Marginal effects of self-assessed health by age, male

while WHODAS gives significant correlation only in 3 cases. The correlation coefficient is positive, meaning that unobserved factors, which increase the probability of labor force participation, could decrease the level of health.

The following test of health exogeneity was conducted: $\mathbf{H}_0 : \tilde{\alpha}_h = 0$ and $\rho = 0$; $\mathbf{H}_1 : \tilde{\alpha}_h \neq 0$ and/or $\rho \neq 0$, where $\tilde{\alpha}_h$ is a coefficient of labour force participation in the health equation, ρ is a coefficient of correlation between errors in the two equations. It rejected exogeneity in most cases with Difficulty and Compared health and in half of all cases with Self-assessed health. However, when WHODAS is used as a health measure, exogeneity is not rejected in most specifications.

Results regarding the effect of pension eligibility are mixed. The variable for reaching the official retirement age is significantly negative in most specifications for women. For men, on the contrary, the same variable is insignificant in most specifications, although always has a negative sign.

Among other significant factors, higher age, being last employed in the public sector and providing time-consuming care for someone in the household reduces the probability of labor force participation. Living in a wealthier household is associated with a higher probability of staying in the labor force in most specifications. Having a spouse encourages retirement among women, while provision of financial care for a household member increases the probability of labor force participation among men. Comparing other occupational groups to unskilled workers, the probability of staying in the labor force is higher for female professionals (International Standard Classification of Occupations, ISCO-88[7], group 2) and lower for female crafts and related trades workers (ISCO-88 group 7).

In the health equation with combined health indicators, only cognitive wellbeing — measured by memory tests — and having a lung disease were significant for both genders in all four specifications with different aggregate health measures. Backpain, depression, number of out-

[7] See http://www.ilo.org/public/english/bureau/stat/isco/isco88/.

patient visits and regular walking or cycling were significant for at least three out of four health measures for both genders with expected signs.

For men, using three out of four health measures, having had a stroke and using inpatient care over the previous year significantly reduce health, while being overweight and doing daily moderate-intensity activities are associated with better health.

For women, higher grip strength is always associated with better health. Using three out of four health measures, cataracts and asthma are significantly associated with worse health, while doing moderate-intensity sports — with better health.

8. Discussion

Hypothesis 1 was strongly confirmed. As expected, health was shown to have a very important role in the decision to retire. Changes in health produce a large variation in the probability of staying in the labor force.

This result is in line with previous research that found health among the most influential factors of labor force participation (Dwyer, Mitchell, 1999; Jones et al., 2010), but contradicts other articles that found its effect relatively weak compared to other factors (Bazzoli, 1985). One reason behind this is that the retirement decision in Russia is made in a context different from the developed countries. Russian elderly have less incentives to retire due to smaller pensions and often continue working after becoming eligible for a pension. This makes health an important factor because its deterioration is likely to become the main reason for retirement.

The strong effect of health has a major policy implication. It provides an effective mechanism to increase labor force participation among the elderly. Programs aimed at improving health could lead to higher effective retirement age, which would contribute to stabilization of the pension system.

Hypothesis 2 was also confirmed. The effect of health is non-linear both in health level and age. Non-linearity is a common result in other research (Cai, Kalb, 2007; Sickles, Taubman, 1986). With respect to health level, the changes of health at extremes are less influential than changes close to moderate values, when other variables are held constant at means. This result could indicate the presence of a certain threshold health level, below which people are likely to retire due to poor health and above which health does not impose work limitations.

Non-linearity has a methodological implication. Some authors suggest converting ordinal health measures into dummies to reduce reporting heterogeneity (Goryakin et al., 2014). This result, however, shows that such a strategy is likely to lead to some changes in interpretation.

Non-linearity in age is an expected result too. The effect of health was shown to be strongest around retirement age in Russia (Goryakin, Suhrcke, 2017). Our results, however, extend this idea. The age of the strongest effect of health is not the same for all health levels: the better the health, the higher the age of the strongest effect.

This pattern can be explained by variation in the ability to work. At younger ages people tend to stay in the labor force even after health changes, possibly by changing their jobs. At older ages, they are more likely to be out of the labor force even controlling for their health, so a health change has a small effect. Between these two tails lies a threshold age where the effect of health is the strongest. This threshold age is higher for people with better health, who have higher ability to work and therefore can be relatively insensitive to health changes at older ages.

From a policy perspective, this result means that a program for improving health should not be universal but rather aimed at specific age-health groups whose propensity to stay in the labor force is the most responsive to changes in health.

Regarding Hypothesis 3, the evidence is ambiguous. In almost all specifications the effect of labor force participation on health is insignificant, which agrees with most other articles (Cai, Kalb, 2007; Sickles, Taubman, 1986; Stern, 1989). Self-assessed health, however, is positively affected by labor force participation among women.

These results may be interpreted in the following way. The estimated coefficient consists of two parts: the direct effect of labor force participation on health, and the reporting bias. While the direct effect can theoretically be negative (e.g. stress at work or bad working conditions reduce health) as well as positive (e.g. mental and physical activity at work improve health), the reporting bias is always positive.

This ambiguity leads to alternative interpretations, and choosing one requires making further assumptions. All four health measures are supposed to reflect the same underling true health, therefore, the difference in estimates should reflect the difference in reporting biases. One possibility is that the three health measures, except for Self-assessed health, reflect health without bias. In this case, there is no direct effect of labor force participation on health, but retired women tend to report worse self-assessed health than women in the labor force with similar health. This is consistent with most previous estimates (Cai, Kalb, 2007; Sickles, Taubman, 1986; Stern, 1989).

Another possibility is that justification bias is present in all health measures. If this is true, then labor force participation must have a negative effect on true health to balance the coefficients around zero. In this case, Hypothesis 3 may be confirmed, and we also find evidence of justification bias, which is consistent with some previous work (Cai, 2010; Lindeboom, Kerkhofs, 2009).

However, these interpretations rest on the assumption that the same underlying true health level pertains across all aggregate health measures. This assumption could be incorrect if different health measures reflect different aspects of true health. In this case, even a positive effect of labor force participation on health reflected in Self-assessed health is possible among women.

Exogeneity tests reject the null hypothesis in most cases with Difficulty and Compared health and in half of all cases with Self-assessed health. The main reason for endogeneity is unobserved factors that affect both dependent variables, which is confirmed by the correlation between errors in the two equations. Unobserved factors that increase labor force participation also tend to reduce the level of health. Therefore, not controlling for this correlation would bias the effect of health towards zero and the effect of labor force participation towards a negative value. The presence of this correlation and its direction agree with previous estimates (Cai, 2010; Stern, 1989).

In specifications with WHODAS, the exogeneity of health was not rejected in most cases. This is likely to reflect the nature of WHODAS. Self-assessed health, Difficulty and Compared health are subjective, single-question variables. WHODAS, in contrast, is an index, constructed from 12 specific questions with less normative content. As a result, WHODAS is a more objective measure, which makes it less prone to endogeneity.

These findings confirm that labor force participation and health should be modeled jointly, and the correlation between errors in the equations should be accounted for. Furthermore, these results support a strategy of using aggregate limitation indexes similar to WHODAS instead of Self-assessed health because they are less likely to be endogenous.

Hypothesis 4 about the significance of reaching the official retirement age was confirmed for men but rejected for women. The point of reaching the retirement age is pivotal in terms of labor force participation among women: as soon as they become eligible for the state pension, they become significantly more likely to retire. This discontinuity implies that even if women want to retire, they tend not to do it until they are eligible for pension, probably, to avoid a gap in the income stream. As soon as they become eligible, this incentive disappears and they become more likely to exit the labor force.

The insignificance of reaching the official retirement age among men suggests that there are other important factors that keep men from retirement. The pension may be too small to rely only on it, and men decide to stay in the labor force to earn more and make savings, which they will spend after retirement.

Alternatively, the insignificance could result from heterogeneity in the true pension eligibility age. People with certain occupations start to receive their pension earlier, so they do not face any changes in incentives at the official retirement age. If early pensions are especially prevalent among men (Gurvich, Sonina, 2012), they could dilute the effect of the official retirement age.

Our analysis shows that an increase in the retirement age, at least in the official retirement age, is not the most effective tool to increase labor force participation. Nevertheless, should it be implemented, health does not seem to impose strict limitations. Although marginal effects of health are quite large, health seems to be good and stable after the retirement age (Appendix 1), so most people will be able to postpone their retirement if necessary.

Among other significant factors of the retirement decision, being last employed in the public sector is strongly associated with higher probability of retirement. This difference from the private companies is possibly explained by retirement conditions. Wages in the private sector are typically higher, but the common practice of underreporting income may lead to pension fund contributions close to or even lower than in the public sector. As a result, employers in the public sector may receive higher pensions and extra severance packages upon retirement, which create more incentives to retire.

Having a spouse significantly reduces the probability of labor force participation among women, but not among men. Providing financial care, on the other hand, increases the probability of labor force participation among men, but not among women. These patterns suggest that elderly men often postpone their retirement to provide income to their spouse or other household members.

Health was modeled using four different health measures. Difference in the sets of significant objective health indicators in the four specifications suggests that these health measures tend to reflect different aspects of true health. Therefore, it is beneficial to estimate models with different health measures to reflect the multidimensional nature of health.

9. Conclusion

This research focuses on the relationship between health and labor force participation of elderly Russians. WHO SAGE data with unique objective health indicators was used to estimate a system of simultaneous equations that describe health and labor force participation. Estimation was conducted with a maximum likelihood approach allowing for error correlation.

The results clearly show that health plays a major role in the decision to retire: healthier people stay in the labor force with higher probability. Marginal effects of moving from one

health level to the next largely depend on age: there is a certain threshold age where the effect is the strongest.

Evidence of justification bias and the direct effect of labor force participation on health is rather mixed and its interpretation depends on the assumptions made. However, there is strong evidence of endogeneity of health in models with single-question health measures, confirmed by error correlation, which verifies that health and retirement should be modeled jointly.

The official retirement age seems to have a moderate effect on labor force participation for women and a weaker or no effect for men. Nevertheless, health does not impose limitations to a possible retirement age reform.

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Appendix 1. Frequency of health levels by age groups

Self-assessed health	Female						Male					
	50–55 Freq (%)	56–60 Freq (%)	61–65 Freq (%)	66–70 Freq (%)	71–80 Freq (%)	80+ Freq (%)	50–55 Freq (%)	56–60 Freq (%)	61–65 Freq (%)	66–70 Freq (%)	71–80 Freq (%)	80+ Freq (%)
Very good	3				1	1	5	2		4	1	
	(0.571)				(0.154)	(0.435)	(1.412)	(0.714)		(1.878)	(0.348)	
Good	112	44	26	29	24	2	103	61	26	15	27	7
	(21.33)	(10.14)	(8.966)	(7.342)	(3.704)	(0.870)	(29.10)	(21.79)	(14.36)	(7.042)	(9.408)	(8.537)
Moderate	363	310	193	233	314	86	198	177	125	138	153	31
	(69.14)	(71.43)	(66.55)	(58.99)	(48.46)	(37.39)	(55.93)	(63.21)	(69.06)	(64.79)	(53.31)	(37.80)
Bad	46	76	69	121	279	127	44	37	26	54	103	40
	(8.762)	(17.51)	(23.79)	(30.63)	(43.06)	(55.22)	(12.43)	(13.21)	(14.36)	(25.35)	(35.89)	(48.78)
Very bad	1	4	2	12	30	14	4	3	4	2	3	4
	(0.190)	(0.922)	(0.690)	(3.038)	(4.630)	(6.087)	(1.130)	(1.071)	(2.210)	(0.939)	(1.045)	(4.878)
Total	525	434	290	395	648	230	354	280	181	213	287	82

Appendix 2. Descriptive statistics of continuous variables

Variables	Units	N	Mean	Sd	Min	p25	p50	p75	Max
				All respondents					
Age	years	3670	64.89	10.16	50	56	64	72	100
Age at first job	years	3670	18.09	3.32	5	16	18	20	52
Age of stop work	years	2327	56.95	6.53	11	55	57	60	80
Working days per week	days	3658	5.26	0.91	0	5	5	6	7
Working hours per day	hours	3658	8.54	2.84	1	8	8	8	24
Working hours per week	hours	3654	43.97	12.16	0	40	40	48	144
Household size	persons	3665	2.45	1.54	1	1	2	3	13
Annual hh income	rubles	2545	184841	303786	1800	72000	120000	216000	6000000
Annual hh income per person	rubles	2545	82247	119427	360	42000	60000	96000	2133560
Years of education	years	3575	11.15	3.68	1	9	11	14	25
				Female					
Age	years	2350	65.57	10.28	50	57	65	73	99
Age at first job	years	2350	18.12	3.25	5	16	18	20	46
Age of stop work	years	1599	56.19	6.14	11	55	55	60	80
Working days per week	days	2345	5.24	0.88	0	5	5	6	7
Working hours per day	hours	2345	8.38	2.69	1	8	8	8	24
Working hours per week	hours	2343	43.03	11.63	0	40	40	48	126
Household size	persons	2347	2.27	1.45	1	1	2	3	13
Annual hh income	rubles	1633	172378	287216	1800	62400	106800	200000	6000000
Annual hh income per person	rubles	1633	80908	112528	360	42000	60000	96000	2133560
Years of education	years	2286	11.01	3.73	1	8	11	14	24
				Male					
Age	years	1320	63.69	9.84	50	55	62	71	100
Age at first job	years	1320	18.04	3.44	6	16	18	20	52
Age of stop work	years	728	58.62	7.05	14	55	60	62	78
Working days per week	days	1313	5.31	0.97	0	5	5	6	7
Working hours per day	hours	1313	8.82	3.07	2	8	8	9	24
Working hours per week	hours	1311	45.65	12.89	0	40	40	48	144
Household size	persons	1318	2.77	1.64	1	2	2	3	13
Annual hh income	rubles	912	207158	330384	4200	85000	144000	240000	6000000
Annual hh income per person	rubles	912	84643	130907	2000	42000	60000	96000	2133560
Years of education	years	1289	11.40	3.58	2	10	11	14	25

Appendix 3. Descriptive statistics of objective health indicators (indicators used in a combined model are marked with a star)

Variable name	Definition of variables	N	Mean value		
			All	Male	Female
	A. Symptom-based conditions				
Backpain*	1 if experienced back pain during the last 30 days	3660	0.60	0.54	0.63
Angina*	Conditions diagnosed based on symptoms	3670	0.15	0.12	0.17
Arthritis*	(see (Arokiasamy et al., 2015) for the algorithms)	3670	0.18	0.15	0.20
Stroke*		3652	0.08	0.07	0.08
Lung disease*		3657	0.17	0.18	0.17
Asthma*		3670	0.07	0.07	0.07
Depression*		3670	0.28	0.19	0.33
Hypertension*		3579	0.60	0.55	0.62
Cataracts*		3651	0.37	0.30	0.40
Oral health problems		3657	0.26	0.22	0.28
	B. Anthropometric characteristics				
Grip strength*	Maximum of 4 grip strength measures	2969	31.92	41.28	26.30
Underweight*	Based on Body-mass index (BMI<18.5)	3580	0.01	0.01	0.01
Overweight*	Based on Body-mass index (25<BMI<30)	3580	0.42	0.49	0.37
Obese*	Based on Body-mass index (BMI>30)	3580	0.35	0.21	0.42
Waist-to-hip ratio moderate risk	Based on Waist-to-hip ratio (0.96<WHR<1 for men and 0.81<WHR<0.86 for women)	2952	0.19	0.18	0.20
Waist-to-hip ratio high risk	Based on Waist-to-hip ratio (WHR>1 for men and WHR>0.86 for women)	2952	0.48	0.28	0.58
Memory*	Index based on memory tests	3511	0.58	0.59	0.58
Bad distant vision	Based on vision test (see (Arokiasamy et al., 2015))	2911	0.28	0.26	0.29
Bad near vision	Based on vision test (see (Arokiasamy et al., 2015))	2988	0.50	0.49	0.51
	C. Behavioral characteristics and risk factors				
Injury*	1 if suffered from bodily injury in the last 12 months	3657	0.06	0.05	0.06
Injury with disability*	1 if suffered from physical disability as a result of injury	3659	0.00	0.00	0.00
Smoking*	1 if currently uses any tobacco product	3663	0.18	0.41	0.05
Smoking years	Years of tobacco use	3535	5.09	13.00	0.95
Alcohol*	1 if consumed alcohol in the last 30 days	3667	0.26	0.34	0.22
Alcohol weekly*	1 if consumed alcohol at least once a week in the last 12 months	3666	0.06	0.15	0.01
Fruits	Number of servings of fruit eaten on a typical day	3126	1.56	1.43	1.62
Vegetables	Number of servings of vegetables eaten on a typical day	3117	1.94	1.97	1.93
Not enough food	1 if did not eat enough because there was not enough food at least once in the last 12 months	3650	0.12	0.10	0.13
No food	1 if did not eat because could not afford enough food at least once in the last 12 months	3652	0.07	0.06	0.07
Vigorous-intensity work*	1 if work involves vigorous-intensity activity	3670	0.30	0.43	0.23
Moderate-intensity work*	1 if work involves moderate-intensity activity	3670	0.75	0.71	0.77
Walk or cycle*	1 if walks or uses bicycle for at least 10 minutes continuously to get to and from places	3670	0.70	0.68	0.71
Vigorous-intensity sport*	1 if does any vigorous-intensity sports, fitness or recreational activities	3670	0.03	0.04	0.02
Moderate-intensity sport*	1 if does any moderate-intensity sports, fitness or recreational activities	3670	0.09	0.11	0.08

End of Appendix 3

Variable name	Definition of variables	N	Mean value All	Male	Female
	D. Health care utilization characteristics				
Surgery last year*	1 if had a surgery in the last 12 months	3202	0.03	0.03	0.03
Healthcare last year	1 if got health care in the last 12 months	3536	0.66	0.56	0.71
Inpatient care last year*	1 if got inpatient health care in the last 12 months	3643	0.16	0.16	0.16
Inpatient stays last year*	Number of inpatient stays in the last 12 months	3642	0.22	0.21	0.23
Outpatient care last year*	1 if got inpatient health care in the last 12 months	3670	0.61	0.53	0.66
Outpatient visits last year*	Number of outpatient visits in the last 12 months	3664	2.12	1.61	2.41
	E. Self-reported conditions				
Angina	1 if reported being ever diagnosed with the condition (last 5 years for cataracts)	3658	0.33	0.28	0.36
Arthritis		3660	0.35	0.25	0.41
Stroke		3658	0.06	0.06	0.06
Lung disease		3659	0.18	0.21	0.16
Asthma		3658	0.03	0.02	0.04
Depression		3657	0.04	0.02	0.05
Hypertension		3660	0.56	0.43	0.64
Cataracts		3541	0.17	0.14	0.19

Appendix 3a. Descriptive statistics of regional and occupation group variables

Variable name	Definition of variables	N	Mean value All	Male	Female
	Regional dummies				
Saint Petersburg	1 if lives in a corresponding Federal District	3670	0.01	0.01	0.01
Central Federal District		3670	0.16	0.13	0.17
Northwestern Federal District		3670	0.03	0.03	0.03
Southern Federal District		3670	0.16	0.16	0.16
North Caucasian Federal District		3670	0.16	0.21	0.14
Volga Federal District		3670	0.12	0.10	0.13
Ural Federal District		3670	0.17	0.15	0.18
Siberian Federal District		3670	0.18	0.18	0.18
Far Eastern Federal District		3670	0.01	0.01	0.01
	Occupational group dummies				
Legislators, senior officials and managers	Major occupation groups based on ISCO-88	3670	0.05	0.06	0.05
Professionals		3670	0.19	0.13	0.23
Technicians and associate professionals		3670	0.03	0.01	0.04
Clerks		3670	0.09	0.02	0.12
Service workers and shop and market sales workers		3670	0.07	0.02	0.09
Skilled agricultural and fishery workers		3670	0.03	0.02	0.04
Craft and related trades workers		3670	0.18	0.28	0.12
Plant and machine operators and assemblers		3670	0.09	0.20	0.03
Elementary occupations		3670	0.14	0.12	0.15

Appendix 4. Estimates of selected coefficients from different specifications

The effect of:	Symptom-based		Anthropometrics		Behavior and risks		Health care utilization		Self-reported conditions		Combined	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Self-assessed health on labor force participation	−0.308*** (0.0860)	−0.623*** (0.128)	−0.633*** (0.136)	−1.018*** (0.102)	−0.752*** (0.113)	−0.832*** (0.0858)	–0.161 (0.108)	−0.664*** (0.124)	−0.208* (0.0838)	−0.615*** (0.102)	−0.398*** (0.109)	−0.715*** (0.0975)
Labor force participation on self-assessed health	−0.411* (0.172)	–0.00629 (0.152)	–0.468 (0.244)	0.0645 (0.207)	−0.615*** (0.147)	–0.388 (0.359)	−0.389* (0.166)	–0.0783 (0.208)	−0.383* (0.181)	–0.102 (0.183)	−0.477* (0.238)	0.0256 (0.225)
State pension eligibility on labor force participation	−0.471*** (0.143)	–0.328 (0.174)	–0.279 (0.160)	−0.542** (0.184)	−0.287* (0.138)	–0.149 (0.170)	−0.645*** (0.129)	–0.184 (0.179)	−0.526*** (0.139)	–0.279 (0.173)	−0.403* (0.180)	−0.360* (0.181)
atanh (rho)	0.475* (0.241)	0.295 (0.235)	1.064* (0.491)	0.920** (0.343)	1.399** (0.437)	1.137* (0.553)	0.231 (0.219)	0.434 (0.272)	0.314 (0.237)	0.400 (0.234)	0.732 (0.392)	0.546 (0.280)
Chi2 (health exogeneity)	5.876	2.920	4.739	12.07**	18.45***	10.12**	7.374*	4.687	6.128*	5.269	4.015	13.55**
N	2221	1250	1483	804	1881	952	1969	1038	2207	1255	1565	883
BIC	5884.9	3688.4	4080.5	2572.5	5223.0	3004.1	5259.0	3159.6	5865.1	3719.6	4226.7	2767.0
Difficulty on labor force participation	−0.294** (0.0895)	−0.768*** (0.104)	−0.555*** (0.133)	−0.952*** (0.0984)	−0.760*** (0.114)	−0.892*** (0.0774)	–0.231 (0.137)	−0.831*** (0.120)	−0.249* (0.0981)	−0.794*** (0.102)	−0.408*** (0.0954)	−0.786*** (0.0911)
Labor force participation on difficulty	–0.115 (0.169)	0.0477 (0.120)	–0.181 (0.316)	0.0136 (0.158)	–0.387 (0.202)	–0.249 (0.172)	–0.116 (0.142)	0.0574 (0.144)	–0.144 (0.138)	0.00754 (0.133)	–0.0637 (0.336)	0.0492 (0.150)
State pension eligibility on labor force participation	−0.557*** (0.120)	−0.359* (0.172)	−0.419** (0.161)	−0.578** (0.191)	−0.353* (0.158)	–0.192 (0.151)	−0.689*** (0.124)	–0.227 (0.172)	−0.582*** (0.119)	–0.322 (0.173)	−0.533*** (0.141)	−0.387* (0.181)
atanh (rho)	0.227 (0.207)	0.428* (0.202)	0.658 (0.446)	0.895** (0.316)	1.167** (0.410)	1.047*** (0.287)	0.124 (0.207)	0.433 (0.224)	0.197 (0.186)	0.493* (0.203)	0.378 (0.383)	0.569* (0.222)
Chi2 (health exogeneity)	1.479	8.654*	5.864	10.90**	8.799*	18.41***	0.668	7.893*	1.234	10.15**	6.157*	14.21***
N	2215	1249	1478	803	1875	951	1965	1037	2201	1254	1561	882
BIC	7604.0	4509.4	5257.4	3119.6	6679.4	3648.5	6894.4	3888.3	7610.8	4570.9	5477.4	3377.2
Compared health on labor force participation	−0.299** (0.107)	−0.767*** (0.108)	−0.636*** (0.143)	−1.012*** (0.0765)	−0.746*** (0.103)	−0.940*** (0.0811)	–0.140 (0.124)	−0.738*** (0.126)	−0.221* (0.0976)	−0.578*** (0.107)	−0.381*** (0.0959)	−0.752*** (0.0907)
Labor force participation on compared health	–0.0586 (0.123)	0.130 (0.152)	–0.0187 (0.146)	–0.0611 (0.217)	–0.184 (0.139)	–0.0546 (0.241)	–0.0535 (0.110)	0.103 (0.190)	–0.0252 (0.117)	0.117 (0.159)	–0.0288 (0.146)	0.102 (0.181)
State pension eligibility on labor force participation	−0.594*** (0.118)	–0.281 (0.171)	−0.429** (0.141)	−0.411* (0.175)	−0.420*** (0.123)	–0.165 (0.152)	−0.703*** (0.127)	–0.174 (0.172)	−0.632*** (0.117)	–0.311 (0.185)	−0.565*** (0.144)	–0.310 (0.170)

End of Appendix 4

The effect of:	Symptom-based		Anthropometrics		Behavior and risks		Health care utilization		Self-reported conditions		Combined	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
atanh (rho)	0.198	0.446*	0.574*	1.217**	0.934***	1.004**	–0.0178	0.385	0.0786	0.179	0.295	0.630**
	(0.180)	(0.224)	(0.273)	(0.410)	(0.274)	(0.342)	(0.176)	(0.255)	(0.167)	(0.202)	(0.198)	(0.237)
Chi2 (health exogeneity)	1.438	12.69**	6.459*	13.62**	13.30**	20.21***	0.530	8.385*	0.264	5.815	4.309	19.29***
N	2177	1229	1457	793	1847	941	1930	1024	2161	1233	1538	875
BIC	5723.3	3520.6	4121.7	2519.1	5048.5	2937.8	5134.9	3034.3	5669.6	3507.8	4196.7	2681.5
WHODAS on labor force participation	−0.023**	−0.069***	−0.057***	−0.087***	−0.050***	−0.078***	–0.022	−0.076***	−0.021*	−0.067***	−0.034***	−0.0743***
	(0.008)	(0.012)	(0.011)	(0.012)	(0.013)	(0.009)	(0.012)	(0.010)	(0.010)	(0.010)	(0.009)	(0.009)
Labor force participation on WHODAS	1.652	1.711	0.363	0.894	–2.749	–3.513	0.253	–0.599	1.610	0.853	1.041	–1.323
	(1.690)	(4.532)	(2.563)	(2.151)	(1.930)	(2.913)	(1.356)	(4.989)	(1.792)	(3.358)	(2.139)	(3.090)
State pension eligibility on labor force participation	−0.606***	–0.559	−0.441*	−0.728**	−0.441*	–0.0716	−0.647***	–0.250	−0.635***	–0.465	−0.552***	–0.289
	(0.120)	(0.415)	(0.187)	(0.247)	(0.182)	(0.308)	(0.135)	(0.674)	(0.119)	(0.375)	(0.162)	(0.521)
atanh (rho)	–0.0966	0.192	0.418	0.584*	0.628*	0.875*	0.00576	0.516	–0.0976	0.245	0.0957	0.640
	(0.169)	(0.459)	(0.309)	(0.293)	(0.291)	(0.420)	(0.189)	(0.566)	(0.192)	(0.324)	(0.245)	(0.425)
Chi2 (health exogeneity)	1.072	3.842	7.350*	7.929*	4.690	8.163*	0.0722	5.251	0.865	4.699	3.551	10.78**
N	2042	1154	1383	755	1740	888	1815	965	2029	1157	1450	826
BIC	17949.4	10228.6	12130.7	6802.6	15518.2	8070.7	16080.0	8627.5	17925.5	10250.8	12590.1	7311.4

Note. Robust standard errors in parentheses. * — $p < 0.05$, ** — $p < 0.01$, *** — $p < 0.001$.