

Identification of Interconnection between Health and Employment of Retirement Age Women*



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Abstract. Recently, Russia has been actively developing and implementing the state policy of encouraging the employment of people of the older generation. The purpose of the paper is to identify the interconnection between the employment of pensioners and their health (on the example of pension age women in the most active age group), which will allow justifying the more efficient policy in this area. The study is aimed at the test of two hypotheses, put forward due to the analysis of theoretical models and sociological surveys of the population. The first one suggests that retirees' labor activity contributes to the preservation of their health; the second one states that only retirees, whose health allows doing it, continue to work. A diagram of the dependencies between the retirees' employment, their health, and other factors, which formed the basis of the regression models, is generated. As a criterion of testing the hypotheses set in the

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research, two multivariate linear regression models, which evaluate the statistical dependence between employment, health status of pensioners, and other variables, were constructed. Based on the calculation of the determinant of the correlation matrix, the existence of linear dependence between explanatory variables in regression models was excluded. The study was conducted on the example of women at the age of 55–59 according to statistical data of Federal State Statistics Service, Federal Service for Supervision in the Sphere of Nature and of the Federal Treasury. The results of the regression analysis confirmed only the first hypothesis, the second one was rejected. The proportion of working women at the age of 55–59 is largely statistically associated with the mortality rate of women of the same age. In turn, economic growth, tensions on the labor market, and the level of pension provision appeared to be statistically significant factors influencing the employment of women at the age of 55–59.

Key words: pensioners, employment, health, regression analysis.

Introduction

According to Rosstat¹, the population in Russia is gradually ageing, and, by 2036, every third resident will be over the working age². In the future, the Russian economy, its industries, and regions of the country may experience a shortage of one of the basic factors of production – labor [1]. In 2018, the number of employed in the economy per a retiree was 1.7 persons³, and, in the future, the burden on the working population will increase. Many researchers [2–4] consider retirees' labor activity as a tool for labor shortage mitigating. The usage of older people's potential is not only additional manpower for the economy, but, first and foremost, the opportunity for senior citizens' self-fulfillment [5]. Continuing labor activity retirees maintain social ties and take care of their health [6]. At the same time, it is necessary to consider the quality of human capital of older people. The study of Maleva T.M. and Sinyavskaya O.V. [7] showed that, by the time a person reaches retirement age,

he or she usually has a number of chronic diseases and often disability. Therefore, the involvement of old people into labor activity and the building of the capacity of active ageing, as the researchers of the Higher School of Economics note [8], may encounter significant limitation. Pensioners' health may limit their performance. The state policy of encouraging the employment of people of older generation (“the new pension formula”, “Strategy of action concerning senior citizens up to 2025”, raising retirement age), which has been actively developed and implemented in recent years in Russia, needs not only to create the possibility of extending the employment period for old people, but also to ensure the preservation of their satisfactory state of health. The study of the relationships between the employment of pensioners and their health will allow conducting a more effective policy in this area. Therefore, the purpose of this research is to identify the causal relationships by on the example of the retirement age women in the most active age group.

Literature overview

The age structure of the population is an important factor contributing to the socio-economic development, which is reflected in a

¹ The estimated population of the Russian Federation. Federal State Statistics Service. Available at: <https://gks.EN/compendium/document/13285> (accessed 01.10.2019).

² Men at the age of 60 and older, women at the age of 55 and older.

³ Employment and unemployment. Federal State Statistics Service. Available at: https://www.gks.ru/labour_force (date treatment: 13.11.2019).

huge number of works devoted to the economics of ageing [9-10]. As F. Notestein rightly pointed out [11], the problem of demographic ageing of population is not a problem, but just a pessimistic view on the mankind's greatest triumph. Undoubtedly, the increase of life expectancy is the main achievement of the socio-economic development, but the ageing of the population brings major challenges to social institutions that require the development of sound policy in this area.

Recently, the emphasis in the approach to improving the quality of life of older people shifted from providing various social protection mechanisms to the stimulation of their potential development and use [12]. Not long ago, new terms have appeared within the framework of this approach, these are the people of "third age" [13] and "fourth age" [14] who deny past ideas about the old age.

The concept of active ageing, which was formed in the 1990s and was aimed at solving the problems of population ageing, became widespread [15]. The concept of active ageing shifts the focus of discussing the effects of ageing from the negative expectations of the growing burden of public expenditure to the analysis of the possibility of using old people's potential [16]. According to the World Health Organization⁴ active ageing is the process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age. The provision of active ageing, i.e. optimizing opportunities for health, participation, and security in order to enhance the quality of life as people age is an important growth strategy. For the active ageing policy to be successful, a radical change of views about the meaning of ageing in economic and social terms is required [17]. Active

ageing allows people to realize their potential for physical, social, and mental well-being throughout life and to participate in the life of society in accordance with their needs, desires, and capacities, providing them with adequate protection, security, and care when they need it. Active ageing aims to increase life expectancy and quality of healthy life for all people as they grow old, including those who are weak, infirm, and need care. Labor and physical activity of elderly people here is considered to be the basis of their health [6].

The data of monitoring of public health of the Vologda Oblast's population, carried out by the Vologda Research Center of the Russian Academy of Sciences [18], showed that working pensioners more positively characterize their own health. The results of the quantitative research, conducted in 2012 in the Ivanovo Oblast [19], revealed that a greater impact on the subjective evaluation of health is made not by the age, but the level of education, current employment, diversity of employment practices. Rogozin D.M. explains it by the fact that employed pensioners independently manage their time, they are included in various social networks and do not depend on the state's care. Similar results were obtained by Lezhnina Yu.P. according to the research of the Institute of Sociology of the Russian Academy of Sciences "Social policy and social reforms as viewed by the Russians"⁵. Pensioners' involvement in the labor process provides them not only with additional income, but it also increases their self-esteem and improves health.

⁴ *Active ageing: a policy framework*. WHO. Geneva, Switzerland, 2002. 59 p.

⁵ Lezhnina Yu.P. Rossiyskie pensionery: uroven' zhizni, zdorovye, zanyatost' [Russian retirees: standard of living, health, employment]. Rossiya reformiruyushchayasya: Ezhegodnik. [Reforming Russia: Yearbook]. Executive editor M.K. Gorshkov, vol. 7, Moscow: Institut sotsiologii, 2008, pp. 178–195.

At the same time, the study by O.V. Egorova⁶, the basis of which was the data from the polyclinics, revealed that employed retirement age women have a higher level of general and chronic morbidity. A complex medico-social study on lifestyle and health status of working women of retirement age (on the example of the Penza Oblast) [20] showed that no one noted the positive effects of work on health among working women over the age of 60. A survey of the population⁷, conducted in 2013 by the Institute of Social Analysis and Forecasting of the Russian Presidential Academy of National Economy and Public Administration [21], showed that the reasons for abandoning work upon reaching the retirement age are ill health and fatigue, because these factors determine the elderly people's capabilities to work.

Thus, in the scientific literature, there are two viewpoints regarding health of working pensioners. The first view is based on the concept of active ageing and suggests the involvement of older people in the workforce that will not only solve the problems of population ageing (labor shortage, the burden on the employed population, etc.), but it will also contribute to the preservation of their health. The second point of view takes into

account the fact that Russian elderly people reach the retirement age with poor health, and the continuation of labor activity may aggravate their condition. To confirm or refute these opposing points of view, causal connections between retirees' employment and their health were revealed in this study.

Approach to the research

On the basis of reviewed theoretical models and the sociological surveys of the population, the following hypotheses were put forward:

H_1 : retirees continue to work, and it preserves their good health;

H_2 : only retirees with good health continue to work.

If the retirees' satisfactory health condition appears as the result of their labor activity in the hypothesis H_1 , the situation is opposite in the hypothesis H_2 , where health condition is the reason of employment. Usually, the studies of health and labor activity of pensioners are carried out within incentives and constraints⁸. In this work, the regression models, revealing the relationship between these variables, were constructed for the verification of set hypotheses. For this purpose, the authors formed a scheme of causal relationships between the retirees' employment and their health, which also shows other potential factors of influence (*Fig. 1*).

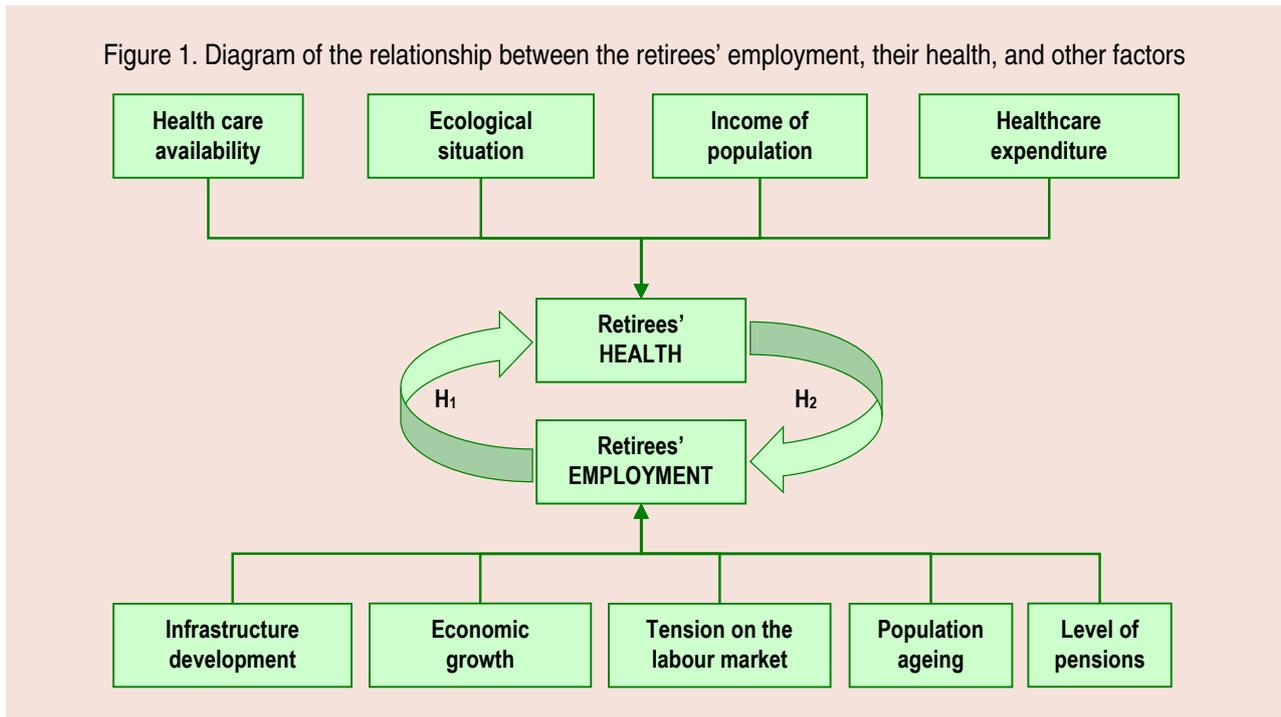
The first regression model is built in order to test hypothesis H_1 and includes a dependent variable – retirees' health, which, in addition to their employment, is influenced by such factors (input variables) as the availability of healthcare, ecological situation, income of the population, and public expenditure on healthcare. This set of variables is based on

⁶ Egorova O.V. *Obraz zhizni i sostoyanie zdorov'ya rabotayushchih zhenshchin pensionnogo vozrasta: diss. ... kandidata meditsinskikh nauk: 14.02.03* [Lifestyle and health condition of working women of retirement age: Candidate of Medical Sciences dissertation: 14.02.03]. Moscow, 2011, 173 p.

⁷ *Vliyaniye trudovogo i pensionnogo povedeniya naseleniya na obespecheniye dolgosrochnoy ustojchivosti pensionnoy sistemy v Rossijskoy Federacii i snizheniye riskov deprivatsionnoy bednosti sredi grazhdan pozhilogo vozrasta: preprint* [The influence of labor and retirement behavior of the population on the ensuring of the long-term sustainability of the pension system in the Russian Federation and reducing the risks of deprivation poverty among the elderly: Preprint]. A.Ya. Burdyack, E.E. Grishina, Yu.A. Dormidontova, Yu.M. Kazakova, V.Yu. Lyashok, E.A. Tsatsura; RANKHiGS, Moscow: Delo, 2014, 80 p.

⁸ Maltseva E. Slaboe zdorov'e meshaet pensioneram rabotat' [Poor health prevents retirees from work]. Scientific-educational portal IQ. Available at: <https://iq.hse.EN/news/177667217.html>. (accessed: 01.10.2019).

Figure 1. Diagram of the relationship between the retirees' employment, their health, and other factors



WHO proposed factors affecting health [22]: lifestyle, genetics, state of healthcare, and environment. The first of these factors in our model is described by the indicators of retirees' employment and incomes of the population, the third one – by the indicators of population's provision with doctors and healthcare costs, the fourth one – by the indicator of the ecological situation. The second factor is not included into the model since, as noted by V.A. Chereshnev [22], it is relevant for children up to 3-6 years of age.

The second model (hypothesis H_2) includes the dependent variable – retirees' employment and explanatory variables – internal factors (retirees' health and pensions level) and environmental factors (infrastructure development, economic growth, tensions in the labor market, and the demographic situation). According to numerous polls, these are the internal factors that have a larger influence on the elderly people's labor activity. The choice of internal factors is substantiated by the results of numerous sociological studies.

According to them, the retirees' involvement in labor activity is involuntary⁹ [23–24]. The reason why they stop working after reaching the retirement age, as already noted, is their poor health condition¹⁰ [21]. In addition to mentioned factors, the external environment also affects the seniors' decision of the possibility of continuing employment. Retirees' labor activity is considered as a tool to mitigate labor shortage [2–3], and that is why the model includes such factors as tension in the

⁹ Burdyack A.Ya., Grishina E.E., Dormidontova Yu.A., Kazakova Yu.M., Lyashok V.Yu., Tsatsura E.A. *Vliyaniye trudovogo i pensionnogo povedeniya naseleniya na obespechenie dolgosrochnoy ustojchivosti pensionnoy sistemy v Rossijskoy Federacii i snizhenie riskov deprivacionnoy bednosti sredi grazhdan pozhilogo vozrasta*. RANKHiGS, Moscow: Delo, 2014, 80 p.

¹⁰ *Osobennosti trudovoy zanyatosti rossijskih pensionerov*. Center for pension reform study. Available at: <http://rospens.EN/research/analytics/osobennosti-trudovoy-zanyatosti-rossijskikh-pensionerov.htm> (accessed: 15.11.2019); Burdyack A.Ya., Grishina E.E., Dormidontova Yu.A., Kazakova Yu.M., Lyashok V.Yu., Tsatsura E.A. *Vliyaniye trudovogo i pensionnogo povedeniya naseleniya na obespechenie dolgosrochnoy ustojchivosti pensionnoy sistemy v Rossijskoy Federacii i snizhenie riskov deprivacionnoy bednosti sredi grazhdan pozhilogo vozrasta*. RANKHiGS, Moscow: Delo, 2014, 80 p.

labor market, economic growth, demographic situation, and infrastructure development. The first of these factors is described by the unemployment rate. As several studies emphasize [25], the competitiveness of individuals who have reached the retirement age on the labor market is extremely low, and their chances for employment are lower than those of younger candidates [26]. Therefore, the presence of vacant jobs creates the need for additional manpower. The second factor also reflects the formation of interest in the retirees' employment: this is economic growth, which, as a rule, is accompanied by the growth of the anthropogenic load on the environment¹¹ [27]. The third factor characterizes the level of demographic ageing of the population, which naturally increases the average age of economically active population. As demographers note [28], the demographic pyramid of economically active population of Russia generally follows the demographic pyramid of the country in the age interval from 15 to 72 years. The indicator of infrastructure development (in particular healthcare, which is especially important for the elderly), is considered to be the fourth factor, because it creates the conditions for life, including the reproduction of labor resources [29–30].

The logic of the research is as follows. If the explanatory variable is statistically significantly associated with the dependent variable, then the hypothesis is not rejected (accepted). The statistical significance of the coefficient before the explanatory variable in the multivariate linear regression was used as the criterion. And the regression model should meet the quality indicators.

¹¹ Economic growth is accompanied by increasing emissions of pollutants. *Demoskop Weekly*, 2004, no. 173–174. Available at: <http://www.demoscope.EN/weekly/2004/0173/barom01.php> (accessed: 14.11.2019).

The research data

Usually, while studying health status of elderly population, the authors use data from sociological surveys that has some limitations for the regression models. First, to ensure a sufficient array of data to build an effective model, the surveys should be regular. Secondly, which is more important, the data on health status are based on the individual's self-esteem, as V.Yu. Lyashok and S.Yu. Roshchin rightly note [31], which has no clear criteria of response selection. Therefore, the given research is based on the statistical data of the Federal State Statistics Service, the Federal Service for Supervision of Natural Resources, and the Federal Treasury.

To assess health condition, mortality indices are used. This choice is justified, firstly, by a close correlation between the health of people in old age and their mortality. According to the Central Research Institute for Health Organization and Informatization of the Ministry of Health of the Russian Federation¹² for 2017, 88.9% of mortality cases among the elderly occur due to the endogenous reasons, i.e. from disease, not from external causes. Secondly, the use of mortality indices, while evaluating health status of the population, allows mitigating the impact of problems of underreporting and detection of latent disease. The problems existing in medical statistics [32] (from problems of detection of hidden latent morbidity of the population [33–34] to the deliberate distortion of information¹³ [35]) often lead to the fact that the statistical data are contradictory or closed [36]. Therefore,

¹² *Mediko-demograficheskie pokazateli Rossijskoy Federacii v 2017 godu: stat. spravochnik*. Ministry of Health of Russia, Moscow, 2018, 264 p.

¹³ ... О приписках в медицине [... On postscripts in medicine]. *Demoskop Weekly*, 2015, no. 667–668. Available at: <http://www.demoscope.EN/weekly/2015/0667/gazeta013.php> (accessed: 15.11.2018).

the use of mortality indices is widely used for the evaluation of health status in many studies, including medical ones. For example, the index of accounting reliability (the ratio of the number of deaths to the number of initially reported cases of malignant tumors) is considered one of the most objective indices of evaluation of the condition of the oncologic help to the population reflecting the level of primary cases underreporting [37]. All the more so, the statistical information on the morbidity of the population over working age has been developed by the Ministry of Health of Russia only since 2010. Thirdly, the use of different subjective measures of health assessment has its methodological limitations [38–42].

The regression models were built according to data on women of 55–59 years old, which is due to the methodology of the study, on the one hand. According to the results of the Comprehensive monitoring of living conditions of the population¹⁴ the average labor experience after retirement is 6.4 years. On the other hand, according to the statistical information, published by the Russian Federal State Statistics Service, the employment of men of the retirement age is presented only in one age group of 60–72 years, which is quite a long time frame for the purpose of the study.

For each hypothesis, a regression model was built and a set of informative indicators was selected. To test hypothesis H_1 , age-specific mortality index of women aged 55–59, per mille was taken as the dependent variable Y . As input (explanatory) variables, the following indicators were used:

X_1 – the proportion of women aged 55–59 in the total number of employed¹⁵, %;

X_2 – the number of doctors per 10.000 of population;

X_3 – emissions of air pollutants per person, kg;

X_4 – the average income of population (in the prices of 2018), thousand rubles;

X_5 – the expenditures of the consolidated budget of a constituent entity of the Russian Federation and territorial state extra-budgetary fund for the healthcare sector (in the prices of 2018) per capita, thousand rubles.

To test hypothesis H_2 , the proportion of women aged 55–59 in the total number of employed people (%), was reviewed as the dependent variable Y . As input (explanatory) variables, the following indicators were used:

X_1 – life expectancy after achieving 55 years of age by women, years;

X_2 – the number of doctors per 10.000 of population;

X_3 – emissions of air pollutants per year per person, kg.;

X_4 – unemployment rate (by ILO methodology), %;

X_5 – the share of population over the working age in total population, %;

X_6 – replacement ratio (the level of replacement of lost earnings by pension), %.

The calculations of the research were conducted in Statistica package.

Results of the research

Testing hypotheses H_1

To reveal causal connection between the employment of women aged 55–59 and their health, a correlation and regression analysis was

¹⁴ Itogi kompleksnogo nablyudeniya usloviy zhizni naseleniya [The results of the comprehensive monitoring of living conditions of the population]. Federal State Statistics Service. Available at: https://www.gks.ru/free_doc/new_site/KOUZ18/index.html (accessed: 01.10.2019).

¹⁵ Itogi vyborochnogo obsledovaniya rabochey sily 2018: stat. sb. Rosstat, Moscow, 2019.; Rabochaya sila, zanyatost' i bezrabotica v Rossii (po rezul'tatam vyborochnykh obsledovaniy rabochey sily). 2018: stat. sb. Rosstat, Moscow, 2018. 142 p.; Ekonomicheskaya aktivnost' naseleniya Rossii (po rezul'tatam vyborochnykh obsledovaniy). 2008: stat. sb. Rosstat, Moscow, 2008, 165 p.

Table 1. Correlation matrix for input and dependent variables

	X_1	X_2	X_3	X_4	X_5	Y
X_1	1.000	-0.136	-0.430	0.797	0.786	-0.848
X_2	-0.136	1.000	0.362	0.155	0.213	0.143
X_3	-0.430	0.362	1.000	-0.637	-0.483	0.787
X_4	0.797	0.155	-0.637	1.000	0.944	-0.912
X_5	0.786	0.213	-0.483	0.944	1.000	-0.846
Y	-0.848	0.143	0.787	-0.912	-0.846	1.000

Table 2. The results of the regression analysis

	Beta	Std.Err. of Beta	B	Std.Err. of B	$t(13)$	p -level
Intercept			13.5647	3.64125	3.72528	0.002544
X_1	-0.41793	0.078887	-0.34714	0.065524	-5.29787	0.000144
X_3	0.466521	0.055641	0.0633	0.007551	8.38455	0.000001
X_5	-0.2925	0.081338	-0.0902	0.025092	-3.59609	0.003256

Table 3. Basic statistics of the regression analysis

Index	Value
Multiple R	0.9846
Multiple R^2	0.9694
Adjusted R^2	0.9623
$F(3,13)$	137.2551
ρ	0.0000
Std.Err. of Estimate	0.3658

Table 4. Paired and partial correlation coefficients between the input variables and the dependent variable

i	1	2	3	4	5
$r_{x_i y}$	-0.848	0.143	0.787	-0.912	-0.846
$r_{x_i y \setminus x_1 \dots x_5}$	-0.744	-0.122	0.789	-0.028	-0.366

conducted. The data were taken from the Rosstat references for the period of 2002–2018. In *table 1* a correlation matrix for input and dependent variables for hypothesis H_1 testing is presented.

The input variables appeared to be multicollinearity¹⁶, i.e. the determinant of the correlation matrix is equal to 0.0058. After removing the statistically insignificant factors (X_2 and X_4) from the model, the regression model was obtained (*Tab. 2* and *Tab. 3*). Multicollinearity for three remaining significant factors is absent,

¹⁶ Magnus Ya.R., Katyshev P.K., Peresetskiy A.A. *Ekonometrika. Nachal'nyi kurs*. Moscow, Delo, 2004, 576 p.

the determinant of the correlation matrix for input variables (X_1 , X_3 , and X_5) is equal to 0.2902.

Additionally, pair and partial correlation between the input variables and the dependent variable were calculated (*Tab. 4*).

The results presented in *table 4* are consistent with the results of the regression analysis. Variables X_2 and X_4 also appeared to be not correlated with the dependent variable Y when fixing the other factors. High pair correlation between X_4 and Y was caused by the impact of other factors (the effect of multicollinearity of input variables).

Thus, we obtained a regression model based on age-specific mortality rate of women of 55–59 years old from the number of women, aged 55–59, in the total number of employed people, the specific emissions of air pollutants and specific expenditures of the consolidated budget of a constituent entity of the Russian Federation and territorial state extra-budgetary fund for health:

$$\bar{Y}(\mathbf{X}) = 13,565 - 0,347X_1 + 0,0633X_3 - 0,0902X_5, (1)$$

Equation (1) shows that, as far as the employment of women aged 55–59 grows by 1%, the mortality rate of women of the same age declines by 0.347 per mille while the emissions of air pollutants and public health costs maintain at the same level.

Formally, to estimate the parameters of model (1), the compliance with the conditions of $RgX = m + 1 = 4 < n$ is sufficient, i.e. there should be more than 4 linearly independent observations (the number of model parameters)¹⁷. However, to ensure the statistical reliability of the model estimation it is typically

required that the number of observations (in this case $n = 17$) should at least 3 times exceed the number of estimated parameters (it equals 4 for model (1))¹⁸. It is evident that this condition is met, and the sample can be considered representative.

Testing hypotheses H_2

The statistics were taken from Rosstat references for the period of 2000–2018. To test hypothesis H_2 , we have also built a correlation matrix for input and dependent variables, the results are presented in *table 5*.

As shown by the calculation of the determinant of the correlation matrix (it is equal to 0.00027), the input variables are multicollinearity; to exclude this, the statistically insignificant factors (X_1 , X_2 , and X_5) were removed from the model. The obtained regression model is presented in *tables 6 and 7*. Multicollinearity for the three remaining significant factors is absent, the determinant of the correlation matrix for input variables (X_3 , X_4 , and X_6) is equal to 0.2378.

Table 5. Correlation matrix for input and dependent variables

	X_1	X_2	X_3	X_4	X_5	X_6	Y_1
X_1	1.000	0.024	-0.632	-0.835	0.957	0.531	0.704
X_2	0.024	1.000	0.391	-0.111	-0.206	-0.048	0.304
X_3	-0.632	0.391	1.000	0.249	-0.724	-0.861	-0.023
X_4	-0.835	-0.111	0.249	1.000	-0.780	-0.144	-0.902
X_5	0.957	-0.206	-0.724	-0.780	1.000	0.548	0.613
X_6	0.531	-0.048	-0.861	-0.144	0.548	1.000	0.049
Y_1	0.704	0.304	-0.023	-0.902	0.613	0.049	1.000

Table 6. The results of the regression analysis

	Beta	Std.Err. of Beta	B	Std.Err. of B	$t(15)$	p -level
Intercept			6.0613	21.2036	0.2859	0.7789
X_3	0.5491	0.1713	0.2121	0.0662	3.2050	0.0059
X_4	-0.9837	0.0881	-3.2787	0.2935	-11.1709	0.0000
X_6	0.3803	0.1677	0.5114	0.2255	2.2681	0.0385

¹⁷ Ayvazyan S.A., Mkhitarian V.S. *Prikladnaya statistika i osnovy ekonometriki*. Moscow, YUNITI, 1998. 1005 p.

¹⁸ Borodich S.A. *Ekonometrika* [Econometrics]. Minsk, Novoye znaniye, 2001, 408 p.

Table 7. Basic statistics of the regression analysis

Index	Value
Multiple R	0.9450
Multiple R^2	0.8931
Adjusted R^2	0.8717
$F(3,15)$	41.7754
p	0.0000
Std.Err. of Estimate	1.8418

Table 8. Pair and partial correlation coefficients between input variables and dependent variable

i	1	2	3	4	5	6
$r_{x_i y}$	0.704	0.304	-0.023	-0.902	0.613	0.049
$r_{x_i y \setminus x_1 \dots x_5}$	-0.040	0.051	0.575	-0.682	0.247	0.446

The results of the calculations of pair and partial correlation between the input variables and the dependent variable are presented in table 8.

The results presented in table 8 are also consistent with the results of the regression analysis. Variables X_1 , X_2 , and X_5 also appeared to be not correlated (X_1 , X_2) or weakly correlated (X_5) with the dependent variable Y when fixing the other factors. The difference of partial correlation coefficients $r_{x_3 y \setminus x_1 \dots x_6}$ and $r_{x_6 y \setminus x_1 \dots x_5}$ from the pair of coefficients $r_{x_3 y}$ and $r_{x_6 y}$ were caused by the influence of other factors due to the effect of multicollinearity.

As a result, we have obtained a regression model for the dependence of the proportion of women aged 55–59 in the total number of the employed from specific emissions of air pollutants, unemployment rate and the replacement rate of the lost earnings by pension:

$$\bar{Y}(\mathbf{X}) = 6,061 + 0,212X_3 - 3,279X_4 + 0,511X_6. \quad (2)$$

The analysis of equation (2) allows concluding that, with the growth of emissions of polluting substances per 1 person per 1 kg, the share of women aged 55–59 and employed in the economy increases by 0.212%, while

other factors remain unchanged. This dependence corresponds to the environmental Kuznets curve, which is an inverted U-shaped curve that describes the impact of the economy on the environment. It is expected that, with the growing prosperity of the population to a certain level, the volume of pollution grows [43]. The increase of the unemployment rate by 1% will cause a decrease of employment among women aged 55–59 by 3.279% while fixing the values of other factors. The increase of the replacement rate by 1% at constant values of other factors requires additional employment growth by 0.511%. In other words, the higher the level of substitution of the lost income is, the higher the number of working retirees, wishing to maintain their previous level of financial security, is.

Estimation of the parameters of model (2) was carried out on the basis of 19 observations, so the data sample is representative, and the parameters' estimates have adequate statistical reliability.

Conclusions

The results of the research confirmed hypothesis H_1 that the retirees' labor activity keeps them healthy. The proportion of working women aged 55–59 years is statistically

significantly associated with the mortality rate of women of the same age. While fixing all other factors, the increase of the average proportion of employed women by 1% reduces their mortality by 0.347 per mille, or by 3.79% on average for the period of 2002–2018.

During the research, we rejected hypothesis H_2 on the influence of health condition on the decision of the women, aged 55–59, concerning the continuation of employment. The following statistically significant factors appeared to influence the employment of women, aged 55–59: economic growth (accompanied by the increase of anthropogenic burden on the environment in the form of air emissions), tensions on the labor market (causing unemployment) and the level of pensions (level of replacement of the lost earnings by pension). The first two factors describe the labor demand

on the part of the labor market, the third factor describes financial interest on the part of the retirees.

Thus, the results of the research testify that the age of active longevity lasts longer than the productive age. That is why, in the ageing of population (the increase of labor shortage and economic burden on the working population), the retirees are significant labor resources, which have necessary experience and skills. At the same time, the involvement of pensioners in economic activity should not be excessive and total, the old people's employment should take into account their capabilities and requirements. It is obvious that the further work on the development of government measures to create conditions for the active participation of the older generation in public relations, which could positively affect their health, is necessary.

References

1. Korovkin A., Dolgova I., Korolev I. Labor shortage in Russia will come between 2010 and 2015. *Demoskop. Weekly*, 2007, no. 277–278. Available at: <http://www.demoscope.EN/weekly/2007/0277/tema01.php> (accessed: 01.10.2019). (In Russian).
2. Ivanova M., Balaev A., Gurvich E. Raising retirement age and the labor market. *Voprosy ekonomiki=Economic Issues*, 2017, no. 3, pp. 1–18. (In Russian).
3. Korovkin A.G., Dolgova I.N., Korolev I.B. Labor shortage in the Russian economy: A macroeconomic estimate. *Studies on Russian Economic Development*, 2006, vol. 17, no 4, pp. 365–376. DOI: 10.1134/S1075700706040022 (In Russian).
4. Gorlin Yu.M., Lyashok V.Yu., Maleva T.M. Raising retirement age: Positive effects and possible risks. *Ekonomicheskaya politika=Economic Policy*, 2018, vol. 13, no. 1, pp. 148–179 DOI: 10.18288/1994-5124-2018-1-06 (In Russian).
5. Vladimirov D.G. Senior generation as a factor of economic development. *Sotsiologicheskie issledovaniya=Sociological Research*, 2004, no. 4, pp. 57–59. (In Russian).
6. Kolosnitsyna M.G., Khorkina N.A. Public policy of active aging: As evidenced by international experience. *Demograficheskoe obozrenie=Demographic Review*, 2016, no. 4, pp. 27–46. DOI: 10.17323/demreview.v3i4.3204 (In Russian).
7. Maleva T.M., Sinyavskaya O.V. Raising retirement age: Pro et contra. *Zhurnal novoy ekonomicheskoy assotsiatsii=Journal of New Economic Association*, 2010, no. 8, pp. 117–137. (In Russian).
8. Vishnevsky A.G., Vasin S.A., Ramonov A.V. Retirement age and length of life. *Voprosy ekonomiki=Economy Issues*, 2012, no. 9, pp. 88–109. (In Russian).
9. Safarova G.L. Demography of ageing: Current state and priority-driven research directions. *Advances in Gerontology*, 2011, vol. 1, issue 1, pp. 5–15. DOI: 10.1134/S2079057011010127 (In Russian).
10. Bucher S. Ageing of the population in the Russian Federation: The current trends and indicators. *Herald of the Russian Academy of Sciences*, 2016, vol. 86, issue 2, pp. 97–104. DOI: 10.1134/S1019331616020027.

11. Notestein F.W. Some Demographic Aspects of Ageing. *Proceedings of the American Philosophical Society*, 1954, no. 98(1), pp. 38–45.
12. Grigoryeva I.A. Shift of the paradigm in the understanding of ageing. *Zhurnal issledovaniy sotsial'noy politiki*=*Journal of social policy studies*, 2018, no. 1, pp. 5–6. (In Russian).
13. Laslett P., The Emergence of the Third Age. *Ageing & Society*, 1987, vol. 7, no 2, pp. 133–160. DOI: 10.1017/S0144686X00012538
14. Gilleard C., Higgs P. Ageing without agency: Theorizing the fourth age. *Ageing & Mental Health*, 2010, vol. 14 (2), pp. 121–128. DOI: 10.1080/13607860903228762
15. Walker A. A strategy for active ageing. *International Social Security Review*, 2002, vol. 55, no 1, pp. 121–139. DOI: 10.1111/1468-246X.00118
16. Varlamova M., Ermolina A., Sinyavskaya O. Active Ageing Index as an Evidence Base for Developing a Comprehensive Active Ageing Policy in Russia. *Journal of Population Ageing*, 2017, vol. 10, no. 1, pp. 41–71. DOI: 10.1007/s12062-016-9164-0
17. Walker A., Zaidi A. New Evidence on Active Ageing in Europe. *Intereconomics*, 2016, vol. 51, no. 3, pp. 139–144. DOI: 10.1007/s10272-016-0592-0
18. Korolenko A.V., Barsukov V.N. Health condition as a factor of labor activity of the population of retirement age. *Vestnik Permskogo universiteta. Filosofiya. Psikhologiya. Sociologiya*=*Herald of the Perm state University. Philosophy. Psychology. Sociology*, 2017, no. 4 (32), pp. 643–657. (In Russian).
19. Rogozin D.M. Liberalization of ageing, or labor, knowledge and health in older age. *Sotsiologicheskii zhurnal*=*Sociological Journal*, 2012, no. 4, pp. 62–93. (In Russian).
20. Tolchenova E.A., Egorova O.V. The role of managerial staff of health institutions in health care of working women of retirement age. *Vestnik Rossiyskogo universiteta druzhby narodov. Seriya: Meditsina*=*RUDN Journal of Medicine*, 2009, no. 4, pp. 705–706. (In Russian).
21. Maleva T.M. A human in the solidarity pension system. *Ekonomicheskaya politika*=*Economic Policy*, 2014, no. 2, pp. 55–84. (In Russian).
22. Chereshev V.A. *Ekologiya. Immunitet. Zdorov'e*. SPb.: SPbGUP, 2016, 32 p.
23. Cherkashina T.Yu. Work in retirement: Necessity or opportunity? *EKO*=*ECO*, 2011, no. 4, pp. 101–114. (In Russian).
24. Barsukov V.N. Labor Activity of the Population of Retirement Age as a Factor in Socio-Economic Development of the Territory. *Ekonomicheskie i sotsial'nye peremeny: fakty, tendentsii, prognoz*=*Economic and Social Changes: Facts, Trends, Forecast*, 2016, no. 1(43), pp. 195–213. (In Russian).
25. Bogdanova E.A. Labor relations with the participation of the retirees: Care or manipulation? *Zhurnal issledovaniy sotsial'noi politiki*=*Journal of Social Policy Studies*, 2016, no. 14(4), pp. 535–550. (In Russian).
26. Klepikova E.A. Age discrimination in hiring: Results of a pilot study. *Ekonomicheskaya politika*=*Economic policy*, 2019, no. 14(2), pp. 64–89. (In Russian).
27. Zabelina I.A., Klevakina E.A. System of indicators for assessing the quality of growth of regional economies. *Vestnik Volgogradskogo gosudarstvennogo universiteta. Seriya 3: Ekonomika. Ekologiya*=*Bulletin of the Volgograd State University. Series 3: Economics. Ecology*, 2014, no. 6 (29), pp. 23–32. DOI: <http://dx.doi.org/10.15688/jvolsu3.2014.6.3> (In Russian).
28. Vasin S., Vishnevskiy A., Denisenko M. Ageing of the working population is counteracted by modernization processes. *Demoskop Weekly*, 2010, no. 429–430. Available at: <http://www.demoscope.EN/weekly/2010/0429/tema07.php> (accessed: 15.11.2019). (In Russian).
29. Krivova D.A. Contradictions of development of social infrastructure in the small city of the Middle Urals. *Voprosy upravleniya*=*Public Management*, 2012, no. 2(19), pp. 213–218. (In Russian).
30. Zhikharevich B.S., Logacheva N.M. Social infrastructure and human capital in the Russian regions: The approach to the assessment of mutual influence. *Jekonomika i upravlenie*=*Economics and Management*, 2012, no. 3 (77), pp. 150–156. (In Russian)

31. Lyashok V.Yu., Roshchin S.Yu. Effect of health on labor supply of the elderly. *Prikladnaja jekonometrika=Applied Econometrics*, 2015, no. 40 (4), pp. 6–27. (In Russian).
32. Kakorina E.P., Ogryzko E.V. Current state of medical statistics in the Russian Federation. *Vrach i informacionnye tehnologii=Information Technologies for the Physician*, 2012, no. 2, pp. 47–53. (In Russian).
33. Avilov K.K., Romanyukha A.A. Mathematical modeling of the spread of tuberculosis and case detection. *Avtomatika i telemehanika=Automation and Remote Control*, 2007, vol. 9, pp. 145–160. (In Russian)
34. Veikher A.A. Evaluation of hidden morbidity by the methods of representative surveys: need, opportunities and constraints. *15th April international scientific conference on problems of development of economy and society: in 4 books*. Moscow: HSE, 2015, book 4, pp. 197–205. (In Russian).
35. Krashenninnikova Yu.A. Medical statistics as a way of legitimizing the allocation of resources in the Russian health care system. *Voprosy gosudarstvennogo i municipal'nogo upravlenija=Public Administration Issues*, 2011, no. 4, pp. 28–42. (In Russian).
36. Ulumbekova G.E. Public health care in Russia: 2018–2024. What should be done? *Novosti. Mneniya. Obuchenye: Vestnik VShOUZ=News. Views. Education: Bulletin of VSHOUZ*, 2018, no. 1, pp. 9–19. DOI: 10.24411/2411-8621-2018-00001 (In Russian).
37. Merabishvili V.M. Analytical performance. The index of accounting reliability. *Voprosy onkologii=Problems in Oncology*, 2018, no. 3, pp. 445–452. (In Russian).
38. Gourbin C, Wunsch G. Health, Illness, and Death. *Demography: Analysis and Synthesis* vol. Burlington: Academic Press, 2006, pp. 5–12.
39. Idler E.L., Benyamini Y. Self-rated Health and Mortality: A Review of Twenty-seven Community Studies. *Journal of Health and Social Behavior*, 1997, no 38(1), pp. 21–37.
40. Palosuo H. How Good Is “Normal” Health? An Exercise in Russian-Finnish Comparative Survey Methodology. *The Finnish Review of East European Studies*, 2000, no 3–4, pp. 41–70.
41. Andreev E.M., McKee M., Shkolnikov V.M. Health Expectancy in the Russian Federation: A New Perspective on the Health Divide in Europe. *Bulletin of the World Health Organization*, 2003, no 81, pp. 778–788.
42. Ramonov A.V. Expected duration of healthy life as an integral health rating of the Russians. *Ekonomicheskij zhurnal Vysshey shkoly ekonomiki=The HSE Economic Journal*, 2011, vol. 15, no. 4, pp. 497–518. (In Russian).
43. Shkiperova G.T. Environmental Kuznets curve as a tool for the study of regional development. *Ekonomicheskij analiz: teoriya i praktika=Economic Analysis: Theory and Practice*, 2013, no. 19(322), pp. 8–16. (In Russian).

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