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Mortality of the working age population of Republic Sakha (Yakutia): trends and forecast

The analysis of the dynamics, the nature of trends of mortality among working-age population of the Republic of Sakha (Yakutia) for the period 2000-2008 years was made and the prediction up to 2015 year was composed.

Keywords: mortality of working-age population, the trends, the prediction.

Introduction

The territory of the Republic of Sakha (Yakutia) refers to areas with adverse the climatic, geophysical and socio-economic conditions for a living population. The combined effects of these factors leads to a rapid depletion of adaptive reserves of the human body and development of environmentally induced disease, complicated by a current chronic disease, premature aging and at the rejuvenation mortality (V.I. Hasnulin and co-authors, 2005).

Study of regional characteristics of the formation of public health is a prerequisite for a rational organization of health system performance in a particular area (V.K. Ovcharov, 2000; J.P. Lisitsyn, 2001; O.P. Shchepin, and co-authors, 2004). According to some researchers, the mortalities are reliable and informative indicators of social, demographic and medical well-being of the population (L.V. Anokhin et al., 1999; M.S. Bedny, 1979, 1984; T.A. Korolkova 1999).

Purpose. To estimate tendencies in mortality of working-age population of the Republic of Sakha (Yakutia) for the period 2000-2008 years and make a forecast up to 2015 year.

Subjects and methods

To investigate the use of official statistics mortality of working age population of the Territorial Department of the Federal State Statistics Service of the Republic of Sakha (Yakutia) for the period 2000-2008. [1].

For analysis of mortality dynamics was calculated the indicators of the dynamic range. When drawing up the equation for calculating the prognostic index performed the alignment of time series by least squares [2, 3].

At T (average growth rate) from 0 to ± 1% of the estimated trends in the dynamics as a stable, at T of up to ± 1,1% ± 5,0% - moderately, at T more ± 5,0% - as expressed by [4].

Results and discussion

When studying the age structure of the population revealed that the period from 2000 to 2008 years indicated a slight (3,1%) increase in the proportion of working- age, while the share of persons under the working-age decreased to 4,9% (Table 1). The population growth over the study period increased from 4,0% to in 2000 year to 6,1% of the – 2008 year.

According to the WHO classification of the population is considered "old" if, before to those aged 65 and over up to 7% of the total population. In the country in 2008 year were 5,9% of residents of this age. The process demographic aging was more typical degree for women (in 2008 year proportion of men aged 65 years and older was 4,1% and 7,2% of women). This disparity is due to increased mortality of men.

In analyzing the dynamics of mortality of the Republic of Sakha (Yakutia) of working-age found that the total mortality for the period from 2000 to 2008 years decreased by 1,5% (Table. 2).

To assess the nature of the trends of mortality were calculated annual increase /decrease in mortality and the rate (Fig. 1, Table 3.). Calculated values show a decrease in mortality of the population of working-age, but the pace of decline has reached in 2006 year -7,7% in 2007 have decreased, while in 2008 year there is an increase of 4,4%. The average absolute increase and the average growth rate of mortality for the period 2000-2008 years presented in Table 4. With average absolute increase in total mortality of working age population of the republic in 2000-2008 years was – 1,34. According to our data, the trend in overall mortality during the analyzed period is regarded as stable. In separate groups of causes of death observed moderate opposite tendencies: increasing - from diseases of the circulatory system, digestive, infectious, endocrine and other diseases, the decline - due to external causes, neoplasms and diseases of the respiratory system.

The structure of the working-age mortality leading causes throughout of the under review the period were of cardiovascular disease, cancer, accidents, poisonings and injuries (Table 5). Their total contribution to the overall mortality rate in 2008 year was 80,5%.

The main contribution to deaths from the cardiovascular diseases has made coronary heart and cerebrovascular diseases (Table 6). Dynamics of mortality from diseases of the circulatory system during the analyzed period is characterized by a moderate upward trend, according to specific reasons (CHD and CVD) - a stable (Table 7).

Mortality rates of working-age population of the republic from external causes between 2000 to 2008 years are presented in Table 8. Throughout the analyzed period, the main causes of mortality from external causes were homicide, suicide and "other" reasons. The trend of mortality from all external causes is characterized by downward decrease with an average absolute increase in mortality was 34,26 per 100 thousand of population (Table 9). There is a pronounced tendency

reduce the Mortality from alcohol poisoning. Mortality of transport of reasons and murder has moderate downward trend, the rate of growth, respectively were -1,95% and 4,08%. The tendency to suicide is characterized as "stable."

With the use of least-squares method for aligning time series rates was calculated forecasting mortality for working-age population on 2009-2015 years. The equation of the linear trend is given by: $\gamma_t = a_0 + a_1 t$

In this $a_0 = \frac{\sum y}{n}$ $a_1 = \frac{\sum yt}{\sum t2}$. After calculating indicators (Table 10), the equation takes the following form:

$$\gamma_t = 7{,}478+(-0{,}08667)*t \quad (1)$$

Standard deviation of the model was 0,33. The average error was 0,21%. Estimation of accuracy approximation model performed by calculating the coefficient of variation and Theil coefficient mismatch. The coefficient of variation was 4,4%, the coefficient of divergence of Theil — 0,02. In connection with this approximation is considered accurate.

The average absolute increase was as follows:

$$\Delta = \frac{yn-y1}{n-1} = -0{,}03$$

$\gamma_{2009} = 7{,}1+ (-0{,}03)*1 = 7{,}07$

$\gamma_{2010} = 7{,}1 + (-0{,}03)*2 = 7{,}04.$

The average growth rate of:

$$k_p = \sqrt[n-1]{\frac{yn}{y1}} = 0{,}997$$

$\gamma_{2009} = 7{,}1 * 0{,}997 = 7{,}07$

$\gamma_{2010} = 7{,}07* 0{,}997 = 7{,}04$

Prognostic indicators of mortality among the population of working-age from all causes in 2009-2015 years, calculated by the formula 1 are as follows:

$\gamma_{2009} = 7{,}478 + (-0{,}08667) * 5 = 7{,}04$

$\gamma_{2010} = 7{,}478 + (-0{,}08667) * 6 = 6{,}96$

$\gamma_{2011} = 7{,}478 + (-0{,}08667)* 7 = 6{,}87$

$\gamma_{2012} = 7{,}478 + (-0{,}08667)* 8 = 6{,}78$

$\gamma_{2013} = 7{,}478 + (-0{,}08667) * 9 = 6{,}70$

$\gamma_{2014} = 7{,}478 + (-0{,}08667) * 10 = 6{,}61$

$\gamma_{2015} = 7,478 + (-0,08667) * 11 = 6,52$

Thus, when save in the Republic of demographic and socio-economic status at the 2008 projected a moderate reduction in mortality of working age population to 2015 year to 6,5 per 1,000 of population.

Conclusions

At the age structure of the Republic of Sakha (Yakutia) there is a trend of population aging, which is expressed in increasing the proportion of people over 65 years.

During the period 2000-2008 years riding in the causes of mortality in the structure of the population of working age were the external causes, diseases of the circulatory system and neoplasms.

The trend in total mortality of working-age population of the Republic of Sakha (Yakutia) generally regarded as stable. There is a moderate tendency to increase mortality from diseases of the circulatory system, digestive, infectious, endocrine and other diseases. Mortality from external causes, neoplasms and diseases of the respiratory system has a moderate downward trend. There is a strong tendency to reduce mortality from alcoholic poisoning. The tendency to suicide is characterized as "stable." In the period before 2015 year is expected to decrease the mortality rate of people of working age.

References:

Demographic Yearbook of the Republic of Sakha (Yakutia). 2009: Statbook / Sakha (Yakutia) stat. - Yakutsk, 2009. - 196 p.

Medik VA, Yuryev VK. The course of lectures on public health and health care. Part 1. Public Health. - Moscow: Medicine, 2003. – 368 p.

3. Balinova VS. Statistics in questions and answers. - M.: TC. Welby, Publishing House of the Prospectus, 2004. -344 p.

4. Belyakov VD, Degtyarev AA, Ivannikov JG. Quality and effectiveness of control measures. - A.: Medicine, 1981. -303 p.

Table 1. Age structure of population of the Republic of Sakha (Yakutia) for the period from 2000 to 2008 (%)

	Years

Age	2000	2002	2003	2004	2005	2006	2007	2008
under working	28,18	26,52	26,37	25,56	24,88	24,20	23,62	23,32
working-age	62,03	63,51	63,67	64,40	64,87	65,25	65,38	65,17
non working-age	9,80	9,98	9,96	10,03	10,26	10,55	11,00	11,51

Years	mortality per 1000 pop.	absolute increase	indicator of visibility, %	indicator of growth, %	rate of increase / decrease, %
2000	7,3		100		
2001	7,9	0,6	108,2	108,2	8,2
2002	7,8	-0,1	106,8	98,7	-1,3
2003	7,7	-0,1	105,5	98,7	-1,3
2004	7,7	0	105,5	100,0	0,0
2005	7,8	0,1	106,8	101,3	1,3
2006	7,2	-0,6	98,6	92,3	-7,7
2007	6,8	-0,4	93,2	94,4	-5,6
2008	7,1	0,3	97,3	104,4	4,4

Table 2. The main causes of deaths of working-age population of the Republic of Sakha (Yakutia) for the period 2000 to 2008 (per 100 thousand population)

Causes	Years								
	2000	2001	2002	2003	2004	2005	2006	2007	2008
all	732,9	787,3	782,8	770,8	771,9	776,2	723,3	680,6	710,4
infectious diseases	18,6	18,6	20,0	21,0	15,5	17,6	15,4	13,2	21,6
neoplasms	77,5	69,1	79,0	76,9	80,5	78,4	71,3	77,5	69,5
endocrine	3,0	2,9	3,6	4,9	3,7	3,0	2,6	4,4	3,3
diseases of the circulatory system	193,2	240,9	230,8	233,4	239,9	265,1	235,9	222,7	238,1
diseases of the respiratory system	28,4	24,2	24,7	27,8	23,8	30,6	21,1	18,0	25,1
diseases of the digestive system	40,9	38,6	43,6	45,8	48,8	44,0	45,6	37,5	46,4
external causes	324,2	344,1	334,8	308,0	302,6	292,7	278,9	263,0	274,1
other diseases	47,1	48,9	46,3	53	57,1	44,8	52,5	44,3	32,3

Table 3. Indicators of the time series of mortality of working- age population

Table 4. Main characteristics of the mortality dynamics of working-age population in Republic of Sakha (Yakutia)

Causes	The average absolute increase	Rate of increase in average, T, %	Characteristic of trends
all	-1,34	-0,18	stable
infectious diseases	0,38	1,89	moderately
neoplasms	-1,00	-1,35	moderately
endocrine	0,04	1,20	moderately
diseases of the circulatory system	5,61	2,65	moderately
diseases of the respiratory system	-0,41	-1,53	moderately
diseases of the digestive system	0,69	1,59	moderately
external causes	-6,26	-2,08	moderately
other diseases	3,86	3,15	moderately

Table 5. The structure of the main causes of deaths of working-age population of the Republic of Sakha (Yakutia) for the period 2000-2008 (%)

Causes	Years								
	2000	2001	2002	2003	2004	2005	2006	2007	2008
all	2,54	2,36	2,55	2,72	2,01	2,27	2,13	1,94	3,04
infectious diseases	10,57	8,78	10,09	9,98	10,43	10,10	9,86	11,39	9,79
neoplasms	0,41	0,37	0,46	0,64	0,48	0,39	0,36	0,65	0,46
endocrine	26,36	30,60	29,48	30,28	31,08	34,15	32,61	32,72	33,54
diseases of the circulatory system	3,88	3,07	3,16	3,61	3,08	3,94	2,92	2,64	3,54
diseases of the respiratory system	5,58	4,90	5,57	5,94	6,32	5,67	6,30	5,51	6,54
diseases of the digestive system	44,24	43,71	42,77	39,96	39,20	37,71	38,56	38,64	38,61
external causes	6,43	6,21	5,91	6,88	7,40	5,77	7,26	6,51	4,49
other diseases	100	100	100	100	100	100	100	100	100

Table 6. Mortality of the working- age population in Republic of Sakha (Yakutia) from diseases of the circulatory system during the period from 2000 to 2008 (per 100 thousand population)

Causes	Years

	2000	2001	2002	2003	2004	2005	2006	2007	2008
all diseases of the circulatory system	193,2	240,9	230,8	233,4	239,9	265,1	235,9	222,7	238,1
coronary heart disease	70,6	82,2	73,1	75,2	73,8	80,6	69,3	61,4	70,8
cerebrovascular disease	48,3	50,3	46,0	51,7	48,0	58,5	51,1	45,7	46,4

Table 7. Trends in mortality of working- age population Republic of Sakha (Yakutia) from diseases of the circulatory system during the period from 2000-2008 years

Causes	The average absolute increase	Rate of increase in average, T, %	Characteristic of trends
all diseases of the circulatory system	5,61	2,65	moderately
coronary heart disease	0,03	0,04	stable
cerebrovascular disease	-0,24	-0,50	stable

Table 8. The structure of the deaths of working-age population Republic of Sakha (Yakutia) from external causes between 2000 and 2008 (per 100 thousand population)

Causes	Years								
	2000	2001	2002	2003	2004	2005	2006	2007	2008
road accidents	24,0	35,2	30,9	29,1	27,8	28,7	31,5	19,3	20,5
murder	74,8	71,0	81,8	66,8	70,1	70,8	57,6	57,3	53,6
suicides	68,9	72,1	69,3	69,8	68,3	67,3	66,0	65,8	67,7
alcohol poisoning	13,8	17,1	15,2	19,9	14,7	14,8	10,6	5,4	7,4
other causes	142,7	148,7	137,6	122,4	180,9	111,1	165,7	147,8	124,9
all	324,2	344,1	334,8	308,0	302,6	292,7	278,9	263,0	274,1

Table 9. Trends in mortality in the Republic of Sakha (Yakutia) from external causes between 2000 and 2008 years

Causes	The average absolute increase	Rate of increase in average, T, %	Characteristic of trends
all	34,26	-2,08	moderately
road accidents	2,56	-1,95	moderately
murder	6,70	-4,08	moderately
suicides	8,46	-0,22	stable
alcohol poisoning	0,93	-7,49	expressed
other causes	15,61	-1,65	moderately

Table 10. Alignment of the time series of mortality of working-age population by the least squares

Causes	Mortality per 1000 pop. γ_t	t	t^2	yt	The theoretical level, γ_t
2000	7,3	-4	16	-29,2	7,73
2001	7,9	-3	9	-23,7	7,64
2002	7,8	-2	4	-15,6	7,54
2003	7,7	-1	1	-7,7	7,45
2004	7,7	0	0	0	7,35
2005	7,8	1	1	7,8	7,26
2006	7,2	2	4	14,4	7,16
2007	6,8	3	9	20,4	7,06
2008	7,1	4	16	28,4	6,97
∑	67,3	0	60	-5,2	

Note: t - serial number of the chronological dates from the center.

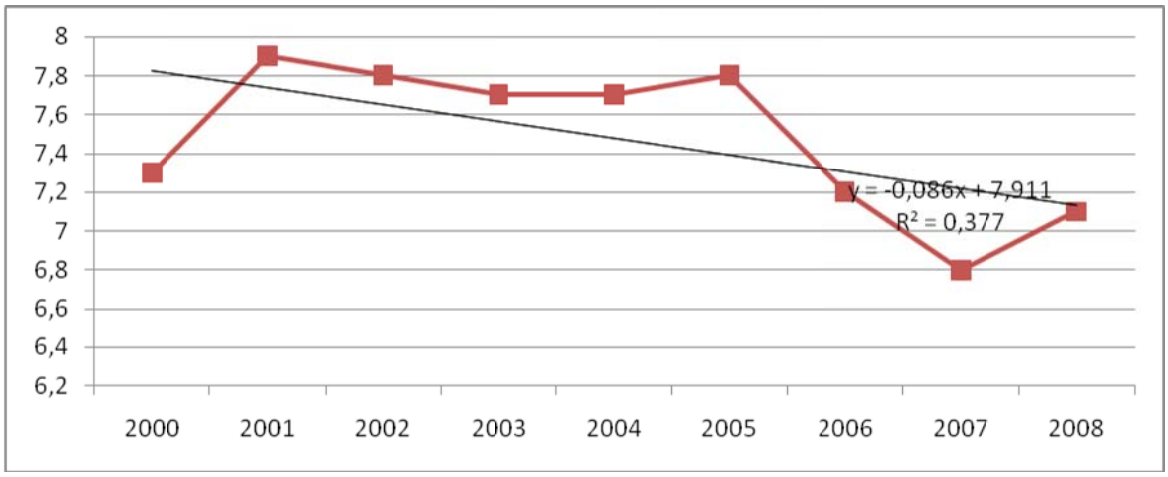

Fig. 1. The dynamics of the mortality of working -age population (per 1000 pop.) and the trend line for the period 2000-2008 years.

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