METHODOLOGICAL TOOLS TO ASSESS AN IMPACT OF HABITAT FACTORS ON POPULATION HEALTH IN RUSSIAN REGIONS

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Abstract

Russia has been suffering the negative tendency of mortality increase since 2017. Moreover, according to statistics, death causes structure in Russia is becoming more similar to the countries with low living standards and underdeveloped health care. In this regard, assessing the impact of certain socio-economic parameters on population health is of great scientific interest.

The authors hypothesize that habitat factors of social and economic essence have disparate impact patterns on population health. To test these assumptions, we create special methodological tools based on data mining and machine learning methods and enabled to make parametric estimates of habitat factors impact on population health. Based on the official statistics database of life quality, economics and population health in Russian regions for 2005-2017, we interpreted the obtained parametric estimates of habitat factors impact on population health and aggregated indicators in several thematic clusters.

The importance of the results for further research is their ability both to identify causal relationships between endogenous and exogenous habitat factors and the population health and to assess an interaction of different indicators. In addition, the research results have practical implementation for developing regional social and economic policy and monitoring its performance.

Keywords: population health, habitat factors, parametric estimates, regional policy

JEL Code: J11, J18

Introduction

Russia has been suffering from the negative tendency of mortality increase since 2017 regardless considerable progress of many social and economic indicators. Moreover, according to statistics, death causes structure in Russia is becoming more similar to the countries with low

living standards and underdeveloped health care. In this regard, assessing an impact of certain socio-economic parameters on population health is of great scientific interest.

To explain a correlation between economic development and health, the researchers use different theories such as economics (Robert Wood Johnson Foundation, Carger, & Westen, 2010), human capital theory (Jatrana, Dayal, Richardson, & Blakely, 2018; Kelly, Rao, Seubsman, & Sleigh, 2017; Qiu, Sung, Davis, & Tchernis, 2018), socioeconomic status concept (Hoffmann, Kröger, & Pakpahan, 2018; Idler & Cartwright, 2018; Lleras-Muney, 2018) and others. Yet all these theoretical ideas do have some working tools to explain how social and economic factors influence health we prefer to employ a concept of sustainable development in terms of governmental policy improving population health.

Based on the idea to harmonize today and future needs, sustainable development composes economic, social, and ecological goals being both universal for humanity and sensitive to national peculiarities. Since 2016 one of the sustainable development goals is "*Good health and well-being*" that means to ensure healthy lives and promote well-being for everybody at all ages. According to this, significant strides ought to be made in increasing life expectancy, reducing mortality rates, fully eradicating a wide range of diseases and addressing many persistent and emerging health issues. Thus, high standards of life quality and health care are supposed to fight the most common mortality causes and to increase life expectancy. To get a great progress of such a goal, a government have to focus on three main health-designed activities such as develop health care, improve life safety, and promote a healthy lifestyle[1].

World Health Organisation provides the idea of the highest possible level of health worldwide. It defines health as a state of complete physical, mental and social well-being, not merely absence of disease or infirmity. Thus, there are four crucial components of health such as biological properties of the organism, health care development, environmental quality, and lifestyle and socio-economic development with the last being of the greatest priority.

Russia generally matches the global health tendencies but there is some national specificity. Statistic data reflect the working-age population have higher mortality and morbidity rates because of poor working conditions and low level of occupational safety. Namely, Russia has about 200 thousand people are injured at work, more than 10 thousand cases of occupational diseases are registered, and more than 14 thousand people are disabled due to occupational injuries and diseases per year (Kozlova, Makarova, Bedrina, & Tukhtarova, 2015). Moreover, health harm seems to be underestimated in terms of delayed effects of

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[1] Goal 3: Ensure healthy lives and promote well-being for all at all ages. (n.d.). Retrieved February 9, 2019, from https://www.un.org/sustainabledevelopment/health/

occupational injuries and diseases. Thus, we explore an impact of habitat factors on population health in Russian regions relying on sustainable development concept (health care, life safety, healthy lifestyle) supplemented working conditions and occupational safety.

1 Data and methods

1.1 Data

In previous section, we have defined health as a complex social and economic concept driven by various factors. In order to assess an impact of habitat factors on population health we needed to determine a proxy-variable of health. According to available statistic data of Russian regions and wide range of similar researches (Ivaldi, Bonatti, & Soliani, 2017; Seklecka, Lazam, Pantelous, & Ohare, 2018) we employed mortality rates of working-age population to measure population health. Then we took 52 main indicators of social and economic development in Russian regions in 2004-2017 years (Regions of Russia, 2018) pooled in several groups appropriate to sustainable development approach such as health care, life safety, quality of life and healthy lifestyle, occupational safety and some others. Using a correlation analysis to judge our panel data, we managed to restrict a set of indicators to these being most correlated with mortality rates of working-age population.

1.2 Methods

According to theoretical review, we hypothesize that habitat factors of social and economic essence have disparate impact patterns on population health. To test these assumptions, we create special methodological tools based on data mining and machine learning methods and enabled to make parametric estimates of habitat factors impact on population health.

Machine learning has its roots in applied statistics, optimization methods, and discrete analysis; therefore, it is devoted to solving problems of data mining. In this particular case, we deal with regression recovery allowed selecting or even creating features correctly. Feature Selection procedure has a wide set of valid algorithms aimed to build a data subset to construct a model of the best quality. As for available software, we used Recursive Feature Elimination algorithm.

Conducting the research, we converted data to comparable form due to overcome data scaling sensibility. Then a set of indicators was divided into test (40%) and training (60%) samples on a random mode to test several counting algorithms and to determine an optimal

modelling method (Vorontsov, 2009). Fig. 1 demonstrates that random forest method is the best one for both data and research purpose. Thus, we used it to make our calculations.

Fig. 1: Determination coefficients of several counting algorithms tested to modelling an impact of habitat factors on population health
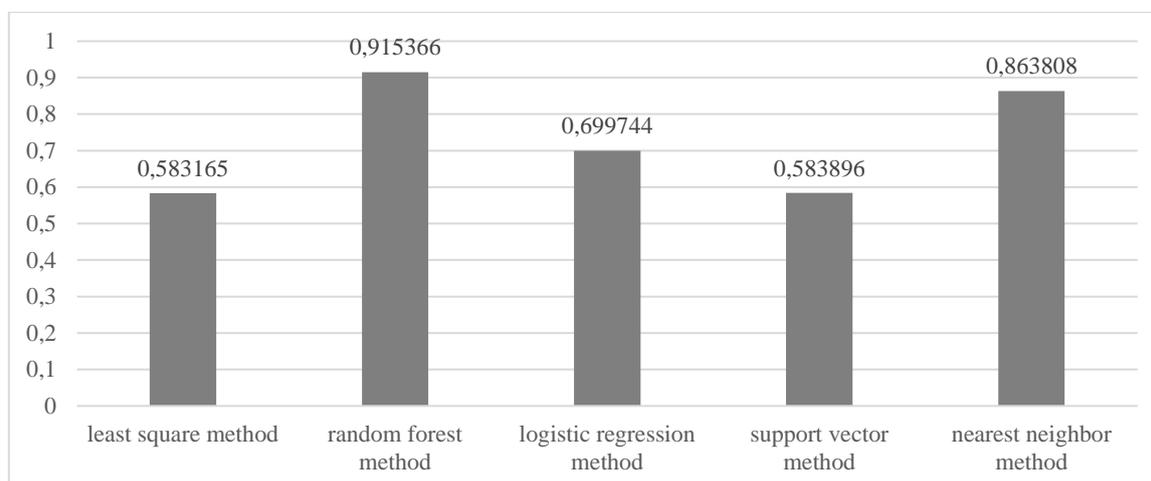

2   Results and discussion

The data of social and economic development in Russia reflect that life quality of population have improving since 2004 despite some indicators have uneven and erratic dynamics because of global economic situation. For example, global financial crisis of 2008 and economic sanction against Russia of 2014 resulted in a little reduction of economic development, but a positive trend came back after a short adaptation. Moreover, considerable decreasing mortality rates of working-age population has accompanying this progressive sustainable development around both a whole country and each of its regions.

Fig. 2 shows our findings how habitat factors influence population health in Russia during 14 years.

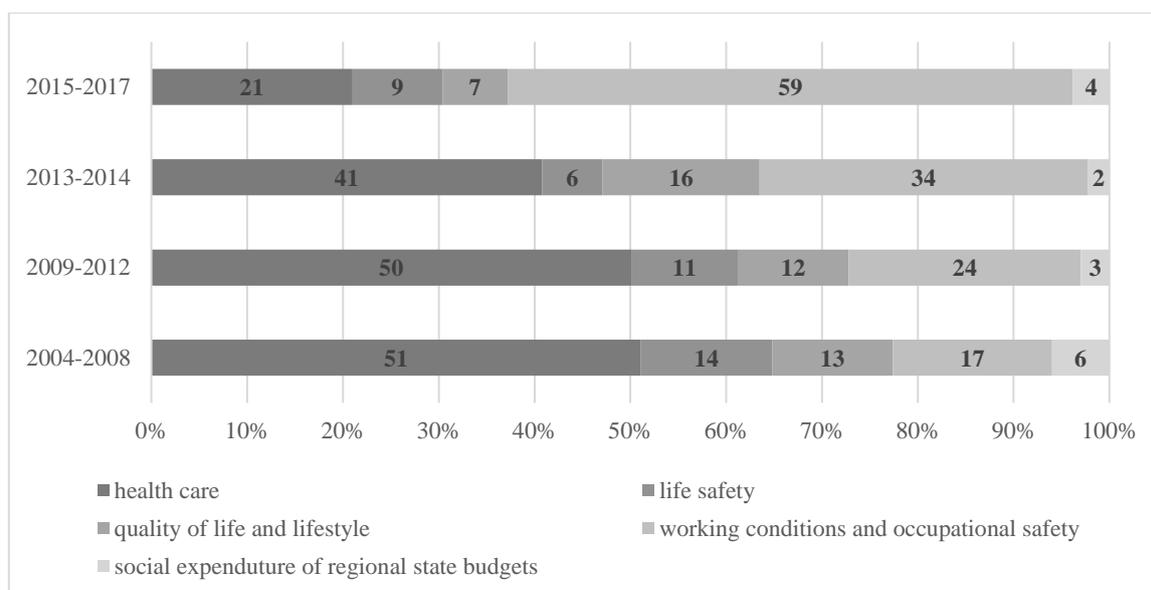**Fig. 2: Partial impact of habitat factors on population health in Russia in 2004-2017, %**
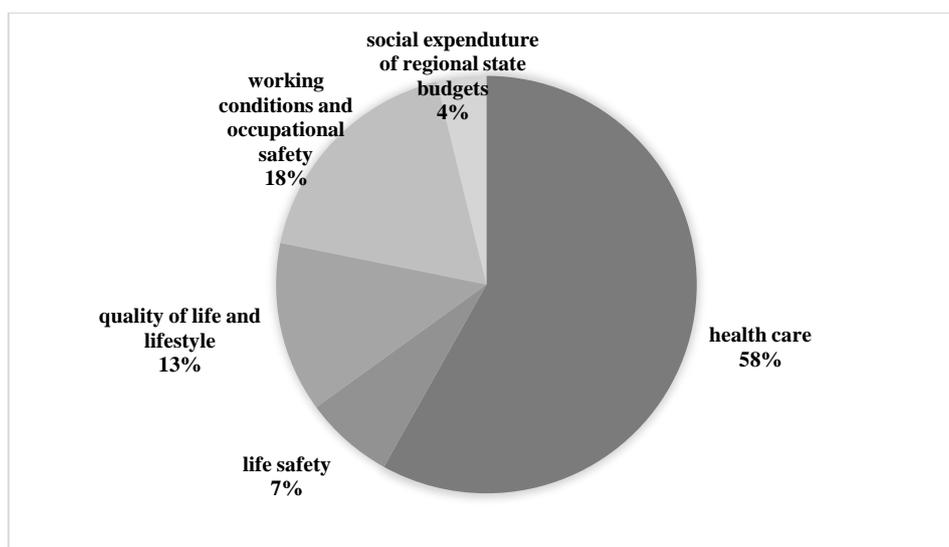
Source: *Regions of Russia. Socio-economic indicators. 2018: Statistical yearbook*. (2018). Moscow: Rosstat.

Mainly, health care has a significant impact on population health; and we should emphasize that our result agrees with (Abbas & Awan, 2017). We estimate that health care takes 58.1% of total impact on population health. Moreover, namely access to health care is a leading to decrease mortality rates of working-age population (number of beds – 45.6%, capacity of outpatient clinics – 6.5%). Working conditions and occupational safety get the second place and demonstrate 18% of total impact of habitat factors on population health including 10.3% influence of hazardous and dangerous conditions. Thus, we confirmed our hypothesis about significant impact of occupational conditions on population health. Quality of life is also an important habitat factor of population health, and its impact amounts 13.2% with average incomes prevailing (6.4%). Life safety has evidently little impact on mortality rates as a proxy-indicator of health (only 6.9%) but it is supposed to influence morbidity rates and well-being of population (Robert Wood Johnson Foundation, Carger, & Westen, 2010); thus, life safety impact on population health is an issue of future discussion. At last, social expenditures of state regional budget provide only 3.8% impact of habitat factors on population health. However, budget social expenditures have close ties to health care and life quality development, so that we should not neglect this piece of impact.

Fig. 3 displays deeper time analysis of our results. Conducting the research, we have found four periods considerably varying what habitat factors mostly influence population health.

Fig. 3: Partial impact of habitat factors on population health during various periods of socioeconomic development in Russian regions, %

Source: *Regions of Russia. Socio-economic indicators. 2018: Statistical yearbook*. (2018). Moscow: Rosstat.

The first period 'Before global financial crisis' (2004-2008) had sustainable social and economic development such as increasing GDP, improving quality of life, prevailing social goals of state policy. At this time, access of health care plays the greatest role in population health (51%), and working conditions take the second place (17%). Life safety and quality of life have 14% and 13% respectively. Finally, social expenditures of regional budgets determine about 6% of habitat factors impact on population health reflected top priority of social goals.

The second period 'Recovery after crisis' (2009-2012) was a time of economic turbulence due to global financial crisis getting financial flows disrupted, businesses stopped and people lost their jobs. Thus, in 2009 index of GDP decreased to 92.2% of previous year, unemployment rate reached 8.4% (compare with 6.3% in 2008), and index of real wages dropped to 96.4% of previous year. However, slowly the economic situation stabilized and returned to the pre-crisis development pathway. Exploring partial impact of habitat factors on population health, we should emphasize that impact of working conditions and occupational safety increased by 7 percentage points and reached 24% including 14.1% impact of hazardous and dangerous occupational conditions. Concurrently, health care saved its impact at 50%. On contrary, life safety, quality of life and social expenditures of regional budgets slightly lost its value as habitat factors of population health. The next periods demonstrated strengthening this trend.

The third period 'First sanctions' (2013-2014) was characterized by worsening international political relations, rising animosity between Western European countries and Russia and introduction of first sanctions against Russia. Thus, violation of existing

international financial and economic relations resulted in slowdown of GDP index to 100.3% of previous year, increasing employment in hazardous and dangerous occupational conditions by 1 percentage point and employment in informal economy by 3 percentage points. All these changes were supposed to maintain average incomes but influence on population heath negatively. Fig. 3 proves that health care had only 41%-impact on population health, and working conditions impact dramatically raise to 34%. In addition, quality of life played a greater role for population health at that time (16%). Concurrently, life safety and social expenditures of regional budgets were not been of importance.

The last period 'During sanctions' (2015-2017) just strengthened the trends described above such as no GDP growth, considerable share of employed in hazardous and dangerous occupational conditions and in informal economy, and sizeable unemployment level. Partial impact of habitat factors on population health has changing its structure in favour of working conditions and occupational safety factor; it takes 59% of total impact including 50.9% impact of hazardous and dangerous conditions. In addition, health care still has its importance (21%). The other factors do not have any considerable influence on population health.

Conclusions

While sustainable development goals are of importance all over the world, Russia has been suffering from the negative tendency of mortality increase since 2017 regardless considerable progress of many social and economic indicators because of national specificity of constructing population health. Using machine-learning methods, our research has shown a significant impact of poor working conditions and low level of occupational safety on mortality rates of working-age population as a proxy-indicator of health especially during the periods of economic turbulence. The importance of the results for further research is their ability both to identify causal relationships between endogenous and exogenous habitat factors and the population health and to assess an interaction of different indicators. In addition, the research results have practical implementation for developing regional social and economic policy and monitoring its performance.

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