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On dynamic urban male population mortality in the Republic of Belarus at the turn of the 20th and the 21st centuries

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Purpose – to evaluate the impact of the changes in the age structure on mortality rates and to analyze mortality trends among urban male population in the Republic of Belarus during 1959–2015.

Materials and methods. The data on the natural urban population movement during 1959–2015 have been analyzed. Crude and standardized mortality rates have been calculated using the direct standardization according to the world standard (Standard "World"). JoinPoint software was used to study time trends.

Results. The urban male mortality growth continued during 43 years (1959–2002). The implementation of a set of measures of state programs ensured social control over the urban male population mortality. The rate of annual mortality decrease exceeded the annual increase rate during the period of death rate growth more than 2 fold.

Conclusions. The changes in the urban male population age structure affected the crude mortality rates. Throughout the study period, the urban male population mortality grew 1.5 fold. Crude rates increased by 2.4 times. Since 2002, the trend towards a decline in the urban male population mortality has emerged and has been kept till 2015.

Key words: mortality, urban population mortality, male mortality, mortality trends.

Introduction

Since the 1970s – 1980s, in the BSSR, a new type of population reproduction has emerged and resulted in the onset of the depopulation, which threatened the demographic security of the country. For the first time in the republic, the death rate exceeded the birth rate in 1993. The demographic situation was characterized by a gradual decline in the birth rate, a decreased size of children and persons of working age in the structure of the population and, as a consequence, the aging of the population. An increased share of people over 60 years with a substantially higher mortality led to the growing crude mortality rates calculated per 1000 of average annual population. A decline in the birth rate and an increase in the mortality changing the age structure and leading to the aging of the population reflect the features of demographic development in Russia, Belarus and Ukraine in the post-Soviet period.

In 1913, in the territory of modern Belarus, the overall mortality rate was 25.5‰. In 1922, in the BSSR, the mortality fell by 43%, and in 1927, by another 14.7%. The lowest overall mortality rate of 6.6‰ was observed in the 1960s, then the death rate began to grow [4]. Socio-economic crisis resulted in transformed demographic trends. For a short period from 1990 to 1999, the overall mortality rate grew from 10.7‰ to 14.2‰. High death rate in 1990–1996 testified to an unfavorable demographic situation in Belarus. During this period, the mortality growth made 22.4%. The greatest increase in mortality in 1993 coincided with the onset of the depopulation. The death rate among the population of Belarus continuously increased up to 2005.

Male overmortality is currently considered to be a demographic phenomenon, which began in the 1980s. The

essence of this phenomenon is the excessive mortality among men compared to that among women in most age groups [7]. The overmortality of men aged 20–50 years versus that of women is one of the essential features of the mortality among the population of the Republic of Belarus in the second half of the 20th and the beginning of the 21st century. In some years, the male death rate exceeded female by 3–5 times that resulted in a significant difference in life expectancy over the past decades [2, 5]. Since the 1960s, an intensive increase in mortality, male overmortality as an excess male mortality versus female (gender aspect), rural overmortality as an excess rural mortality versus urban (territory aspect) determined the study of mortality among subpopulations to be an actual direction of the research.

Mortality is the most objective medico-social indicator reflecting the public health status [6]. Death rate along with birth rate determines the continuous reproduction of the population and the succession of generations. The overall mortality rate does not fully characterize the mortality as a phenomenon, since this indicator is affected by the changes in the population age structure. The predominance of older age groups in the population structure causes a decrease in birth rate and an increase in death rate [9, 16]. The change in the age structure influences not only the growth of mortality rates but also increased differences in mortality between urban and rural population. In the rural population structure, the number of elderly and senile people grows more rapidly as compared to urban. The intensive drain of the young working population to the cities has led to the situation that in rural areas the predominant population are elderly and senile people. An increase in urban and rural mortality began in the 1960s, and the rural population death rate is currently higher than that of the urban population [3]. When evaluating the crude rates, it

has been established that for 45 years (1969–2005) the urban mortality index grew 2 fold [8].

The analysis of dynamic mortality based on the study of standardized rates allows eliminating (excluding) the impact of the age structure of different subpopulations on mortality rates. Most of the dynamic mortality studies among different subpopulations of the Belarusian population and their comparison estimated crude mortality rates, and only in a small number of national studies, the dynamics of standardized mortality rates among urban and rural population was evaluated. Within 1960–2013, an increased mortality rate was related, to a certain extent, to the growth of number of people over 60 years in the structure of the urban population (17.2% by 2013) [10]. According to some authors, an established excess of standardized mortality rates over the crude ones during 1982–2007 determines an increased proportion of deaths in young ages [1]. The change in the age structure influenced the crude death rates among the urban population of the republic. Within 1959–2015, the growth of crude mortality rates was 1.6 times higher than that of standardizes rates. The annual mortality decrease rate (2002–2015) exceeded 3 fold the annual mortality increase rate. Standardized mortality value observed in 1964 was registered by 2015 [18]. The Board of the Ministry of Health of the Republic of Belarus noted that in order to stabilize the main medical and demographic indicators in 2017, a set of measures including an analysis of the demographic situation is required [12]. Targeted planning of actions aimed at improving the health of the population should be based on a constant study of morbidity, dynamic mortality and its causes. Due to the fact that the reduced mortality and increased life expectancy are in the sphere of demographic interests of the state and society, the study of mortality is an actual direction of medical and demographic research.

Purpose – to evaluate the impact of the changes in the age structure on mortality rates and to analyze mortality trends among urban male population in the Republic of Belarus during 1959–2015.

Materials and methods

The data on the natural urban population movement during 1959–2015 have been used. State statistical reporting forms and official data on calculating the primary data from statistical agencies were used as sources of information.

A part of statistical data was obtained from the national State Archives of the Republic of Belarus. Specific (further crude) and standardized mortality rates among urban male population have been calculated using the direct standardization according to the world standard (Standard “World”) approved by WHO [19] JoinPoint software [Joinpoint Regression Program, Version 4.3.1.0 – April 2016; Statistical Methodology and Applications Branch, Surveillance Research Program, National Cancer Institute] was used to study time trends as well as MS EXCEL 2010.

Results and discussion

The process of urbanization, which began in the early 20th century on the territory of modern Belarus, was accompanied by the concentration of the population in urban areas. However, the BSSR still remained predominantly an agrarian republic because in 1924 rural residents accounted for 83.74%, in 1927 – 82.37%, in 1933 – 82.28% in the structure of the population. Despite an increased total size of the urban population, its share in the population structure began to grow only in the 1930s [4]. In 1940, the proportion of urban residents was 21.7%. The process of urbanization in the BSSR actively continued in the second half of the 20th century. The rural population of working age became a source for the urban population growth. By 1974, the population of the BSSR was urbanized, since the number of urban residents was practically similar to that of rural [17]. In the second half of the 20th century, not only the population size but urban-to-rural male ratio changed due to internal migration.

Throughout this period, urban male mortality undergoes some changes. In 1965, the lowest value of crude 5.50‰ and standardized 9.11‰ urban male mortality was observed. Extreme maximum values of crude 13.04‰ and standardized 13.74‰ rates were seen in 2010 and 1999, respectively. Minimum and maximum standardized rates exceeded the crude mortality rates among urban males by 1.2 and 1.1 times, respectively. The range of extreme minimum and maximum standardized mortality values made 4.63‰ and was 1.6 fold lower than that of crude rates 7.54‰. The period of the range of extreme standardized mortality values made 34 years (1965–1999) and was 11 years shorter compared to that of the crude mortality rates range among urban males (1965–2010) (table 1).

Table 1
Crude and standardized mortality rates (WHO, 2000)
among urban male population in the Republic of Belarus during 1959–2015 (‰)

| Year | Crude mortality rate | Standardized mortality rate | Year | Crude mortality rate | Standardized mortality rate |
|------|----------------------|-----------------------------|------|----------------------|-----------------------------|
| 1959 | 6.98 | 10.72 | 1995 | 11.25 | 13.62 |
| 1960 | 5.91 | 9.18 | 1999 | 12.46 | 13.74 |
| 1961 | 5.73 | 9.16 | 2000 | 11.76 | 12.88 |
| 1962 | 5.97 | 9.74 | 2001 | 12.24 | 13.01 |
| 1963 | 5.92 | 9.48 | 2002 | 13.00 | 13.55 |
| 1964 | 5.61 | 9.13 | 2003 | 12.76 | 13.16 |
| 1965 | 5.50 | 9.11 | 2004 | 12.48 | 12.70 |

Continuation of Table 1

| | | | | | |
|------|------|-------|------|--------------|-------|
| 1966 | 5.51 | 9.25 | 2005 | 12.84 | 12.90 |
| 1967 | 5.65 | 9.59 | 2006 | 12.67 | 12.52 |
| 1968 | 5.71 | 9.53 | 2007 | 12.25 | 11.89 |
| 1969 | 6.09 | 10.43 | 2008 | 12.41 | 11.84 |
| 1970 | 5.84 | 9.8 | 2009 | 12.74 | 11.75 |
| 1975 | 6.39 | 10.27 | 2010 | 13.04 | 11.86 |
| 1979 | 7.23 | 11.11 | 2011 | 13.03 | 11.68 |
| 1980 | 7.11 | 11.01 | 2012 | 12.02 | 10.78 |
| 1985 | 7.51 | 11.13 | 2013 | 11.71 | 10.46 |
| 1989 | 7.80 | 10.83 | 2014 | 11.48 | 10.24 |
| 1990 | 8.10 | 11.12 | 2015 | 11.12 | 9.88 |

Up to 2005, standardized values exceeded crude mortality values, and only since 2006, crude rates began to exceed the standardized. From 1965 (5.15‰) to 2010 (11.10‰), urban male population mortality calculated on the basis of crude rates grew by 2.4 times. From 1965 (9.11‰) to

1999 (13.74‰), mortality calculated on the basis of standardized rates increased by 1.5 times, being 1.6 fold lower. In 2015, crude urban male mortality rate of 11.12‰ was similar to that of 1995, and standardized rate of 9.88‰ to that of 1970 (table 1, figure 1).

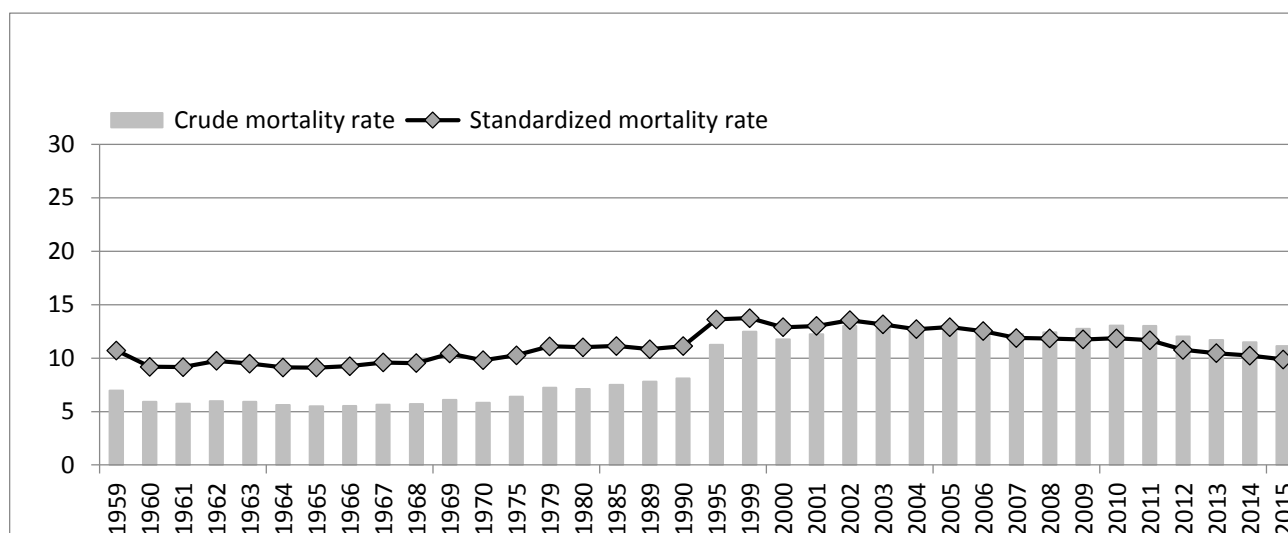


Figure 1. Dynamic crude and standardized mortality rates among urban male population in the Republic of Belarus during 1959–2015

Due to the revealed differences in time ranges, values and ratios of the minimum and maximum mortality rates, the research of time trends of standardized mortality rates among urban male population of the Republic of Belarus during 1959–2015 has been conducted using JoinPoint software for

the analysis of population time trends. Segmented-linear regressive models were used to evaluate the rates of an increase/decrease in mortality among this subpopulation throughout the study period. The results of the study are presented in table 2 and figure 2.

Table 2
Mortality trends among urban male population in the Republic of Belarus during 1959–2015 (%)

| Mortality trend/ beginning | Mortality trend/end | Increase/decrease rate (%) | 95%CI | Statistical significance (P) |
|----------------------------|---------------------|----------------------------|----------|------------------------------|
| 1959 | 2002 | 0.9 | 0.8;1.1 | ≤0,05 |
| 2002 | 2015 | -2.1 | -2.6;1.6 | ≤0,05 |

From 1959 to 2002, the male urban mortality growth was observed ($P \leq 0.05$) with an annual increase rate of 0.9(95%CI 0.8;1.1)%. The peak in the urban male mortality

was registered in 2002, after that a decline in the mortality ($P \leq 0.05$) with an annual decrease rate of -2.1(95%CI -2.6; -1.6)% was observed up to 2015.

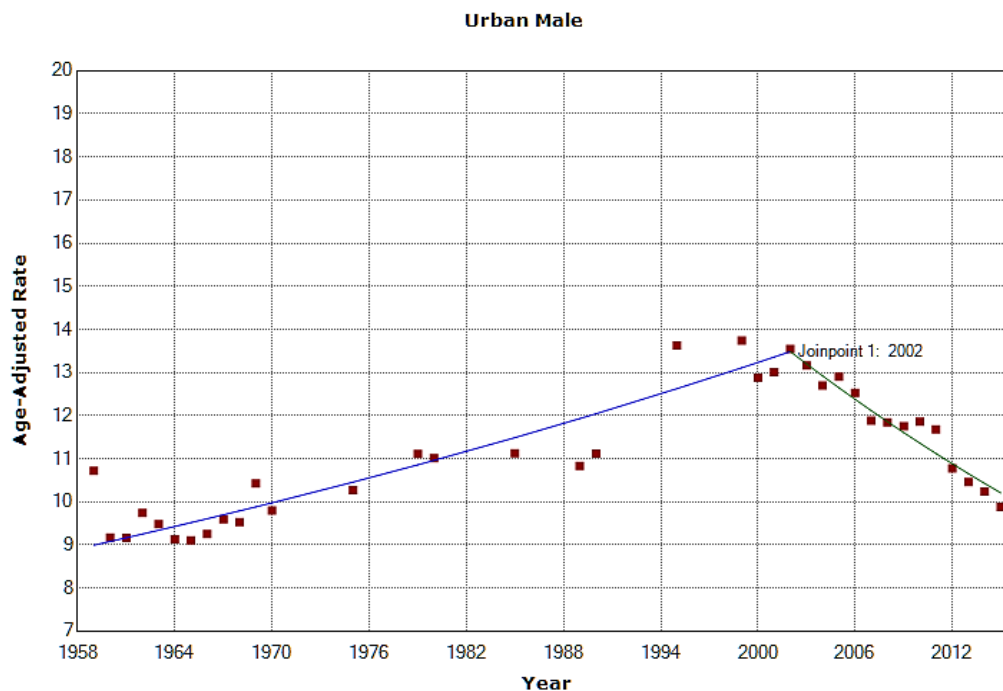


Figure 2. Mortality trends among urban male population in the Republic of Belarus during 1959–2015

The period of the urban male mortality growth continued 43 years (1959–2002). In 2002, the trend in the urban male mortality changed its direction towards a decrease. In 2002–2015, the rate of the annual urban male mortality decrease was -2.1 (95%CI -2.6;-1.6)% and exceeded 2.3 fold the annual rate of mortality increase of 0.9(95%CI 0.8;1.1)% in 1959–2002.

A rapid growth of the rural male mortality compared to urban was related to the changes in the age structure of the population due to an increased share of the elderly, especially in the rural area. The age structure of urban males influenced crude mortality rate values. From 1959 to 2004, the values of standardized mortality rates exceeded those of crude rates testifying to a more pronounced mortality among the urban male population observed in this period. The urban male age structure shifted in favor of young men of working age, who constantly moved to cities and thus leveled the mortality intensity among this subpopulation for a long time. A high birth rate in the 1960s–1970s also resulted in a slow accumulation of the elderly and senile people in the urban male structure. In 2005, the urban male population age structure corresponded to that of a standard age structure (WHO, 2000), so that both standardized and crude mortality rates had similar values. Crude rates have begun to exceed standardized only since 2006, when there have been observed the changes in the age structure towards the accumulation of elderly people in the population. Subsequently, the difference in the values of standardized and crude mortality rates was small amounting to 1.24% in 2015.

Due to the negative demographic trends testifying to a crisis of social, biological, economic and medical bases of the nation evolution, the Law of the Republic of Belarus “On Demographic Security” was adopted in 2002, with the National Program of Demographic Security being its main form of implementation [11]. Since 2007, two National Programs of Demographic Security of the Republic of Belarus for 2007–2010 and for 2011–2015 were consecutively adopted and implemented in the country [14, 15]. Since 2016, the State Program “People’s Health and Demographic Security of the Republic of Belarus” for 2016–2020 has been implemented [13]. During the past decade, as a result of a complete set of state actions within state programs, the rate of the annual urban male population decrease exceeded 2.3 fold the annual rate of an increase seen during the period of the mortality growth.

Demographic regulation takes place in the conditions and with due account of the actively changing external environment affected not only by natural, but also social crises. The environment is influenced by the activities of society, occurrence and impact of a large number of factors, which are difficult to be predicted and evaluated in real-time conditions. Strategic and tactical decisions on demographic regulation are taken in a highly uncertain environment. The impact on the society demographic behavior has a delayed, prolonged effect, which can change over time due to the ongoing events. The results of studying mortality and its dynamics throughout a long period of time can be used for evaluating the efficiency of programs that ensure the

demographic security of the county and for developing a set of measures aimed at protecting public health.

The dynamic study of standardized mortality rates allowed making the following **conclusions**:

– Negative medico-social trends among urban male population of the Republic of Belarus began to grow since the 1960s. Urban male population mortality growth continued for 43 years (1959–2002).

– The change in the age structure among urban men affected and still affects crude mortality rates values. Throughout the study, the urban male population mortality

grew 1.5 fold, being lower as compared to the mortality increase estimated on the basis of crude rates (2.4 fold).

– Since 2002, the trend towards a decline in the urban male population mortality has emerged and has been kept till 2015. In 2015, standardized mortality rate among urban men was similar to that of 1970, and crude to that of 1995.

– The implementation of a set of measures of state programs ensured social control over the urban male population mortality. The rate of annual mortality decrease exceeded the annual increase rate during the period of death rate growth more than 2 fold.

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Про динаміку смертності чоловічого міського населення Республіки Білорусь на рубежі ХХ–ХХІ століть

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Мета – оцінити вплив змін вікової структури на формування показників смертності та провести аналіз трендів смертності міських чоловіків Республіки Білорусь у 1959–2015 роки.

Матеріали та методи. Використані дані природного руху міського населення за 1959–2015 роки. Проведено розрахунок грубих і стандартизованих показників смертності методом прямої стандартизації за світовим стандартом (Standard “World”). Аналіз часових трендів проведено з використанням програмного забезпечення JoinPoint.

Результати. Зростання рівня смертності міських чоловіків продовжувалося протягом 43 років (1959–2002). Реалізація комплексу заходів державних програм забезпечили соціальний контроль над смертністю чоловіків, які проживають у містах. Темпи щорічного убутку смертності більш ніж удвічі перевищили щорічний темп приросту в період зростання рівня смертності.

Висновки. Зміни вікової структури міських чоловіків впливали на грубі показники смертності. Смертність міських чоловіків протягом періоду дослідження зросла в 1,5 разу. Підвищення грубих показників становило 2,4 разу. З 2002 р. сформувалася та набула сталого характеру тенденція зниження смертності чоловічого міського населення, яка зберігалася до 2015 року.

Ключові слова: смертність, смертність міського населення, смертність чоловіків, тренди смертності.

О динамике смертности мужского городского населения Республики Беларусь на рубеже ХХ–ХХІ столетий

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Цель – оценить влияние изменения возрастной структуры на формирование показателей смертности и провести анализ трендов смертности городских мужчин Республики Беларусь в 1959–2015 годы.

Материалы и методы. Использованы данные естественного движения городского населения за 1959–2015 годы. Проведен расчет грубых и стандартизованных показателей смертности методом прямой стандартизации по мировому стандарту (Standard “World”). Анализ временных трендов проведен с использованием программного обеспечения JoinPoint.

Результаты. Рост смертности городских мужчин продолжался в течение 43 лет (1959–2002). Реализация комплекса мероприятий государственных программ обеспечили социальный контроль над смертностью мужчин, проживающих в городах. Темпы ежегодной убыли смертности более чем в 2 раза превысили ежегодный темп прироста в период роста смертности.

Выводы. Изменение возрастной структуры городских мужчин оказывало влияние на грубые показатели смертности. Смертность городских мужчин в течение периода исследования выросла в 1,5 раза. Рост грубых показателей составил 2,4 раза. С 2002 г. сформировалась и приобрела устойчивый характер тенденция снижения смертности мужского городского населения, которая сохранялась до 2015 года.

Ключевые слова: смертность, смертность городского населения, смертность мужчин, тренды смертности.

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