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As a manuscript

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**Old-age mortality in Moscow**

Thesis Summary for the purpose of obtaining PhD in Sociology

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## **Statement of research problem**

The main features of mortality at old age in Moscow compared to the rest of Russia are: a higher life expectancy; the lack of mortality increase in the second half of the 1990s - early 2000s and a higher contribution of changes in mortality at old age to the increase in life expectancy at birth.

The advantage of life expectancy in Moscow compared to the rest of Russia was noted long before the period of socio-economic crises and changes. Until the mid-1980s life expectancy in Moscow compared with Russia 2.3-2.5 years higher for males and less than six months for females. At the beginning of 1990-s along with sharp fluctuations in mortality Moscow's advantage significantly declined. But already in 1995-1996 the growth rate of life expectancy in Moscow was significantly ahead of those in Russia. From 1995 to 2005, the difference in life expectancy between Moscow and Russia increased from almost zero to 8.4 years for males and 4.1 years for females, and then stabilized at the level of 7-8 years and 3.5 - 4.6 years for males and females, respectively, which is significantly higher than the difference observed in the 1970s.

Such a phenomenal increase in life expectancy over the entire period from the mid-1990s to the mid-2000s was provided by mortality at working ages<sup>1</sup>. Mortality at older ages changed relatively little, being at the level of those high values that were established back in the 1970s. Since the mid-2000s, unlike the previous period, increase in life expectancy was due to a decrease in mortality not only at working age and childhood, but also at old age<sup>2</sup>. An analysis of regional inequality in mortality showed that the divergence between regions explained by unusually rapidly decreasing mortality at old ages in Moscow and St. Petersburg, along with the large population weight of these cities in the country's population<sup>3</sup>. These

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<sup>1</sup> Shkolnikov V., Andreev E., Leon D., McKee M., Meslé F., Vallin J. Mortality Reversal in Russia: The story so far. In: *Hygiea Internationalis*, 2004, vol. 4, №4, p.29-80.

<sup>2</sup> Grigoriev P., Meslé F., Shkolnikov V. M., Andreev E.M., Fihel A., Pechholdova M. and Vallin J. (2014). The Recent Mortality Decline in Russia: Beginning of the Cardiovascular Revolution? *Population and Development Review*: 40: 107–129. doi:10.1111/j.1728-4457.2014.00652.x; Shkolnikov, V; Andreev, E; McKee, M; Leon, D (2013) Components and possible determinants of the decrease in Russian mortality in 2004-2010. *Demographic Research*, 28 (32). pp. 917-950. DOI: 10.4054/DemRes.2013.28.32

<sup>3</sup> Timonin S.A., Danilova I.A., Andreev E. M., Shkolnikov, V. M. (2017). Recent mortality trend reversal in Russia: are regions following the same tempo? *European Journal of Population*. Vol. 33 (1) <https://doi.org/10.1007/s10680-017-9451-3>

changes in Moscow's position in terms of life expectancy were accompanied by an increase in the gross regional product, in which Moscow is third among all regions of Russia. By 2010, per capita gross regional product in Moscow was comparable to per capita GDP in Austria, Canada, Ireland and the Netherlands. Nevertheless, life expectancy in Moscow still turned out to be lower than would be expected given the level of GRP<sup>4</sup>.

The rapid increase in difference between Moscow and the rest of the country in the mid-2000s raised doubts about its reliability, especially among males at working age<sup>5</sup>. Researchers also noted problems with the quality of census data, which include overstatement of the elderly population, a large part of which are in Moscow<sup>6</sup>. This, as well as the implausible mortality indicators at older ages, indicates the need to verify the mortality indicators observed in Moscow.

Thus, for a long period, Moscow is significantly ahead of other regions of Russia in terms of life expectancy, and this advance is largely due to the mortality of the elderly population. Changes in mortality at older ages is becoming an increasingly important component of the overall increase of life expectancy in Russia and in Moscow, at the same time doubts arise about the quality of mortality statistics at older ages.

Decreased mortality among the elderly, along with other factors, determines the growth of the population share of the advanced-age groups (from 80 years and older), and, consequently, the increasing burden on the health care and social security systems. The reliability of forecasting the extent and depth of demographic aging, as well as the quality of planning in the areas of medical services and the activities of social services, depend on the quality of estimates of mortality and life expectancy in older ages. Therefore, the question of the reliability and accuracy of

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<sup>4</sup> Shkolnikov, V. M., Andreev, E. M., Tursun-Zade, R., & Leon, D. A. (2019). Patterns in the relationship between life expectancy and gross domestic product in Russia in 2005-15: a cross-sectional analysis. *The Lancet. Public health*, 4(4), e181–e188. doi:10.1016/S2468-2667(19)30036-2

<sup>5</sup> Andreev E.M., Kvasha E.A., Kharkov T.L. (2006). Special points on the mortality map // Population of Russia 2003–2004. Eleventh to Twelfth Annual Demographic Report, p. 298-305.

<sup>6</sup> Andreev E.M. On the accuracy of the results of Russian population censuses and the degree of trust in various sources of information / *Statistics Issues* No. 11 2012. p. 21-35; Mkrtchyan N.V. (2012). Problems of accounting for the population of certain age groups during the 2010 census: reasons for deviations of the obtained data from the expected / *Demographic aspects of socio-economic development*

these estimates, obtained from the mortality statistics has great scientific and practical significance.

The answer to it allows us to establish to what extent success of Moscow in life expectancy increasing is a real consequence of a decrease in mortality, and to what extent a statistical artifact. After it we can turn to studying the features of mortality in Moscow in comparison with other countries, to analyzing social factors, including the availability of medical care, which turned population of Moscow into a leading group in Russia in reducing mortality. Thus, the problem of this research thesis is to determine the features of mortality at old age in Moscow and its reliability, taking into account the quality problems of statistical data.

### **Literature review**

The question of the mortality at older ages in Moscow was not previously considered in the context presented in this thesis. The mortality of the elderly population in Russia itself is considered in very few publications. It is usually analyzed in the general context of increase in life expectancy, along with the mortality of the working age population. Problems with the quality of statistics on causes of death in older ages are primarily noted in papers on mortality of the elderly population in Russia. However, it was shown that a significant part of the lag in life expectancy is determined by mortality from diseases of the circulatory system. Features of the situation with mortality and life expectancy in Moscow were considered, as a rule, in the context of regional differentiation of mortality in Russia<sup>7</sup>.

In these works it is noted that even before the start of the anti-alcohol campaign of 1985-1987 and subsequent fluctuations in mortality, Moscow had a small advantage in life expectancy over the other regions. In the 1990s, this advantage of Moscow disappeared due to a sharp increase in mortality from external causes, which could be associated with increased mortality among migrants, whose number

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<sup>7</sup> Vallin J., Andreev E.M., Meslé F., Shkolnikov (2005). Geographical diversity of cause-of-death patterns and trends in Russia. *Demographic Research*, 12(13), 323-380.

increased, including due to the higher income in Moscow<sup>8</sup>. It is also indicated that in the 1990s a significant proportion of deaths from external causes had been taking place among the population with a low level of education and manual workers<sup>9</sup>. There was also noted a very rapid increase in mortality rates for older women between 1990 and 2001<sup>10</sup>.

After 1994, researchers noted difference between trends in mortality in Moscow and the rest of Russia, as the absence of a significant increase in mortality in Moscow, and the earlier start of its steady decline. Researchers have questioned the quality of mortality statistics in Moscow and the reliability of rapid increase in life expectancy and difference with the rest of the country in this period. Estimates adjusted for a possible underestimation of mortality rates show significantly lower values of life expectancy for males, but advantage of Moscow over the rest of Russia continues to exist<sup>11</sup>.

Papers on mortality in Moscow since the mid-2000s, in the years of steady increase in life expectancy, indicates its advantage compared to the rest of Russia, and lags behind countries with high life expectancy. It was also shown that the inter-regional disparity in mortality in Russia is increasing due to the extremely low mortality of the elderly population in Moscow and St. Petersburg<sup>12</sup>.

At age 65 and over, the excess of the mortality rate of the Russian population over Europe countries in 2003-2005 was observed for three groups of causes: diseases of the circulatory system (2.5 times), symptoms, signs and abnormal clinical and laboratory findings (3.3 times) and external causes (2.3 times). A significant preponderance of mortality rates from circulatory diseases can be explained by the fact that the elderly population of Russia has a higher prevalence

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<sup>8</sup> Shkolnikov V.M., Cornia G.A. (2000). Population crisis and rising mortality in transitional Russia. In G.A. Cornia, R. Panicià (Eds.), *The mortality crisis in transitional economies* (pp. 253-279). Oxford: Oxford University Press.

<sup>9</sup> Shkolnikov V.M., Cornia G.A., Leon D.A., Meslé F. (1998). Causes of the Russian Mortality Crisis: Evidence and Interpretations. *World Development*, 26(6), 1995-2011.

<sup>10</sup> Bakhmetova G.Sh. Mortality in the elderly // In *Sat: Mortality: trends, research methods, forecasts*. M.: MAX Press. - 2007. - S. 256 - 271

<sup>11</sup> Andreev E.M., Kvasha E.A., Kharkova T.L. (2006). Special points on the mortality map // *Population of Russia 2003–2004. Eleventh to Twelfth Annual Demographic Report*, p. 298-305.

<sup>12</sup> Timonin S.A., Danilova I.A., Andreev E. M., Shkolnikov, V. M. (2017). Recent mortality trend reversal in Russia: are regions following the same tempo? *European Journal of Population*. Vol. 33 (1) <https://doi.org/10.1007/s10680-017-9451-3>

of cardiovascular diseases, or by the fact that patients with these diseases do not receive the necessary medical care, as a result of which they die more often than in other countries<sup>13</sup>.

The studies also highlight important problems in the quality of diagnosis and medical statistics in Russia. It was shown that clinically undifferentiated diagnoses are largely present in diseases of the circulatory system. In addition, there is an inadequate dynamics of mortality rates by age in the Russian population compared with the other countries. In Russia at age 75 and older the mortality rates from diabetes (for females), pneumonia (for males), cirrhosis and a number of other diseases are lower or almost at the same level as at a younger age<sup>14</sup>. It was also noted that by the change in age-specific mortality from neoplasms, Russia is markedly different from other countries. In European countries, the mortality rate from neoplasms increases rapidly with age, in Russia it remains almost unchanged or decreases after 80 years.

Papers by Danilova I.A.<sup>15</sup> is devoted to the quality of the coding of causes of death in Russia, in which the homogeneity of cause-of-death coding practices in Russian regions and the accordance of Russian coding practices to those in other countries were analyzed. It was found that among the regions of Russia, approaches to the use of the cause of death "Senility", which belongs to class XVIII of ICD-10 "Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified", are especially different. The proportion of this cause of death among deaths over age 80 varies in different regions from less than 1% to more than 60%. In comparison with European countries, the mortality at old ages from diseases such as diabetes mellitus, neuropsychiatric diseases, neoplasms, and several others underestimated in Russia, because deaths from these causes are probably encoded as deaths from "Senility".

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<sup>13</sup> Maksimova T.M., Lushkina N.P. The composition of the causes of death of the elderly population as an indicator of the quality of medical care // <http://demoscope.ru/weekly/2009/0369.php>

<sup>14</sup> Maksimova T.M., Lushkina N.P. The composition of the causes of death of the elderly population as an indicator of the quality of medical care // <http://demoscope.ru/weekly/2009/0369.php>

<sup>15</sup> Danilova I.A. Quality problems of Russian statistics on causes of death in old age / *Advances in gerontology* - 2015 - V. 28, No. 3. S. 409-414; Danilova I., Shkolnikov V., Jdanov D., Meslé F., Vallin J. Identifying potential differences in cause-of-death coding practices across Russian regions / *Population Health Metrics*, 2016, 14:

A number of researchers note that the period 2004-2010 is unique by decrease in mortality at old ages, especially from cerebrovascular diseases for females, it can be explained by improved control of blood pressure and awareness of the risk of diseases<sup>16</sup>. It is noted, that the gap in life expectancy between Russia and Western countries remains significant, and is associated with mortality from diseases of the circulatory system, external causes of death and causes of death associated with alcohol.

### **Focus of the research**

**The object of the research** - mortality at old ages.

**The subject of the research** is the mechanisms and factors of Moscow's leadership in reducing the mortality at old ages in comparison with the rest of Russia.

**The aim of the research** is to determine features of old-age mortality in Moscow and to what extent it is a real consequence of a decrease in mortality, and to what extent is a statistical artifact; how much does the mortality decreasing in Moscow correspond to the experience of other countries and regions of Russia.

### **The goals:**

1. Identify and structure features of mortality at old ages in Moscow;
  - 1a. To identify features of changes of old age mortality in Moscow in comparison with the rest of Russia and European countries;
  - 1b. To characterize the features of the age profile of old age mortality in Moscow and its changes in the period of mortality decrease since the mid-2000s;
  - 1c. To identify the features of the structure of old-age mortality by causes of death in Moscow in comparison with the rest of Russia and European countries;

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<sup>16</sup> Shkolnikov, V; Andreev, E; McKee, M; Leon, D (2013) Components and possible determinants of the decrease in Russian mortality in 2004-2010. Demographic Research, 28 (32). pp. 917-950. DOI: 10.4054/DemRes.2013.28.32

2. Test the hypothesis about the reliability of estimates of life expectancy and population for the advanced age in Moscow and the mechanisms of their distortion;
3. To provide adjusted estimates of life expectancy at old ages in Moscow based on the experience of countries with reliable mortality statistics;
4. To evaluate the health status and factors of health and mortality in Moscow.

**Hypothesis** - estimates of the life expectancy of the elderly population of Moscow are overstated, but even the adjusted estimate of mortality in Moscow shows the leadership of the capital among the other regions of Russia.

### **Data and methods**

Research is carried out by methods of demographic analysis, allowing to assess the dynamics and level of mortality, as well as the contribution of various causes of death to the intensity of mortality: the method of life tables, decomposition of life expectancy<sup>17</sup>, standardized mortality rates; logistic regression are used to determine the differences in self-rated health between Moscow and other regions of Russia.

The method we used to correct official estimates of life expectancy in Moscow at age 80 is based on comparison of mortality statistics for Russia and Moscow with Human Mortality Database (HMD) data for other countries. We assumed that the relationship between life expectancy for the age interval of 50-69 years and life expectancy at age 80 in the regions of Russia should correspond to the relationship observed in economically developed countries with reliable mortality statistics. This relationship approximated by cubic polynomial regression. To construct the regression model, data from 1,872 HMD mortality tables for 19 countries were used.

Based on the assumption formulated above, we estimate life expectancy at age 80, at a retirement age and at birth using the obtained regression models. We chose the 50- to 69-year age interval because of the distinctive features of older and

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<sup>17</sup> Andreev E.M., Shkolnikov V.M., Begun A.Z. (2002). Algorithm for decomposition of differences between aggregate demographic measures and its application to life expectancies, healthy life expectancies, parity-progression ratios and total fertility rates. *Demographic Research*, 7(14), 499–522. doi:10.4054/DemRes.2002.7.14.

younger age groups. It is commonly known that the mortality at age 15- to 49-years in Russia (including in Moscow) is extremely high relative to the international level. The age-specific mortality rates at age 70-79 in Russia and Moscow may be underestimated to a lesser extent than those for their 80+-year-old counterparts.

To analyze the data on self-rated health and other characteristics of respondents in Moscow and the rest of Russia we used regression analysis (logistic regression models), tabulation (by gender and age, level of education), age-specific and standardized prevalence rates of poor self-rated health and some other indicators.

A comparison of Moscow with Russian regions and with other countries is made for the total population. At the same time, Moscow is predominantly represented by the urban population. From this point of view, it would be appropriate to compare the population of Moscow with the urban population of other regions or countries. However, in European countries there is no clear pattern of excess of life expectancy of the urban population over life expectancy of the total population. On average, the advantage of the urban population in Europe is not so large and amounts to 1-2%<sup>18</sup>. In this regard, a comparison of Moscow with the country's population as a whole seems justified in the context of research focus.

Data on the deaths counts and population estimates by single and five-year age groups for the period 1989-2017 provided by the Federal State Statistics Service (Rosstat). An additional source of data on age-specific mortality rates and mortality rates by causes of death is the Russian Fertility and Mortality Database of the Center for Demographic Research of the New Economic School, which also presents Rosstat data in a database format<sup>19</sup>.

For international comparisons data from the Human Mortality Database (HMD), which is the most authoritative source of accurate mortality data

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<sup>18</sup> Koster E.M., R. de Gelder, F. Di Nardo, G. Williams, A. Harrison, L.P. van Buren, H. Lyshol, L. Patterson, C.A. Birt, J. Higgerson, P.W. Achterberg, A. Verma, E.J.C. van Ameijden; Health status in Europe: comparison of 24 urban areas to the corresponding 10 countries (EURO-URHIS 2), *European Journal of Public Health*, Volume 27, Issue suppl\_2, 1 May 2017, Pages 62–67, <https://doi.org/10.1093/eurpub/ckw188>

<sup>19</sup> Russian Fertility and Mortality Database. Center for Demographic Research, Moscow (Russia). Available at [http://demogr.nes.ru/index.php/ru/demogr\\_indicat/data](http://demogr.nes.ru/index.php/ru/demogr_indicat/data)

comparable in years and countries. The WHO Mortality Database was also used as a source of mortality data by causes of death<sup>20</sup>.

Data from the Civil Registry Office database, which contains individual depersonalized data for all deaths registered in Moscow, were used. This database is the basis for the official mortality statistics. Data of the Pension Fund for the Moscow city and the Moscow Region, data of the Moscow Department of Health also were used.

The Russian Longitudinal Monitoring Survey - HSE [RLMS HSE] 20 and 24 rounds (years 2011 and 2015) is used as a source of data on factors of health and mortality. The data are presented by the main sample of RLMS for all Russia, including Moscow, as well as an additional sample for Moscow, the polls for which were conducted in accordance with the RLMS questionnaire for these rounds<sup>21</sup>.

### **Academic novelty of research**

1. It is shown that a higher life expectancy of the elderly population of Moscow is formed both due to the real characteristics of mortality, and due to inaccuracies in the statistical data.

2. The decisive role of changes in mortality at old ages in Moscow in maintaining the difference in life expectancy between Moscow and the rest of Russia in 2005-2017 is shown.

3. A significant underestimation of the age-specific mortality rates in Moscow over age 80 and an overestimation of life expectancy and population at older ages is shown.

4. The adjusted estimates of the life expectancy at old ages in Moscow and Russia are calculated and the adjusted estimates of the changes of the life expectancy at old ages in Moscow is shown.

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<sup>20</sup> WHO Mortality Database (2017) World Health Organization URL: [http://www.who.int/healthinfo/statistics/mortality\\_rawdata/en/](http://www.who.int/healthinfo/statistics/mortality_rawdata/en/)

<sup>21</sup> Russia Longitudinal Monitoring survey, RLMS-HSE», conducted by National Research University "Higher School of Economics" and OOO "Demoscope" together with Carolina Population Center, University of North Carolina at Chapel Hill and the Institute of Sociology of the Federal Center of Theoretical and Applied Sociology of the Russian Academy of Sciences. (RLMS-HSE web sites: <http://www.cpc.unc.edu/projects/rlms-hse>, <http://www.hse.ru/org/hse/rlms>)

5. The features of Moscow in self-rated health and factors of health and mortality analyzed.

## **Main results**

### ***The quality problems of demographic statistics are determined by specific limitations in the system of collecting information on mortality and population***

Based on the analysis of the practice of statistical registration of deaths, migration and population in Russia, several discrepancies between them can be distinguished:

1. As a result of the fact that part of the population during the 2002 and 2010 censuses was counted on the basis of administrative sources<sup>22</sup> the resident population of Moscow likely to be overestimated due to the inclusion of people who are not actually living in Moscow but registered at the place of residence in Moscow, or due to double counting of persons whose place of residence by registration and actual place of residence differs within Moscow. The proportion of the population counted on the basis of administrative sources cannot be determined. The current vital statistics does not provide the actual place of residence, as a result some of the deaths of Muscovites (which is counted by the census as living in Moscow) can be registered in other regions if the death occurred outside of Moscow. These factors reduce the accuracy of accounting for the number of deaths and the population of Moscow and can lead to the numerator-denominator bias (the number of deaths / the population) when calculating age-specific mortality rates.

2. Number of migrants departing from Moscow to other countries and regions is inaccurate (underestimated) due to underestimation of migrants departing without issuing relevant documents. These limitations of the current migration statistics should have been corrected by the population census. However, by using the administrative sources, which have the same limitations as migration statistics, for counting the part of the population in 2002 and 2010 censuses, this problem may

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<sup>22</sup> Andreev E.M. On the accuracy of the results of Russian population censuses and the degree of trust in various sources of information / Statistics Issues No. 11 2012. p. 21-35; Federal Law "On the All-Russian Population Census" (as amended by Federal Laws of November 28, 2009 No. 293-Ф3, dated July 27, 2010 No. 204-Ф3).

remain relevant even after the population census and may lead to underestimation of mortality rates due to an overestimation of the denominator.

3. The principles of age accounting for censuses (respondent's response without confirmation by documents) and for registration of deaths and migration (based on documents) differ. In the census data, the age of the respondent may be distorted (underestimated, overstated or rounded). Thus, the inaccuracy of estimating the size of the age group, which turned out, for example, to be overestimated as a result of inaccurate age indications, will increase with time, since the age at death and age of population mistakenly assigned to different ages.

These biases can be especially critical for mortality estimates for the oldest age groups, in which the population is relatively small and even small absolute discrepancies can lead to significant distortions of the mortality indicators.

To understand the mechanisms of underestimation mortality at old ages, the resident population of Moscow can be divided into several components:

**1. Resident population living in Moscow (including de jure population)** is counted by the census in the number of resident population by the census survey and/or administrative sources. In a population census, the number of the de jure population could be overestimated due to double counting of a part of the population using administrative data sources. In the intercensal period, an inaccurate estimate may be due to unregistered migration to other regions or countries, registration of deaths in other regions.

**2. The de jure population that does not live in Moscow** (counted by the census according to administrative sources). Deaths of this population group cannot be accounted by statistics for the Moscow, so this part of population does not decrease with time. This leads to an underestimation of mortality rates, the degree of which is determined by the real population - the "statistical artifact" population ratio.

The same mechanism determines the overestimation of the population by age due to inaccurate indication of age. Since the population, erroneously assigned to the wrong age group, decreases due to mortality to a lesser extent than in fact, the

statistics continue to list a part of the non-existent population, which may aggravate the problem outlined above. Overestimation of age is more typical for males<sup>23</sup>, which correlates with a greater underestimation of mortality rates for males compared to females.

***The problems of quality of demographic statistics in Moscow are appeared in the mortality rates at old ages***

The oldest age groups are characterized by extremely high rates of mortality decline and unrealistically low mortality rates, an unreliable change in mortality with increasing age.

1. Extremely intensive growth in life expectancy (LE) of Muscovites in the oldest age groups, with particularly sharp increase in 2011, and unrealistically low mortality rates at older ages, which contradict the high mortality in Moscow at younger ages. Since 2011 male life expectancy at age 80 in Moscow has been higher than even in countries with the highest life expectancy.

2. Significant male-female mortality crossover at old ages according to statistics (from the age of 82 years).

This indicates problems with the quality of statistical data used to calculate mortality rates and determines the need to adjust estimates of life expectancy in Moscow<sup>24</sup>.

***Data of Pension Fund and method of extinct generations show lower population than official statistics***

According to the data of the Pension Fund and estimates of the population by the method of extinct generations, Moscow is characterized by a particularly significant overestimation of the number of males, more noticeable with increasing age. The overestimation of the elderly population in Moscow is manifested, in particular, in the low number of pensioners according to the Pension Fund compared

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<sup>23</sup> Kannisto V. The advancing frontier of survival. Odense (Denmark): Odense Univ. Press. - 1996.

<sup>24</sup> Papanova E.K., Shkolnikov V.M., Andreev E.M., Timonin S.A. (2017) High life expectancy of Muscovites over age 80 - reality or statistical artifact? // Advances in gerontology, No. 30-6, p. 826-835

with the official number of elderly people. The proportion of retirees receiving old-age insurance pension in Moscow for males is 63% of the resident population of the corresponding age, for females - 85%; this proportion decreases with age and by age 100 years and over it is 5% for males and 16% for females.

According to the 2002 census data for population by year of birth and the number of registered deaths according to the Civil Registry Office of Moscow, for males born in 1912 the survival rate from 2002 to 2016 was 25%, born in 1906 - 34%, for generations born before 1905, this value is even higher - 67%. Such a high level of survival is not realistic for the population of these ages (for example, for males in Sweden in the corresponding age range survival rate was 0.25%). The contradictions shown in the statistical data indicate the advisability of adjusting the results of the census for certain age and gender groups.

### ***Trends in mortality of the elderly population of Moscow characterized by rapid growth in life expectancy***

At the beginning of the period of socio-economic reforms (until 1994), life expectancy at age 60 years in Moscow was slightly different from Russia as a whole (0.1-0.3 years for males and -0.5-0.2 years for females). Since 1994, the difference in life expectancy of the elderly population between Moscow and the rest of Russia has been steadily increasing. From 1993 to 2017 this difference increased from almost zero values to 5.4 years for males and 2.8 years for females. This happened both due to rapid growth of life expectancy and due to the lack of mortality increase in Moscow in the late 1990s and early 2000s.

Especially fast increase in life expectancy of Muscovites at age 60 years and older has been observed since 2004, immediately after that Moscow ahead of Estonia for the male population, and since 2010 - the Czech Republic. In 2017, life expectancy at age 60 was 21.4 years for males and 24.5 years for females (in Russia - 16.5 and 22 years, respectively). In 2011, there was a sharp increase in life expectancy at old age in Moscow in 2011, when life expectancy for males increased by 1.4 years, and for females by 0.5 years, which can be partially explained by the compensatory increase after its short decline due to the heat of 2010.

***Adjusted estimate of life expectancy lower than the observed indicators, but Moscow remains a significant leader compared to the rest of Russia***

Adjusted estimates of life expectancy (see Data and methods) at age 80 for all included in the analysis the territories of Russia turned out to be lower than the observed indicators. However, significant differences were found depending on gender and region. In Moscow, an imbalance between the sexes is observed not only in mortality, but also in the degree of underestimation of its mortality rates.

The mortality rates of the elderly population of Moscow are especially underestimated among males, and the degree of this underestimation has been increasing since the mid-2000s, along with an increase in life expectancy. In 2015, according to the adjusted estimate, the life expectancy of males at age 80 in Moscow was 5.9 years, which is lower than the mortality statistics estimate by 3.9 years.

Life expectancy at the retirement age<sup>25</sup> in Moscow as a result of adjusting is reduced by 2 years for males and 0.6 years for females. In the Central Federal District and in Russia (excluding Moscow), life expectancy for males decreases less noticeably - by 0.4 and 0.5 years, respectively, and almost does not decrease in women. The adjusting of life expectancy at birth leads to a decrease of its indicators by 1.6 years for males and 0.4 years for females in Moscow, and has almost no effect on indicators in the Central Federal District and Russia (excluding Moscow).

Thus, adjusted estimates of life expectancy at old ages in Moscow show a systematic deviation from official mortality statistics, which increases with increasing life expectancy and is especially pronounced for males. However, despite a significant decrease in life expectancy as a result of adjusting and other factors, Moscow remains a significant leader compared to the average Russian indicators.

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<sup>25</sup> 60 years for males, 55 years for females

### ***Features of old-age mortality by causes of death***

In general, Moscow is characterized by the same features of the structure of mortality by causes of death as in Russia as a whole, however, there are differences in Moscow:

- 1. A high proportion of deaths from diseases of the circulatory system (CVD) in total mortality and a rapid decrease in CVD mortality.** During the period of growth in life expectancy (since 2003), the mortality from diseases of the circulatory system in the oldest age groups (over 80 years) rapidly decreased. In Moscow, a similar dynamics has been observed since 1993, by 2017, mortality at these ages from CVD for males in Moscow was lower than in Sweden. At the same time, male mortality at younger ages decreased more slowly, and remains at a significantly higher level compared to Sweden.
- 2. Low mortality from neoplasms over the age of 80.** With higher mortality from neoplasms under the age of 75-80 years, at an older age the rates in Russia and in Moscow are noticeably lower than in Sweden and Estonia. However, there are also noticeable differences from the Russian age-specific mortality model - in Moscow, with age, the tendency to increase mortality from neoplasms is more noticeable, especially among females. In the dynamics of mortality from neoplasms in Moscow, there is a tendency towards a relatively rapid compared with other territories decrease in death rates at older ages for males. Mortality in most older ages among females in Moscow remains higher than in Russia.
- 3. The absence of deaths from the cause of death "Senility".** In Moscow, according to the Federal State Statistics Service, there are practically no deaths due to the cause of death "Senility" (in Russia - up to 15% of all deaths over the age of 80<sup>26</sup>). At the same time, Moscow from the beginning of the 2000s was characterized by a high proportion of deaths with a cause

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<sup>26</sup>Danilova I.A. Quality problems of Russian statistics of causes of death in old age / Successes of gerontology - 2015 - V. 28, No. 3. S. 409-414.

from the block “Ill-defined and unknown causes of mortality” (ICD-10 code - R96-R99). However, mortality from the causes of death in chapter “Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified” in Moscow was lower than in Russia, and in 2016-2017 reached a minimum level. In Moscow, the majority of such deaths occur in working age, while the age-specific mortality rate stabilizes after age 40, while in Russia the rate increases sharply after age 80. In 2016-2017 the proportion of deaths attributed to uncertain causes of death in Moscow decreased in all age groups.

4. **In Moscow and the rest of Russia the same tendencies in the change in mortality from amenable causes of death are observed<sup>27</sup>.** The proportion of amenable deaths in total mortality by 2017 also does not differ in these populations (29% of deaths in males and 22% in females). The majority of amenable deaths are caused by diseases of the circulatory system - 83% of all amenable deaths for males, 71% for females in Moscow and 75% for females in other regions. Moreover, in the early 1990s the situation in Moscow was worse than in other regions, and since the mid-1990s. Moscow is ahead of other regions - in terms of reducing amenable mortality, the lag between populations is about 10 years. Females in Moscow have a more noticeable contribution of amenable deaths from malignant neoplasms, which may be due to differences in the practice of choosing the cause of death.

### ***Health Status and Factors of Health and Mortality at old ages in Moscow and Russia***

Self-rated health is widely used to calculate integral health indicators at the population level, such as life expectancy or years of life lost. However, self-rated health steadily works as a predictor of higher mortality for individuals reporting poor health<sup>28</sup>. This allows to use self-rated health as an indirect indicator of mortality, and

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<sup>27</sup> Nolte E., M. McKee. Does health care save lives? Avoidable mortality revisited. London: The Nuffield Trust, 2004

<sup>28</sup> Perlman, F., & Bobak, M. (2008). Determinants of self rated health and mortality in Russia - are they the same? International journal for equity in health, 7, 19. doi:10.1186/1475-9276-7-19; Idler, E., & Benyamini, Y. (1997).

using the example of this indicator to identify factors that determine differences in mortality at the individual level.

However, the average estimates of the prevalence of poor self-rated health at the population level are weakly correlated with life expectancy and other mortality indicators for general population on a country level<sup>29</sup>. Self-rated health and risk of death may be related in different ways to social and behavioral factors<sup>30</sup>, females tend to report poor health more often than males, but have lower mortality<sup>31</sup>. Thus, self-rated health correlates well with mortality within population groups, but this correlation is not always observed in the population level.

In this thesis, we made an assumption that data about self-rated health are comparable between Moscow and other regions of Russia. Self-rated health, which is one of the most common indicators of health status, is an important indicator of quality of life in general, complementing life expectancy.

Age-standardized estimates of the prevalence of poor self-rated health show a lower proportion of respondents with poor health in Moscow compared to other regions in both 2011 and 2015. Standardization by age and educational structure reduces the difference between Moscow and other regions of Russia in proportion of people with poor self-rated health to 1 percentage point for both sexes (2 p.p. for males and 0.8 p.p. for females). Estimates of the prevalence of poor self-rated health, taking into account the educational structure of respondents in 2015, were also lower than in 2011.

Results of logistic regression for 2011 controlling for the age and sex, the chances of a good self-rated health are 20% higher for Moscow compared to other regions, for 2015 - 19% higher. Both in 2011 and in 2015, controlling for the educational level, the advantage of Moscow compared to other regions decreases to

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Self-Rated Health and Mortality: A Review of Twenty-Seven Community Studies. *Journal of Health and Social Behavior*, 38(1), 21-37. doi: 10.2307/2955359

<sup>29</sup> S.J. Babones, The consistency of self-rated health in comparative perspective, *Public Health*, Volume 123, Issue 2, 2009, Pages 199-201; Sen, A. (1998). Mortality as an Indicator of Economic Success and Failure. *The Economic Journal*, 108(446), 1-25; De Maio FG. Health inequalities in Argentina: patterns, contradictions and implications. *Health Sociol Rev* 2007;16:279-91

<sup>30</sup> Perlman, F., & Bobak, M. (2008).

<sup>31</sup> Oksuzyan A., Juel K., Vaupel J., and Christensen K. (2008) Men: good health and high mortality. Sex differences in health and aging // *Aging Clin Exp Res*. 2008 Apr; 20(2): 91-102.

7-8% and becomes statistically insignificant. Completed higher education increases the chances for a good self-rated health by 74-76% compared with low education; secondary and incomplete higher education - by 21-24%. Similar results were obtained for males and females separately, but with less statistical significance of differences in self-rated health.

A higher life expectancy in Moscow compared to other regions is due to both a longer healthy life expectancy (HLE) and a higher unhealthy life expectancy (uHLE). HLE at age 60, adjusted for an underestimation of mortality at age over 80, in Moscow in 2011 was 12.1 years for males and 13.3 years for females, which is 2.4 and 2.1 years higher compared to other regions for males and females, respectively. uHLE in Moscow is also higher than in other regions (by 1.5 years for males and 0.7 years for females). By 2015, the life expectancy in Moscow and other regions has grown, the difference in HLE and in uHLE decreased for females, while for males this indicator increased from 1.5 to 2.2 years.

The level of education is one of the most important characteristics of the population, affecting demographic processes. It is reliably known that mortality is lower among the most educated groups of the population. The educational structure of the population in Moscow differs markedly from the population in the rest of Russia. In all ages in Moscow, the proportion of the population with higher education is 1.5-2 times higher than in Russia, and among older people (over 75 years old) 2.3-2.4 times. The characteristics of the structure of the population of Moscow are an important factor in the advantage of Moscow in comparison with other regions.

### **General findings**

The proposed hypothesis is confirmed by the results of the study. Moscow's leadership in reducing the mortality at old ages is partly explained by the underestimation of mortality rates at oldest old ages, which is determined by an inaccurate estimate of the elderly population by the vital statistics and censuses. However, adjusted life expectancy estimates still shows the advantage of Moscow in comparison with the rest of Russia.

The main features of the structure of mortality in Moscow are similar to that in other regions. Moscow, like Russia, is characterized by a high proportion of diseases of the circulatory system in the structure of causes of death, a high proportion of coronary heart disease and a low proportion of deaths from other CVD remain. At the same time, the statistics of mortality in Moscow, in comparison with Russia, seem to more fully reflect mortality from main causes of death at old ages. Thus, the age profile of mortality from the main causes in Moscow looks more similar to the patterns observed in countries with more reliable statistics on mortality by causes of death.

With steady growth in life expectancy, the older age groups make an increasingly significant contribution to the difference in life expectancy between Moscow and the rest of Russia. Overestimated old age population in Moscow significantly distorts mortality in this age group, but the real indicators of mortality at this age in Moscow is an intermediate position between Russia and European countries. Given the decisive role of educational level as a factor of lower mortality, shown by many studies, and higher proportion of the population with higher education in Moscow, a significant part of Moscow's leadership in life expectancy compared to the rest of Russia is probably determined by structural differences.

**Main findings:**

1. Features of mortality at old ages in Moscow are manifested in a higher life expectancy; the absence of an increase in mortality in the second half of the 1990s and early 2000s and the greater contribution of changes in old-age mortality to increase in life expectancy at birth.
2. Lower mortality indicators at old ages in Moscow determine the constant difference in life expectancy between Moscow and the rest of Russia since the mid-2000s.
3. The mortality indicators at old ages in Moscow are underestimated, due to the overestimation of its number by results of population censuses of 2002 and 2010, which is more noticeable for males.

4. The advantage of Moscow compared to the rest of Russia is declining, but remains after the adjusting of estimates of life expectancy.

5. Statistics of mortality by causes of death in Moscow compared with the rest of Russia more accurately indicate mortality at old ages from main causes of death, especially neoplasms.

6. Moscow is characterized by a better self-rated health compared to the rest of Russia, this difference is explained mainly due to the higher proportion of people with higher education in Moscow.

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### **List of papers**

*Papers published in the peer-reviewed scientific journals from the Scopus international database:*

1. Papanova E.K., Shkolnikov V.M., Andreev E.M., Timonin S.A. High Life Expectancy of Muscovites Over Age 80: Reality or a Statistical Artifact? // *Advances in Gerontology*. 2018. Vol. 8. No. 2. P. 86-95.

*Papers published in the journals from the list recommended by HSE:*

1. Papanova E.K., Shkolnikov V.M., Timonin S.A. Distinctive features and components of mortality decrease in Moscow in 1989-2017 // *Demographic*

Review. 2019. V. 6. № 1. P. 50-103.

<https://doi.org/10.17323/demreview.v6i1.9113>

2. Papanova E.K. Determinants of differences in self-rated health between Moscow and the rest of Russia // *Social aspects of population health*. 2020. [in press].

*Papers published in other sources:*

1. Papanova E.K., Timonin S.A. The system of indicators for assessing public health // *Moscow Medicine*. 2017. No. 1. P. 25-26.
2. Papanova E.K., Timonin S.A. Mortality from diseases of the circulatory system in Russia and Moscow in the light of global trends // *Moscow Medicine*. 2017. No. 4. P. 609-613.
3. Papanova E.K. In Search of Resources: Elderly Population of Russia. Book Review: Rimashevskaya N. M. (ed.) (2014) *Starshee pokolenie kak resurs social'no-jekonomicheskoy modernizacii Rossii* [The Older Generation as a Resource for Socio-Economic Modernization of Russia], Moscow: Economic Education, 212 p. ISBN 978-5-7425-0174-9. // *The Journal of Social Policy Studies*. 2016. V. 14. №4. P. 609-613.