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POINT OF VIEW

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ANALYSIS OF LIFE EXPECTANCY OF POPULATION OF THE IRKUTSK REGION

DOI 10.25789/YMJ.2020.72.28

The purpose of the research is to analyze life expectancy (LE) of the population of the Irkutsk region and to identify factors affecting the indicator at the municipal level.

Materials and methods of research. The data were used for LE of the Irkutsk region and the Russian Federation for 1990-2019, municipalities of the region for 2018; methods of descriptive statistics, correlation and regression analysis, criterion *W* of the Shapiro – Wilk test to check the normal distribution of 42 indicators.

Results and discussion. In the Irkutsk region, LE of the population increased from 66.5 years in 1990 to 69.60 years in 2019. The difference in LE in the region was lower than the national average by 3.8 years, for men and women - by 4.2 and 2.9 years. In 2018, the following characteristics of LE were recorded for the municipalities of the region: 1) maximum - 75.8 years; minimum - 58.3; 2) 18 municipalities with LE of men below 60 years old; 3) the amplitude of LE of men was 20.3 years, women - 14.1 years; 4) the maximum gender difference is 18.1 years, the minimum is 6.6 years. Due to the uneven development of the territories of the Irkutsk region, the indicators had high variability. This made it difficult to select them to study the influence of factors on LE at the municipal level. The resulting multiple regression models include: general mortality rate (LE of both sexes, men, women); mortality from diseases of the circulatory system (LE of both sexes and men), total fertility rate (LE of women); provision of hospital beds (LE of both sexes, men), provision of paramedical personnel (LE of women).

Conclusion: Irkutsk region in terms of LE is one of the last places among the subjects of the Russian Federation. 70% of the main measures to increase LE are included in state programs for the development of the region, but unsolved problems of socio-economic development impede their effective implementation. According to the results of the correlation and regression analysis, the links between LE at the municipal level and the general indicators of fertility and mortality, mortality from diseases of the circulatory system, provision of hospital beds and paramedical personnel were established. To achieve LE of 80 years in 2030, a differentiated socio-demographic policy is required for individual municipalities of the region.

Keywords: life expectancy, region, municipal level, socio-economic indicators, correlation and regression analysis

Introduction. Life expectancy (LE) of the population is an integral indicator of the state of health, quality of life of the population, an assessment of the level of socio-economic well-being of the state, and is used to calculate the human development index [3, 10, 13]. Despite the gradual growth, LE in the Russian Federation remains quite low, as well as lagging behind developed countries, including by gender gap, interregional variation, difference for urban and rural population [3, 6, 8-10, 13, 15, 23]. Efforts of all levels of government are required to increase LE with significant geographical differences [17, 19, 20]. Due to the special significance of the indicator, it is important to monitor trends and find out the reasons for the decline and stagnation [21, 25].

The purpose of the research is to analyze LE of the population of the Irkutsk region and to identify factors affecting the indicator at the municipal level.

Materials and methods of research. The Rosstat data on life expectancy of the population of the Irkutsk region and the Russian Federation for 1990-2019 have been applied; morbidity, mortality, socio-economic indicators for 42 municipalities for 2018. Life expectancy indicators for medical organizations for 2018 were calculated on the basis of the age and sex composition of the resident population of the Irkutsk region as of 01.01.2019 and the number of deaths from tables C51 «Distribution of deaths by sex, age groups and causes of death». The ranking of the subjects of the Russian Federation to determine the rating was carried out in descending order of the indicator.

Statistical analysis of the data was carried out using Microsoft Excel 10 and the Shapiro-Wilk Test calculator (https://www.statskingdom.com/320ShapiroWilk.html). Checking the correspondence of the distribution of variables to the law of normal distribution was carried out using the Shapiro-Wilk test (W). Descriptive statistics were calculated, an analysis of the variability of variables by coefficients of variation (Cv), Pearson correlation analysis, multiple regression analysis using the method of successive exclusion of variables was carried out. Before building regression models, the applicability of the multiple regression method was tested. The statistical significance of the constructed model was assessed using Fisher's F-test. The quality of fitting a linear function was assessed by the multiple determination coefficient (R2). The

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critical value of the level of significance when testing statistical hypotheses was taken equal to 5%.

Results and discussion. In the Irkutsk Region, the LE of the population decreased from 66.5 years in 1990 to 60.0 years in 1994, then the indicator increased and reached its maximum value in 2019 - 69.6 years. During 1990-2019 life expectancy indicators of the population of the region were below the national indicators by an average of 3.8 years. According to the three forecast variants of Rosstat, in 2030 the LE of the population of the Irkutsk region will be: 77.6 years (high option), 74.8 years (middling) or 71.3 years (low option) (Fig. 1).

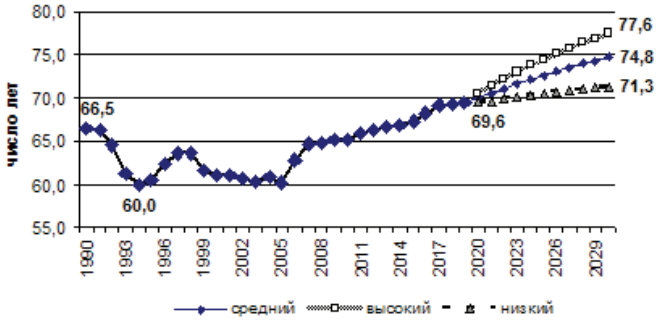

Fig.1. The dynamics of life expectancy of the population of the Irkutsk region for 1990-2019 and forecast for 2020-2030 in three options (number of years)

For the study period, the minimum values of LE were recorded in men of the Irkutsk region in 2005 (53.3 years), women in 1994 (68.1 years). In 2018, the LE of the population of the Irkutsk region was 69.3 years, for men and women - 63.3 and 75.2 years, respectively. According to the medium version of the forecast, the LE of women in the Irkutsk region will reach 79.6 years by 2030; men - 69.8 years (Table 1).

In 2018, according to the LE of the population, the Irkutsk region occupied the 80th place among 85 constituent entities of the Russian Federation (2019 the 80th); 83rd - for the LE of men, 79th - for LE of women. The Irkutsk region was assigned to the "catching up" group of regions with LE below the average for Russia and a relatively low standard of living [14].

The difference in LE of the population of the Irkutsk region with all-Russian values during 1990-2018. fluctuated: for men from 2.8 to 5.6 years (on average for 4.2 years), for women from 2.1 to 4.2 years (on average for 2.9 years); in 2018, the difference was 3.6 years, for men and women 4.4 and 2.6 years. In 2030, the difference in LE of the population of the Irkutsk region and the Russian Federation, according to all forecast variants, will be 2.2-3.5 years, for men and women - 2.9-4.2 and 1.4-2.6 years, respectively (with a low version - 3.5; 4.2 and 2.6 years).

Zaitseva N.V. et al. [5] note that «for the Russian Federation, the regional aspect of the demographic issue is particularly relevant, reflecting significant differences both in socio-economic indicators and in the indicator of LE».

In 2018, the following LE characteristics were recorded for the municipalities of the Irkutsk region: 1) the maximum age in the Irkutsk municipal district (75.8 years); the minimum age in Katanga municipal district (58.3 years); 2) 18 municipalities with LE of men below 60 years; 3) the amplitude of the LE of men was 20.3 years, for women - 14.1 years (Table 2); 4) the maximum gender difference in the Bodaibo municipal district (18.1 years), the minimum - in Bayandaevsky municipal district (6.6).

The contemporary studies have found that life expectancy is influenced by a variety of factors: heredity; natural ecological; level of development and health system services; macroeconomic, socio-economic; Lifestyle; socio-psychological, racial / ethnic, behavioral, metabolic and other risk factors [3, 4, 6-8, 10, 13, 14, 17-20].

Difficulties in selecting indicators for the correlation and regression analysis are associated with the lack of information at the municipal level and the high variability of available data. According to the results of descriptive statistics, half of the socio-economic indicators of the municipalities of the Irkutsk region were excluded for further analysis due to a high coefficient of variation: investment in fixed assets per capita – 477 %; the introduction of living space for 1 person. - 213%; emissions, kg / person - 175%; migration increase / decrease - 150%; unemployment rate - 60%, indicators of home improvement - from 54 to 60%; education expenses - 49%, etc. Despite the significance of such a factor as health care costs [8, 10, 19, 24], the latter was not included in the analysis due to the high coefficient of variation (41%), right asymmetry, and the presence of three pop-up values. 17 analyzed parameters were rejected that did not have a normal distribution according to the criteria of the W Shapiro – Wilk test. All of the above allows us to conclude about the extremely uneven development of the municipalities of the region.

According to the results of the correlation analysis, the aggregate linear dependence of the average strength between **the LE of the population** and the two studied factors with the correlation coefficient of 0.67 was established. As a result of applying the selection of factors, a linear model of

Table 1

Life expectancy of the population of the Irkutsk region for 1990-2018 and forecast for 2030 (number of years)

Indicators and forecast options	both sexes	men	women
for 1990-2018			
minimum	60.0	53.3	68.6
maximum	69.3	63.3	75.2
M (SD)	64.1 (2.9)	57.7 (3.2)	71.0 (2.1)
forecast for 2030			
low	71.3	66.1	76.6
average	74.8	69.8	79.6
high	77.6	73.2	81.7

Table 2

Life expectancy of the population of municipalities of the Irkutsk region in 2018 (number of years)

Indicators	both sexes	men	women
minimum	58.3	51.9	66.1
maximum	75.8	72.2	80.2
M (SD)	66.6 (3.6)	60.4 (3.9)	72.9 (3.2)

multiple regression was constructed:

$y_1 = 83{,}833 – 1{,}537\ x_2 – 0{,}007\ x_{21}$,

where y_1 - life expectancy (both sexes), the number of years; x_2 - total mortality rate per 1000 people; x_{21} - mortality rate from diseases of the circulatory system per 100 thousand. All factors are statistically significant with a probability of 0.95. The multiple correlation coefficient confirms the feasibility of including the above factors in this model (R = 0.82). Determination coefficient R2 = 0.67. The average approximation error is 2.56%. The F-stat value of 39.74 indicates the statistical significance of the model as a whole. A similar linear model of multiple regression was obtained for **the LE of men**:

$y_2 = 78{,}822 – 1{,}665\ x_2 – 0{,}009\ x_{21}$.

The model of multiple regression about the influence of factors on **the LE of women** includes two factors:

$y_3 = 93{,}098 – 0{,}383\ x_1 – 1{,}036\ x_2$,

where y_3 is the expected duration of women, the number of years; x_1 - total fertility rate per 1000 people; x_2 - total mortality rate per 1000 people. The multiple correlation coefficient is 0.81; coefficient of determination - 0.66; F- statistics - 38.53; the average approximation error is 2.05%, factors are significant with a probability of 95%. Thus, the expected result of the association of LE and the overall mortality rate [7], as well as LE of men and the whole population and mortality from diseases of the circulatory system, was obtained. Often, the causes of a decrease in LE include external causes of death: homicide, suicide, drug overdose, etc. [5, 16, 21, 25].

It was found that among the factors describing the availability of medical care, the **LE of the population** is affected only by the availability of beds (R = 0.65); the coefficient of determination of R2 is 0.42. The multiple regression model is obtained:

$y_1 = 74{,}752 – 0{,}119\ x_{12}$,

where life expectancy (both sexes), a number of age; x_{12} - hospital bed provision per 10 thousand population. The indicator «hospital bed provision» x_{12}, included in the regression model, and the model itself are statistically significant. Therefore, there is a connection between LE of the whole population of the Irkutsk region and the hospital bed provision for the population. A similar linear model of multiple regression was obtained for **the LE of men**:

$y_2 = 69{,}446 – 0{,}133\ x_{12}$.

The linear model of multiple regression **of LE of women** is represented by the following equation:

$y_3 = 79{,}141 – 0{,}132\ x_{11} – 0{,}053\ x_{12}$,

where y_3 is the LE of women, the number of years; x_{11} - availability of paramedical personnel for 10 thousand; x_{12} - hospital bed provision per 10 thousand. All factors are statistically significant with a probability of 0.95. The multiple correlation coefficient confirms the feasibility of including the above factors in this model (R = 0.48). The determination coefficient R2 = 0.23. The average approximation error is 3.31%. The F-stat value of 4.97 indicates the statistical significance of the model as a whole.

Conclusion: At present, the LE of the population of the Irkutsk region is one of the lowest in the Russian Federation - 69.6 years (80th place). Despite the fact that about 70% of the main directions for implementing measures to increase LE were included in state programs for the development of the region, the presence of unsolved problems of socio-economic development impedes the success of the measures taken [14]. Irkutsk region in 2030 will not reach the target of 2024 (78 years), even according to the high version of the forecast. According to the results of the correlation and regression analysis, the links of LE of the population of the municipalities of the Irkutsk region with the general indicators of fertility and mortality, mortality from diseases of the circulatory system, hospital bed provision and availability of paramedical personnel were established.

To achieve the indicator of LE of 80 years by 2030 [8-10, 12], a scientifically sound state and regional socio-demographic policy, investments, time, and differentiated decisions for individual territories are required [1, 3, 13]; a significant increase in government spending on the maintenance and development of the health system, including the municipal level, the effective use of financial resources to ensure the availability of medical care to the population. Therefore, the socio-economic well-being of the population is considered as an important factor affecting health and longevity, and as the main measure of impact in the system of managerial decisions [17, 24].

In recent years, much attention has been paid to such important socio-economic measures to increase LE, such as reducing poverty, crime, improving housing conditions and improving housing, organizing safe working conditions, recreation, achieving sanitary and epidemiological well-being, public health education, and the development of specialized medical care et al. [14]. But reserves for increasing LE remain, therefore, the use and activation of all reserves is an important condition for the further growth of LE of the population [9].

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