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MODERN PATTERN OF MORTALITY AND SURVIVAL OF POPULATION IN UKRAINE

This paper presents a statistical analysis of recent changes of morality and survival regime of Ukrainian population. Scenarios of short-term forecasts the survival parameters of Ukrainian population have been carried out. The results of statistical modeling allow to estimate the character of possible changes of population structure and also to correct strategy of state demographic policy.

Key words: *probability of survival, trend of mortality, hypothetical population.*

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СУЧАСНИЙ ХАРАКТЕР СМЕРТНОСТІ ТА ДОЖИТТЯ В УКРАЇНІ

У статті подано результати статистичного аналізу процесів смертності та дожиття населення України за часу набуття незалежності і до початку соціально-політичного і воєнного конфлікту. Особливу увагу приділено дослідженню зміни характеру смертності населення в розрізі статі, віку та виду поселень, а також структури та інтенсивності смертей за причинами у післяпереписний період. За допомогою індексного аналізу та методу стандартизації виявлено вплив структурних чинників та фактора смертності (загальної і вікової) на розмір фактичних та гіпотетичних природних втрат населення за мирних часів. Компонентний вертикальний аналіз внеску вікових груп у динаміку середньої очікуваної тривалості життя за 2002–2012 рр. показав помітне поліпшення характеру дожиття населення середнього віку та молодшого пенсійного віку, особливо серед чоловіків. У роботі наведено результати триваріантного короткострокового прогнозу чисельності та статево-вікового складу населення України з урахуванням параметрів його дожиття у доконфліктний період.

Ключові слова*: імовірність дожиття, динаміка смертності, гіпотетичне населення.*

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СОВРЕМЕННЫЙ ХАРАКТЕР СМЕРТНОСТИ И ДОЖИТИЯ В УКРАИНЕ

В статье представлены результаты статистического анализа процессов смертности и дожития населения Украины со времени обретения независимости и до начала социально-политического и военного конфликта. Особое внимание уделено исследованию изменения характера смертности населения в разрезе пола, возраста и типа поселения, а также структуры и интенсивности смертей по причинам за послепереписной период. С помощью индексного анализа и метода стандартизации выявлено влияние структурных факторов и собственно фактора смертности (общей и повозрастной) на размер фактических и гипотетических потерь населения в мирное время. Компонентный вертикальный анализ вклада возрастных групп в динамику средней ожидаемой продолжительности жизни за 2002–2012 гг. показал заметное улучшение характера дожития населения среднего и младшего пенсионного возраста, особенно среди мужчин. В работе приведены результаты трехвариантного краткосрочного прогноза численности и поло-возрастного состава населения Украины с учетом параметров его дожития в доконфликтный период.

Ключевые слова: *вероятность дожития, динамика смертности, гипотетическое население.*

Introduction and actuality of problem. A major demographic problem of modern Ukraine is the deepening of depopulation process. The primary reserves of saving Ukraine from depopulation are the support of childbearing activity and positive «migration balance», the improvement of the survival regime and reduction of mortality. Against the background of a long-term reduction in life expectancy by 2007–2013, there have been significant improvements in infant and child mortality rates, as well as in juvenile mortality over the last five years. Over a relatively short time the maternal mortality rates have rapidly reduced, while the life expectancy of elderly people has considerably increased. On the other hand, premature mortality of Ukrainian people aged up to 65 is unreasonably high, especially among men of reproductive and active working age. Thus, the problem can be outlined as follows: how important the current (pre-conflict) regime of survival and mortality as a regulator of the demographic prospects in Ukraine is going to be, and what are the ways to improve it?

Recent researches and publications review. The evolution of mortality at the modern replacement regime and peculiarity of its motion in the Eastern Europe countries is a subject of many Ukrainian and foreign investigations, such as by authors: N. Levchuk, O. Rudnitskij, N. Foigt, P. Shevchuk, A.Vichnevsky [1], T. Kharkova, E. Kvasha, F. Meslé [2], J. Vallin [3] and others. Some of acknowledged scientific works are sanctified to the analysis of age-sex and regional differentiation of mortality taking into account causes of death and its influence on life expectancy: E. Libanova [4], S. Pirozhkov, L. Darskij, P.K. Andersen [5], V. Canudas-Romo, R. Schoen [6]. A special scientific and practice value presents the components analysis methods of the life expectancy, worked out by U. Korchak-Chepurcovsky, E. Andreev [7], A. Stefanovsky [8]. The results of some researches the modern trends of survival, using as a base for the multy-optional forecasts of population size and structure [9, 10, 11]. However, a lesser measure is examining the statistical aspects of changes in the character of population survival in unstable social-political and economical conditions and its influence on reproductive potential.

The purpose of the paper is to analyze the recent trends in the survival parameters of the Ukrainian population, to determine their forecast levels and to evaluate the hypothetical and expected changes in the population size and age-sex structure.

The main results of research. Throughout the history of sovereign Ukraine mortality has performed a destabilizing role in the reproduction of the population, while its dynamics had an uneven nature. Fluctuations of mortality growth and its slight reduction were observed between 1991 and 2007. Only within the last six years the overall mortality rate has shown a regular de-

crease, albeit with different intensities (Fig.1). Despite this positive trend, in 2013 the decline in mortality rate has slowed down and its level 14.6 ‰ did not reach the baseline of 12.9 ‰ of 1991. The trend of number of deaths depends on changes of population size and intensity of its mortality. The factors index analysis, in particular, the index rows allows to estimate the separate influence of each component on the change of number of deaths every year (Fig.1).

In overall, between 1992 and 2013, the annual deaths have decreased by 7.59 thousand persons as a result of multidirectional action of both factors. Thus, for this span of time the reduction of number of deaths took place not due to the decline of intensity of deaths, but by extensive factor – reduction of population size. So, as a result of catastrophic decline in the overall population size, the number of deaths decreased by 84.72 ('000s) in 2013 compared with 1991. If at the modern mortality rate (2013), the population remained the same as in the first year of Ukraine's Independence (1991), the number of deaths in 2013 would have increased compared to the base year by 13.2% (+77.13 thousand persons). However, for the last seven years a positive role an intensive factor began to carry out. Figure 1 show that from 2006 the annual fluctuation of deaths was a result of decline the population size and reduction of death rate.

The overall mortality rate depends on the age population structure and the intensity of death at every age. Therefore, for the disclosure of the internal mechanism of the formation of trends in mortality and impact of each factor an index factor analysis was used (Table 1). Due to the fact that during the last 22 years the mortality dynamics were multidirectional, it is expedient to conduct a further analysis of changes over the period after census in three distinctive time intervals: 2002–2005 – a recent greatest increase in mortality, 2005–2012 – a period of gradual decline in mortality, and 2011–2012 – the year of stabilization of the mortality ratio.

It is obvious that the negative dynamics of the overall mortality rate was prevalently supported by an unfavorable age structure of the population. Thus, due to intensive aging of Ukrainians, their mortality has increased by 3.3% from 2002 to 2005. If aging hadn't been the case, the mortality rate would have dropped by 20.5% instead of 12.4 % (2005–2012)

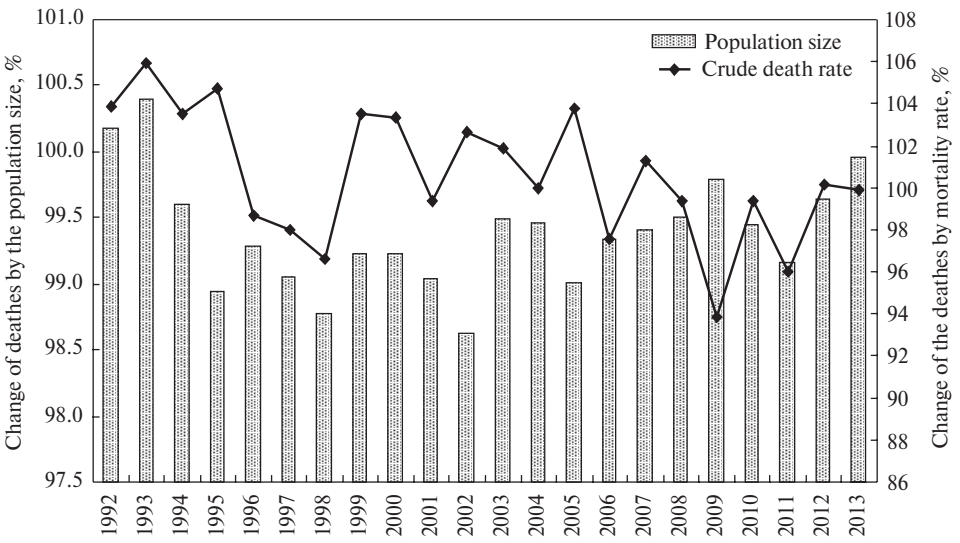

Fig.1. **Annual rates of change in deaths in Ukraine due to population size and mortality rate, 1992–2012**

Source: author's own calculations based on data from the State Statistics Service of Ukraine.

Table 1. **Changes of the crude death rate in Ukraine by the factors, %**

Changes of crude death rate	2002–2005	2005–2012	2011–2012
Total	105.9	87.6	100.0
By factors: age–specific mortality	102.6	79.5	98.6
Age structure	103.3	110.2	101.5

Source: author's own calculations based on data from the State Statistics Service of Ukraine.

in the following years. The powerful influence of the aging factor is connected to a significant increase in the number of retired population, born in the postwar period. Only in the 2012 the mortality rate remained almost unchanged due to leveling of the multi-directional impact of the both factors. In general, over the last 7 years Ukraine has made a major step on its way from high to medium mortality of 14.6 ‰, (according to the international rating scale). It is necessary to point out that in order to make a proper comparison of mortality in Ukraine to that of the EU-28, standardized mortality ratios were used (European standard revised in 2012). It was found that if the standard European age structure was inherent to the Ukrainian population, the overall mortality rate in 2012 would be 1.3 times lower and would amount to 10.9 ‰ against 14.6 ‰ of the real structure (Table 2). Due to the old age structure of the female population, the actual mortality rate is 1.7 higher than the standardized rate of 8 ‰. Moreover, the depth of aging distorts the real intensity of rural female mortality in Ukraine.

Thus, in 2012 mortality of women in rural areas with extremely old actual structure was 2.1 times higher than the standardized rate of 8.4 ‰ corresponding to a low mortality rate. Therefore, the demographic aging of Ukrainian population significantly increases its real rate of extinction intensity. Does it mean that in reality the mortality regime in Ukraine corresponds to the European one? To answer this question it is reasonable to analyze and compare mortality of Ukrainian and European population in the context of gender and by causes of death.

The standardized cause-specific mortality ratios in 2012 show some discrepancy in the overall mortality rate of Ukrainian population (10,9 ‰) and EU–new members since May 2004 (8,2‰) and at the same time almost a complete coincidence in the ranks of death causes of Ukrainian population and the population of the expanded European Union. A comparison of level of crude death rate in Ukraine and countries of EU–28 (data of 2011Y) shows

Table 2. **Actual and standardized (standard European) mortality rates of Ukrainian population by sex and type of residence, 2012**

Gender	Total population			Urban population			Rural population		
	Mortality rate, ‰		Comparative mortality indices, %	Mortality rate, ‰		Comparative mortality indices, %	Mortality rate, ‰		Comparative mortality indices, %
	actual	standardized		actual	standardized		actual	standardized	
Male	15.5	15.1	103	14.4	14.4	100	17.9	16.4	109
Female	13.8	8.0	173	12.2	7.8	157	17.3	8.4	206
Total	14.6	10.9	134	13.2	10.5	126	17.6	11.8	149

Source: author's own calculations based on data from the State Statistics Service of Ukraine and Eurostat Database Population and social conditions.

the almost double (in 1,9 times) exceeding the mortality rate of the Ukrainian population. The most common causes of death are the two classes: the diseases of circulatory system and malignant neoplasms. However, while mortality caused by cardiovascular diseases is 3.2 times higher in Ukraine than in the countries of the EU–28 (data of 2011), Ukrainians die 10% less often due to malignant neoplasms. These differences can be explained not only by the actual structure of the diseases and the extent of their consequences, but also by excessive diagnostics of the first-class causes and underestimation of the second-rate causes – both conscious or subconscious attributing of malignant tumors to diseases of other systems, including the respiratory and digestive system diseases. However, rather high prevalence of exogenous causes is also characteristic of Ukraine, as of some post-soviet countries, notably, external unnatural deaths (traffic accidents, suicides, homicide and alcohol poisoning) [1]. Due to these causes, Ukrainian people die 2.4 times more often than Europeans. It is due to external causes that Ukrainian men die 4.6 times more than their female compatriots. The extreme prevalence of mortality from infectious and parasitic diseases in Ukraine that is 3.4 times higher than the pan-European level also deserves attention. In particular, mortality from tuberculosis and complications of AIDS gaining an epidemic nature in Ukraine kill three times more men than women. As F. Meslé stressed: «a proportion of deaths registered as due to tuberculosis should be attributed to AIDS, which also rose sharply in the 90s» [2, 45–70]. So, it is important for Ukraine to curb the well regulated and socially conditioned causes of death associated with lifestyle, sanitary culture and personal hygiene.

The extreme age differentiation of excess mortality rate of the Ukrainian population as compared to the population of the European Union (EU–28) is shown by the indices of death probabilities at a certain age (Fig. 2). It is obvious that in all age groups of the Ukrainian population death probability is at least 1.7 times higher than that in European countries.

Meanwhile, Ukrainian men are distinguished by particularly high indices. The curves of indices of excess the mortality of Ukrainian population in the context of gender have almost the same trajectory. The fivefold excess of probability of death of the most active Ukrainian men in the working age of 35–40 also attracts attention, while the main causes of death are unnatural: traffic and job-related injuries, accidents, alcohol poisoning, suicide, murder. It is notable that among European men at this age the ranks of death causes slightly change, while the proportion of endogenous factors begins to increase [2, 3]. In particular, the intensity of deaths from chronic diseases of circulatory and digestive systems doubles. Thus, it is clear that it is the contingent

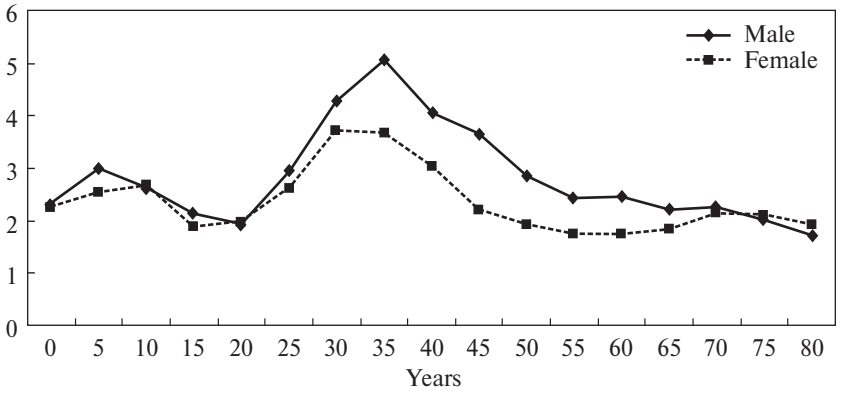

Fig.2. **Indices of death probabilities by gender of the Ukrainian and EU-28 population, 2011**

Source: data from the State Statistics Service of Ukraine and Eurostat Database. Population and social conditions.

of men aged 25–50 that comprises the main reserve for preservation of life and reduction of excess mortality due to external reasons that can be prevented by following a proper behavior, lifestyle and working conditions. Among women in Ukraine the age range of the triple excess of probability of death is somewhat narrower – 25–40 years, however, the structure of the causes of death is also different, dominated by malignant neoplasms, diseases of the digestive system and infectious diseases. Thus, the control of female mortality at a young age may be effective, provided that regular medical examinations are restored, and early diagnostics of cancer is widely implemented. This particularly applies to establishing an accessible and efficient rural medicine. Taking into consideration the fact that the fourth place in the structure of total mortality and even the third one among women is occupied by diseases of digestive system, the strategic focus should be placed on improvement of the quality of drinking water and food, as well as changes in the diet. According to a sample survey of health self-assessment by the population (2012), in the daily diet of Ukrainians fat exceeds the rational daily limit twice, while the diet lacks protein (30%) and carbohydrates (20%) [12, p.60].

It is equally important for the population of Ukraine to preserve lives of the youngest groups of its population. Notably, over the period 1991–2013s infant mortality has decreased by 43.2% or on average by 2.5 % annually up to the level of 7.9 ‰. Only in the last 10 years there have been positive changes in the structure of infant mortality under 1 year old, with 62 % of deaths being localized within the neo-natal period (under 28 days). Moreover, 70% of neo-natal deaths in Ukraine are registered at the very early stage of life (under 7 days), when the survival of a baby is predominantly affected by factors of perinatal development and birth defects and abnormalities. This is totally consistent with the modern European tendency for reduction in the number of post-neonatal deaths to 35–30%. The shift of mortality toward an early neo-natal period indicates the effectiveness of modern medical measures, due to establishment of a network of regional perinatal centers. Sustained positive changes in the nature of child and infant mortality have significantly improved life expectancy of the population in general.

The key parameters of population survival are the average life expectancy at birth and a lag in life expectancy of men and women at a particular age, as well as exact age and age-specific probability of surviving of the population. An analysis of distribution patterns and dynamics of the age-specific probability of surviving enables us to project of life expectancy at birth and identify the hypothetic population size and age-structure.

Over the period 1991–2012, life expectancy at birth, as well as mortality varied in a wave-like manner and fluctuated from a minimum of 66.9 years in 1996 to the highest level of 71.2 years in 2012. Reasons for these fluctuations were different. At the beginning of the period (1991–1996) the reduction in life expectancy was due to an increase in the already high rates of child and infant mortality, and also the intensive rise of mortality of middle-aged adults and early retirement age. Since 2006 there has been a steady increase in the life expectancy at birth among men that has reached the level of 1989 in 2012 (66.1 years), while it has constituted the highest historical record of 76 years for women. Over the last 16 years there have been positive changes in Ukraine in the lag of life expectancy between men and women that has decreased by almost two years. The present-day difference in the male and female life expectancy is 9.9 years to the benefit of women (2012) against maximum 11.8 years (1997). A comparison of the lag in life expectancy of Ukrainian and European population that comprises 5.8 years (2011) points out to the actual potential for improving the survival of the Ukrainian population as a whole and for each gender in particular. This is especially true of the life expectancy of young men aged 15 to 40 years, which is on average 10 years less than that of their peers in the EU-28 countries. The trend of the age-specific probability of surviving of the Ukrainian population over the period after censuses

(2002–2012) is characterized by a rapid growth of its rates among men over 40 years old and women over 55 (Fig.3). Meanwhile, the survival regime of children and youth (15–25 years old) over the last 10 years almost has not changed.

There are a few approaches of estimation the age-specific contribution to general increase of life expectancy [5, 6, 7]. A component vertical analysis by A. Stefanovsky [8, p. 78–90] has shown reformatting of the impact of individual age groups during 2002–2012. Thus, data of tabl.3 show, during 2002–2005 a slight decrease in the life expectancy at birth took place (–0.47 years for men, –0.16 years for women) mainly due to an increase in mortality rate at the age of 45–74.

The adverse change at that time was subtly offset by an improvement in the survival regime of the children and youth aged 15–29. Since 2005 and until now the average life expectancy has been growing due to all age groups. Over the last 10 years the two-thirds (+2.07 years) of the total increase in male life expectancy at birth (+3.4 years) were provided by groups of medium and pre-retirement age (45–59), as well as those of the retirement age of 60–74 years old.

Female life expectancy has increased to a lesser extent (+1.9 years), but 75% of the increase were provided by the oldest age groups. The contribution of middle and older reproductive age cohorts into the increase of life expectancy of women (30-44 years old) was twice less than among men. It is also necessary to take into account the existing differentiation between the life expectancy in urban and rural areas. In 2012 city residents had a chance to live 2 years longer than residents of villages, while the life expectancy of the latter has increased over the last 10 years only by 2.1 years vs +3.2 years of those in urban areas. Clearly, the modern urban medical and social infrastructure and access to it provide urban residents a better quality of life. The 66% of gain in life expectancy of urban residents were secured by middle and senior retirement age groups.

An analysis of trends in the survival characteristics of the Ukrainian population (until social-political and military conflict) of allows us to determine their projected levels for the short-time (by 2020) in general and by gender. To be more precise, there have been developed three options of possible changes in the nature of the survival. And this case we are don't took to account the recent social shocks. According to the first optimistic scenario, the age-specific probability of surviving of each gender will increase with a tendency for the most intense growth that has taken place over the last seven years, and, therefore, the life expectancy at birth will be extended, meanwhile, the lag in female and male life expectancy of

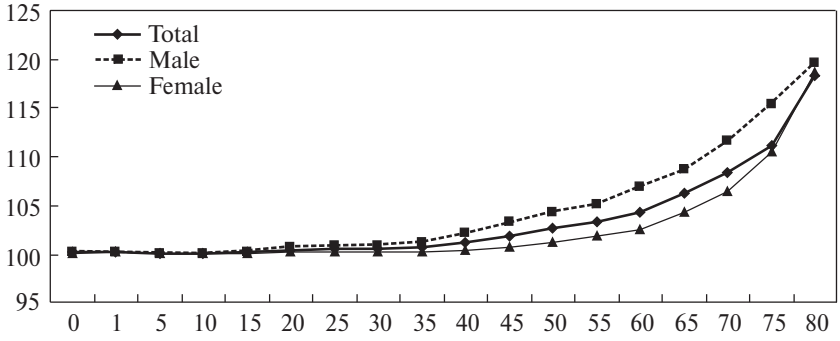

Fig. 3. **The dynamics of the age-specific probability of surviving of the Ukrainian population, 2002–2012**

Source: on data from the State Statistics Service of Ukraine.

Table 3. **The contribution of age cohorts into the increase of life expectancy by birth in Ukraine, 2002–2012 pp.**

Age groupe	2002–2005		2005–2011		2011–2012		2002–2012	
	Valume of change, years	Percent of contribution, %	Valume of change, years	Percent of contribution, %	Valume of change, years	Percent of contribution, %	Valume of change, years	Percent of contribution, %
	Male							
0–14	0.03	4.3	0.04	1.1	0.01	9.4	0.08	2.5
15–29	0.06	10.0	0.09	2.7	0.01	11.0	0.18	5.0
30–44	0.00	5.7	0.39	10.1	0.02	16.5	0.41	11.9
45–59	–0.2	28.6	1.09	29.1	0.03	19.7	0.92	27.0
60–74	–0.25	35.7	1.4	37.3	0.01	4.7	1.15	33.7
75 +	–0.11	15.7	0.74	19.7	0.05	38.6	0.68	20.0
Total	–0.47	100.0	3.75	100.0	0.13	100.0	3.41	100.0
	Female							
0–14	0.03	9.7	0.03	1.6	0.006	4.4	0.05	2.8
15–29	0.03	9.7	0.05	2.1	0.007	4.2	0.08	4.4
30–44	–0.01	6.5	0.12	6.3	0.005	3.5	0.11	6.0
45–59	–0.09	29.0	0.31	16.2	–0.001	1.2	0.22	11.6
60–74	–0.11	35.5	0.68	35.6	0.017	11.3	0.58	30.6
75 +	–0.01	9.7	0.74	38.2	0.112	75.5	0.84	44.6
Total	–0.16	100.0	1.91	100.0	0.144	100.0	1.89	100.0

Source: author's own calculations based on data from the State Statistics Service of Ukraine.

urban and rural areas will decrease. According to the second, more likely scenario (medium option), an increase in the age-specific probability of survival will be driven by the trend of the whole period under study (1991–2012), during which the mortality of children under 5 and young people (15–20 years old) decreased to a bigger extent, while the mortality of senior-aged people – to a lesser extent. Under these conditions, the life expectancy at birth will increase (to 67.2 years for male and 77.1 for female), but the lag in female and male life expectancy will return to the baseline of 2012 (9.9 years). The third, medium-pessimistic scenario was based on an assumption about a recurrence of the six-year-long wave of decline in the average life expectancy that took place in 2000–2005. In this case the average life expectancy for men will reduce more – up to 65.1 years, and less for women – up to 75.7 years. As a result, the gap between the life expectancy of men and women will increase again and will constitute 10.6 years.

Thus, if in the short run a favorable survival regime is preserved, in which mortality of young and middle-aged population (30–55 years), including mortality resulted from external factors and infectious and chronic diseases will be overcome, then the overall mortality rate will drop to 13.7 ‰, and infant mortality – to 6.2 ‰. The male life expectancy at birth will increase more intensively (4.7 years compared to 2012), and therefore the difference

in life expectancy between men and women will decrease to 7.6 years. A steady growth of age-specific probability of surviving among senior age groups (65–74 and, especially, 75–84 years old) can lead to a significant increase in the rate of aging up to 17% and, thereby, to a reduction in the portion of the reproductive contingent by 3.2 p.p. All these changes will help to slow down the further depopulation and reduce losses in the quantity of the population by 500 thousand people.

According to the second scenario, the life expectancy at birth will increase more slowly. The overall mortality rate (15 ‰) will be determined by the survival regime of the middle-aged population with retaining relatively high mortality rates among men aged 30–45. A further decline in infant mortality to 7 ‰ is also expected. Due to a higher positive impact of the survival of young cohorts, the decline in the proportion of people of childbearing age (15–49 years old) will slow down a bit.

The third scenario predicting a possible temporary deterioration in the survival regime warns about the possible decline in male life expectancy by 1 year as compared to 2012 year. The total mortality rate will significantly increase up to 15.9 ‰ with a slight increase in infant mortality. As a result, the process of aging may slow down, thus leading to an automatic increase in the proportion of the childbearing contingent.

Conclusions. The modern regime of replacement imposes certain restrictions on the parameters of population recovery. Unstable fluctuating trends in the survival regime indices of the Ukrainian population over the period of its sovereignty largely reflect the instability of social and economic development of the country. Periods of overcoming the crisis, improvements of the material conditions of the population, development of the social infrastructure and its accessibility altogether foster mortality reduction and increase longevity of the population. Survival regime indices of the representatives of less socially protected groups, like children and senior cohorts are usually the first to react to the positive changes. However, the encouraging trends of the decade (before second part of 2013) give reasons to expect further improvements in the survival regime of the population of both genders and types of settlement. The gradual convergence of survival curves of men and women in Ukraine of young and senior age, the fact that they are approaching the European average, as well as reduction of the excess mortality of middle-aged men contribute to the overall prolongation of life expectancy and slowing down of depopulation. Research results can be taken into account in further investigations at the evaluation of losses of the Ukrainian population through political and military conflict.

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