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RESEARCH ARTICLE

Avoidable mortality from circulatory system diseases in Moldova

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Abstract

Mortality from avoidable circulatory system diseases causes one of the major losses in life expectancy, especially in males and population of working ages. The main contributors are the deaths caused by ischaemic heart diseases, cerebrovascular diseases, and hypertensive diseases. This article analyses the trends in avoidable mortality caused by diseases of the circulatory system and estimates the possible increases in life expectancy due to the elimination of these causes of death. In this regard, the author uses methods of standardization, mortality decomposition and cause-elimination model. The study shows a decline in avoidable mortality from circulatory system diseases during the analyzed period, especially for earlier ages. At the same time, there is a significant differentiation in mortality dynamics depending on sex. In 2016–2018, avoiding these deaths could assure an increase in life expectancy by 3.8 years in males and 2.8 years in females. This possible increase in life expectancy could be partially achieved by improving the quality of the health care system and introducing policies and programs aimed at improving the health of the population. Moreover, programs aimed at preventing diseases of the circulatory system might influence on mortality diminution from other non-communicable diseases and external causes of death.

Keywords

avoidable causes of death, life expectancy, circulatory system diseases, mortality in Moldova

JEL codes: J10, I10

Introduction

Since the mid 1960s, a significant increase in life expectancy was observed in western Europe and other high-income countries, which was possible as a result of a decrease in mortality from non-communicable diseases (especially in cardiovascular diseases) and external causes

of death (Vallin and Meslé 2004; Meslé and Vallin 2002; Leon 2011). In Moldova, despite some improvements, life expectancy displayed long-term stagnation (Gagauz et al. 2016). In this regard, the life expectancy trends are similar to those observed in Eastern Europe, particularly in post-soviet countries (see **Fig. 1 and 2** below). Thus, in Moldova, the greatest contribution to overall mortality is made by deaths caused by circulatory system diseases, cancer, external causes of death, and respiratory system diseases (Penina 2014a; Gagauz et al. 2016), most of which are considered preventable and treatable (Stirba 2020; Stirba and Pahomii 2019). The observed increase in life expectancy over the last decade was mainly achieved due to a decrease in mortality from avoidable causes of death (Stirba and Pahomii 2019).

This article describes trends of the avoidable mortality from circulatory system diseases in Moldova for the years 2007–2018, considering gender and age group variations. Additionally, it is assumed that diminution in avoidable mortality from circulatory system diseases, in analysed years, could contribute to a significant increase in life expectancy. Thus, in order to identify the prospective resources for an increase in life expectancy, the author applies a model of cause-elimination. The avoidable deaths from circulatory system diseases represent deaths that can be mainly avoided through timely and effective public health and health care interventions, and correspond to the joint OECD and Eurostat lists of preventable and treatable causes of death (OECD/Eurostat 2019).

Background and motivation for the study

In the last two decades, life expectancy in Moldova demonstrated a modest growth of 3.0 and 3.9 years in males and females, reaching 66.8 and 75.1 years, respectively, by 2019 (**Fig. 1 and 2**). A gradual increase in the life expectancy in males and females began in 2011. Life expectancy in Moldova shows the dynamics similar to the former Soviet countries (mostly for males) and differs from that of Romania (a country from the region) and developed countries. The lag in the growth of life expectancy is mainly due to the high mortality from circulatory diseases, as well as cancer, external causes of death, and diseases of the respiratory system.

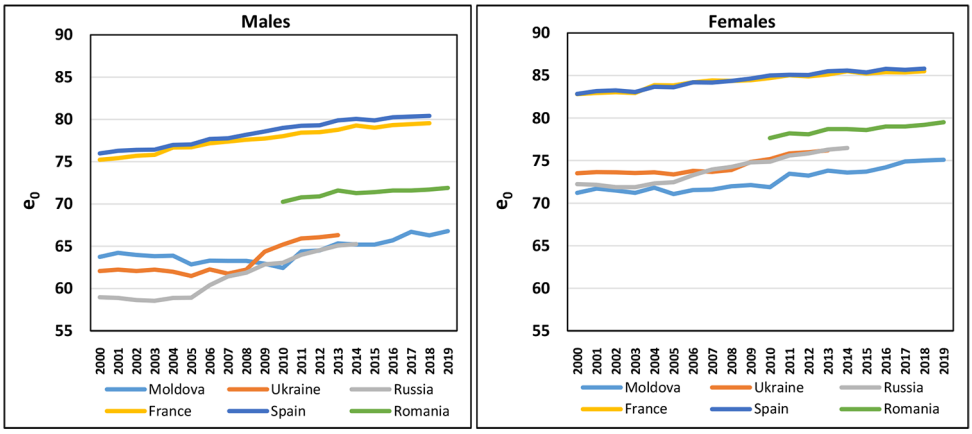

Fig. 1–2. Life expectancy dynamics in France, Spain, Ukraine, Russia, and Moldova, males and females, 2000–2019. *Source*: For France, Spain, Ukraine, and Russia (The Human Mortality Database), for Romania (Eurostat database; National Institute of Statistics 2020), for Moldova (Penina, Jdanov and Grigoriev 2015; NBS Database).

Previous studies on Moldova show a visible contribution of the avoidable mortality decline to the life expectancy changes (Striba and Pahomii 2019; Striba 2020). Herewith, the avoidable deaths are mostly associated with the diseases of the circulatory system. Thus, the observed increase in life expectancy might be associated with the implementation of policies aimed at reducing mortality from cardiovascular diseases (Order of the Government No. 300 2014; Parlamentul hotărîre Nr. 82 2012), tobacco and alcohol control programs (Order of the Government № 100 2012; Order of the Government № 360 2019), and a significant increase in the number of provided surgeries under the interventional cardiology program (National Health Insurance Company 2018; National Health Insurance Company 2019). This article analyses trends in avoidable mortality from circulatory system diseases and highlights resources for increasing life expectancy as a result of eliminating these causes of death.

Literature overview

The concept of avoidable mortality used in the article was formulated in the 1970s and evolved over the years in the context of medical capacities development (Rutstein et al. 1976; Nolte and McKee 2011; ONS 2011; OECD/Eurostat 2019).

The specifics of the mortality dynamics in post-Soviet countries are described in a large number of studies, most of which highlight mortality from diseases of the circulatory system as the main contributor in slowing the growth of life expectancy (Grigoriev et al. 2010; Penina 2014b; Vallin and Meslé 2004; Meslé and Vallin 2002). Generally, Moldova demonstrates similarities in the structure of mortality and the dynamics of life expectancy with the post-Soviet region.

In Moldova, mortality from cardiovascular diseases has been widely studied since its contribution to overall mortality is significant (Vallin and Meslé 2004; Penina and Raevschi 2020) and creates a substantial difference in the dynamics of life expectancy between Moldova and developed countries (Vågerö 2010; Mackenbach 2013). Even though some improvements in the population's health have occurred over the last years, diseases of the circulatory system continue to make a visible contribution to overall mortality (Murphy et al. 2018). This situation could be changed through a series of actions, namely, improvement of medical equipment and healthcare services, introduction of targeted preventive programs, performing cardiosurgery operations, individual's lifestyle adjustments, etc. (Burcin 2009). Some studies focus on behavioural factors, such as alcohol (Trias-Llimós and Janssen 2018; Penina 2017) and tobacco consumption (Erhardt 2009; Laatikainen et al. 2020), that affect the health of the population, especially influencing the incidence of the circulatory system diseases.

Data and method

In the present research, avoidable deaths from circulatory system diseases are distributed across the following causes: ischaemic heart diseases (I20–I25), cerebrovascular diseases (I60–I69), hypertensive diseases (I10–I13, I15), and other circulatory system diseases (rheumatic and other heart diseases, venous thromboembolism, aortic aneurysm, and other atherosclerosis; I00–09, I26, I70, I71, I73.9, I80), and correspond to the OECD/Eurostat lists

of preventable and treatable causes of death (OECD/Eurostat 2019). The data on age- and cause-specific mortality distribution were obtained from the World Health Organisation mortality database (WHO Mortality Database).

Due to distorted population statistics and high migration rate, in this article, the author uses two data sources on population exposure, both of which cover resident population (residents are those who stayed within the country for at least 9 months in a calendar year). For 2007–2013, the author uses alternative estimates (Penina, Jdanov and Grigoriev 2015; The Human Cause-of-Death Database), while for the period of 2014–2018 data on population were retrieved from the National Bureau of Statistics database (NBS Database).

The used cause-elimination model assumes exclusion of all preventable and treatable deaths from circulatory system diseases according to the OECD/Eurostat list of avoidable mortality, without any change in the denominator (since each death contributed by an average of 0.5 person-years to the population exposure, and the avoided death does not exclude the probability of dying during the corresponding period).

The author performs life expectancy decomposition using Andreev's method (Andreev 1982; Andreev, Shkolnikov and Begun 2002) and compares *de facto* e_0 and e_0^{-i}, where avoidable causes of death by circulatory system diseases are excluded. The calculation bases on the abridged life table with a five-year age-group interval; the last interval is open-ended and embraces the group of population aged 85 and older. Direct mortality standardization is conducted using the New European Standard Population with the similar open-ended age interval. Due to the lack of data, the region on the left bank of the Nistru River and Bender municipality are not included in the presented research.

Results and discussion

During the first years included in the analysis (2007–2010), overall mortality showed a slight increase and stagnation, after which, mortality from all causes of death gradually decreased in both sexes, thereby having a direct impact on the dynamics of life expectancy. Diseases of the circulatory system make the largest contribution to overall mortality, a significant part of which can be avoided through their prevention and treatment. Besides, a significant difference in the level and structure of mortality is observed in males and females.

Figures 3 and 4 show the standardized death rate (SDR) for the major causes of death for males and females. Over the observed period, SDR in males hit its maximum in 2010 (30.4 deaths per 1000) then decreasing to 25.8 deaths per 1000 by 2017. In females, SDR decreased from 19.9 deaths per 1000 in 2007 to 17.1 deaths per 1000 in 2018. The proportion of circulatory system diseases in SDR differ greatly between males and females due to the higher mortality rate in males from neoplasms, external causes of death, digestive system diseases, and other causes of death.

Besides the changes in overall mortality, which were more pronounced during the last years of the observation, we can clearly see a decrease in the SDR for avoidable deaths from circulatory system diseases in both sexes, from 6.6 deaths per 1000 (2010) to 4.9 deaths per 1000 (2018) in males, and from 3.9 deaths per 1000 (2007) to 2.5 deaths per 1000 (2018) in females. The prospective decrease in avoidable mortality from diseases of the circulatory system in the coming years might be expected due to the constant increase in the number of surgeries provided under interventional cardiology program (National Health Insurance Company 2019).

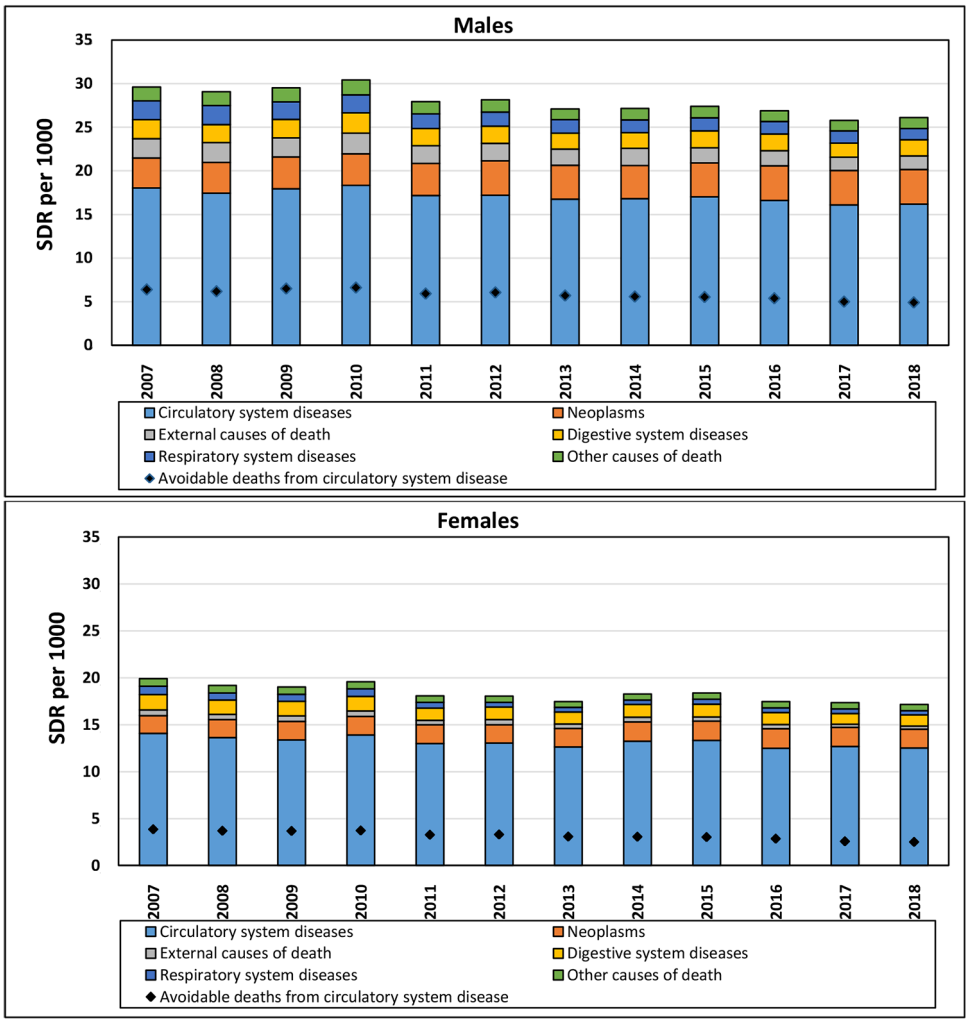

Fig. 3–4. Standardized death rate in Moldova per 1000, for males and females, 2007–2018. *Source:* Author's calculations based on the data from (WHO Mortality Database; NBS Database; Penina, Jdanov and Grigoriev 2015)

Deaths from ischemic heart disease make the largest contribution to preventable and treatable mortality from diseases of the circulatory system. The distribution of the expected number of avoidable deaths from ischaemic heart disease (d_x^i) is significantly differentiated by sex in the population aged from 35 to 65, where males have greater losses (Table 1). In males, the d_x^i distribution demonstrates a noticeable increase starting from the age of 40, registering 0.8 thousand deaths within the ages 45–49, and 1.2 thousand, 1.8 thousand, 2.7 thousand, 3.3 thousand, and 4.5 thousand in the age groups of 50–54, 55–59, 60–64, 65–69 and 70–74 years old, respectively. In females, the distribution of the expected number of death from ischaemic heart disease shows an increase in the ages 55–59 with 0.7 thousand deaths, and about 1.5 thousand in the age group of 60–64 years old, 2.6 thousand among aged 65–69, and 5.0 among aged 70–75, respectively.

The distribution of d_x^i from cerebrovascular diseases shows a more significant increase, in both sexes, starting from the age of 50, and reaching the peak at the age of 70–74 with 2.3 thousand deaths in males, and 2.5 thousand deaths in females. The numerical difference in cumulative d_x^i from cerebrovascular diseases between males and females is about 1.1 thousand deaths (7.0 thousand for males and 5.9 thousand for females). The largest gender gap in the expected number of deaths from cerebrovascular diseases is registered between the ages of 40 and 60 years old.

Avoidable deaths from hypertensive diseases in males and females make almost equal contribution to overall mortality, demonstrating the most pronounced differences in the population aged 70–74 years old. The age distribution of the expected number of deaths in hypothetical cohorts indicates a d_x^i growth from the age of 55 years and cumulatively reaches 1.4 thousand in males and 1.6 thousand in females by the age of 70–74 years old.

The expected deaths from atherosclerosis, aortic aneurysm, venous thromboembolism, rheumatic, and other heart diseases contribute to avoidable mortality from diseases of the circulatory system much less than the main causes. Age distribution of their contribution is characterised by significant gender differences, and greater losses of d_x^i in hypothetical cohorts are observed in males. The main contribution of d_x^i by other avoidable circulatory system diseases falls on the age groups of 30–74 years, amounting to 1.1 thousand expected deaths (0.6 thousand in males and 0.5 thousand in females).

Thereby, overall deaths from circulatory system diseases that could be prevented or treated constitute losses in hypothetical cohorts of about 24.2% in males and 18.6% in females.

Table 1. Expected number of deaths dx^i by major causes of avoidable deaths from circulatory system diseases per 100 thousand birth cohort, by age and sex, 2014–2016

Age	Males							Females						
	Aortic aneurysm	Hypertensive diseases	Ischaemic heart diseases	Cerebrovascular diseases	Other atherosclerosis	Rheumatic and other heart disease	Venous thromboembolism	Aortic aneurysm	Hypertensive diseases	Ischaemic heart diseases	Cerebrovascular diseases	Other atherosclerosis	Rheumatic and other heart disease	Venous thromboembolism
0–14	0	0	0	6	0	0	2	0	0	0	0	0	0	0
15–29	3	1	73	28	0	1	3	1	0	21	18	0	0	3
30–34	0	1	105	44	0	1	3	0	1	24	13	0	0	0
35–39	10	5	234	63	0	5	8	0	0	65	29	0	2	2
40–44	10	7	452	167	3	7	13	2	0	110	52	0	9	7
45–49	7	28	795	296	2	7	23	2	9	192	130	0	11	11
50–54	19	33	1151	497	11	15	24	0	13	416	247	0	20	19
55–59	18	68	1803	729	18	21	42	9	92	745	555	4	20	30
60–64	30	210	2717	1229	36	23	43	8	229	1524	831	13	23	29
65–69	33	386	3312	1669	42	19	42	25	394	2593	1522	13	53	31
70–74	17	619	4540	2247	71	10	21	24	825	4973	2499	34	32	55

Source: Author's calculations based on (NBS Database; WHO Mortality Database)

Diseases of the circulatory system lead to significant losses in life expectancy. Lack of their treatment and prevention annually reduces life expectancy by 3.8–4.2 years for males and 2.6–3.7 for females, respectively (**Fig. 5 and 6**). Despite the apparent decrease in mortality from avoidable deaths of circulatory system diseases, there are tangible gender differences in mortality trends. In males, life expectancy loses due to avoidable deaths from circulatory system diseases demonstrated almost no change over 2007–2013, and then slightly declined to 3.8 years loss in life expectancy by 2018. In females, a constant decrease in life expectancy losses was observed during the analysed period, and it was most pronounced in 2016–2018.

The main resources for a potential increase in life expectancy are related to avoidable deaths from ischaemic heart diseases, cerebrovascular diseases, hypertensive diseases, and at a lesser degree from deaths caused by other circulatory system diseases, such as rheumatic and other heart diseases, venous thromboembolism, aortic aneurysm, and other atherosclerosis. Even though the life expectancy losses due to avoidable deaths from circulatory system diseases decreased in both sexes, mortality by main causes of death evolved differently in males and females. Mortality from ischaemic heart disease has reduced the life expectancy in males by 2.5–2.7 years in 2007–2018, where a slight decrease was recorded within the last observed years. In females, mortality reduction from ischaemic heart diseases contributed to the increase of life expectancy by 0.5 years in 2007–2018. Due to the decrease in mortality from cerebrovascular diseases, life expectancy increased by 0.3 years for males and by 0.6 years for females, thus, the loss of life expectancy decreased from 1.3 years to 1.0 years, and from 1.4 years to 0.8 years for males and females, respectively. While the cumulative loss in life expectancy caused by deaths from diseases of the circulatory system is declining in both sexes, the contribution of hypertensive diseases is growing — from 0.1 years in 2007 to 0.2 years in 2018 for males and females.

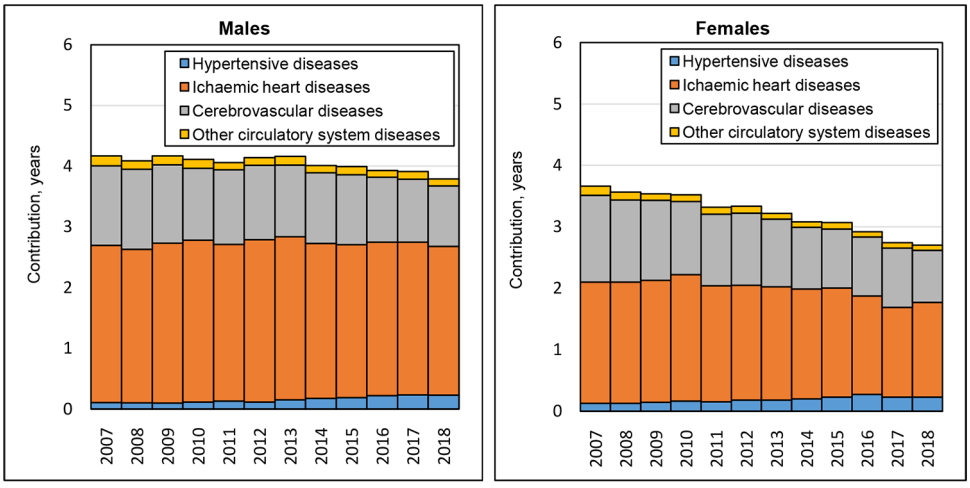

Fig. 5–6. Estimation of the possible increase in life expectancy by excluding avoidable deaths caused by diseases of the circulatory system, by sex and cause of death, 2007–2018. *Source:* Author's calculations based on the data from (WHO Mortality Database; NBS Database; Penina, Jdanov and Grigoriev 2015)

Figures 7–10 present potential resources for increasing life expectancy by age, when avoidable deaths from circulatory system diseases are excluded from overall mortality. The estimates reveal a differentiated contribution of preventable and treatable deaths in life ex-

pectancy losses across age and sex groups. Besides, a considerable change in cause-specific components of life expectancy is observed in two periods, 2007–2009 and 2016–2018. The life expectancy losses due to avoidable circulatory system diseases decreased in both sexes: in males by 0.3 years, most notably in the ages of up to 59 years old, and in females by 0.8 years, almost evenly across all age groups.

Generally, age distribution of avoidable deaths from circulatory system diseases differs by sex. In females, a significant loss in life expectancy is concentrated within the ages of 50–74, whilst in males, the resources for a potential increase in life expectancy is observed in the working ages (40–64 years old) and in post-retirement ages (65–74 years old). In both sexes, a significant proportion of these deaths occur under the age of 65.

Ischaemic heart diseases have the biggest contribution to the avoidable mortality from circulatory system diseases in both sexes. However, a decrease in contribution of these causes is observed mostly in females, which increased life expectancy in this group by 0.4 years. In males, improvements are less prominent — here we observe an increase in life expectancy by 0.1 years. Reduction in mortality from cerebrovascular diseases assured an increase in life expectancy in 2016–2018, compared with the period 2007–2009, by 0.3 years in males and 0.4 years in females.

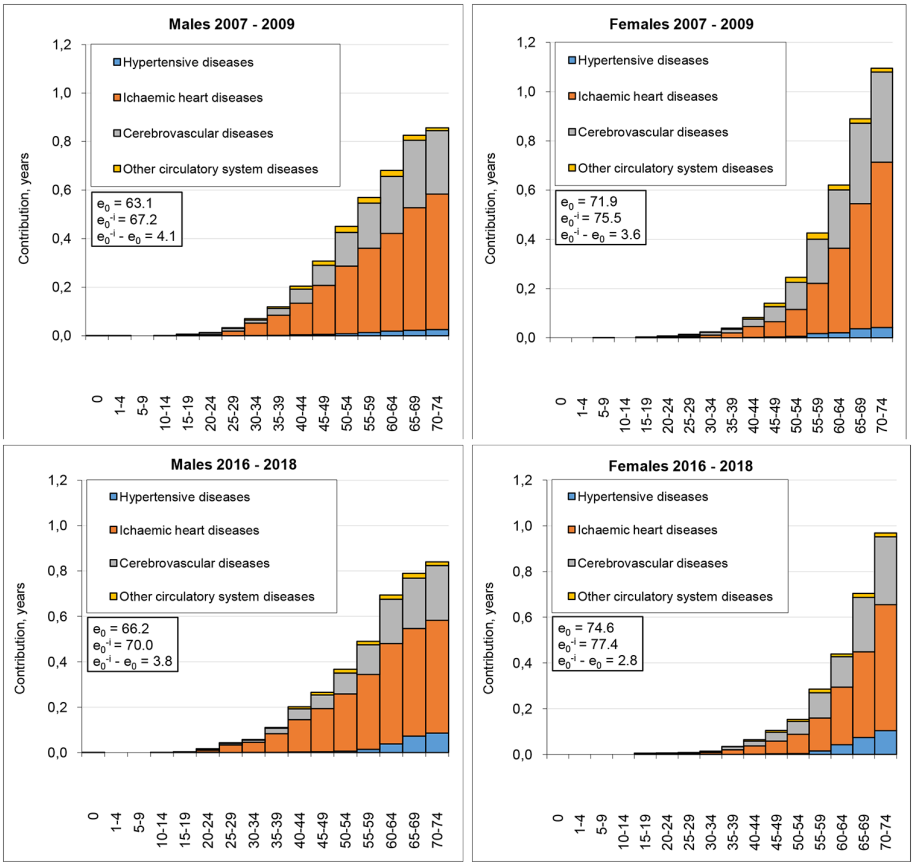

Fig. 7–10. Estimation of the possible increase in life expectancy by excluding avoidable deaths caused by diseases of the circulatory system, by age, sex, and cause of death. *Source*: Author's calculations based on the data from (WHO Mortality Database; NBS Database; Penina, Jdanov and Grigoriev 2015)

The diagrams show a very convincing increase in life expectancy due to a decrease in mortality from avoidable diseases of the circulatory system in the last year included into the analysis. This progress can be attributed to the increase in the number of provided interventional cardiology surgeries and the program to renew the emergency medical service equipment, which made it possible to reduce the time necessary for first medical aid provision. Also, the observed increase in life expectancy may be the result of other socio-economic factors, as well as national health programs.

At the moment, the impact of a high outbuond migration on mortality and health of the population has not been sufficiently studied. It is known that healthy workers and salmon bias effects can influence the aggregated national health indicators and life expectancy. On the other hand, the migration experience can influence the economic status and the behaviour of certain population strata in terms of their nutrition, alcohol and tobacco consumption, physical activity, etc.

Even though there is a lack of data on cause-of-death distribution for the years 2019 and 2020, we can make an assumption regarding the changes in avoidable mortality from circulatory system diseases based on the available statistics. Thus, in 2019, based on the observed increase in life expectancy (**Fig. 1 and 2**), but also on the increase in the number of interventional cardiology surgeries (National Health Insurance Company 2019), we can deduce that there could be registered a decline in avoidable mortality from diseases of the circulatory system. For the years 2020–2021, based on the conditions of the epidemiological situation, when the healthcare system was overloaded, and some medical visits, including planned ones, were postponed, we can expect a sharp rise in mortality from diseases of the circulatory system. An increase of 11.7% in the number of deaths registered in 2020 compared to 2019 reported by the National Bureau of Statistics (National Bureau of Statistics 2021) can be considered an inderect evidence for this assumption.

The cause-elimination model used in the study assumes an ideal scenario, where all avoidable deaths from circulatory system diseases are excluded from overall mortality. It can be expected that programs to prevent risk factors in order to reduce mortality from diseases of the circulatory system can reduce mortality from cancer, external, and other causes of death. In addition, comorbidities, especially in the elderly, can be one of the challenging aspects of the prospective prevention of diseases of the circulatory system.

In the context of health program implementations, an increase in health inequality may be expected between different population strata. An overall reduction in alcohol and tobacco consumption, as well as dietary changes and lifestyle adjustments might have a greather influence on the population-level risk factor prevention, rather than at the individual-level health status improvement (Rose 2001).

Limitations of the study

The presented research is based on the cause-elimination model, which assumes complete exclusion of preventable and treatable causes of death by circulatory system diseases from overall mortality. The author aims to highlight the hypothetically available resources to increase life expectancy as a result of mortality diminution by circuatory system disease prevention. In this regard, the presented results must be interpreted with caution.

The denominator used in this article refers to the resident population, i.e. population staying within the country for at least 9 months in a calendar year. Thus, some seasonal mi-

grants might be excluded from the denominator. Besides, due to the lack of data, the region on the left bank of the Nistru River and Bender municipality is not included in the presented research.

Conclusion

Hypothetically, a complete prevention of avoidable causes of death associated with circulatory system diseases could provide a substantial increase in life expectancy in Moldova. The results presented in this paper flow from an ideal scenario and assume a complete reduction in preventable and treatable deaths from diseases of the circulatory system. Generally, on a certain scale, this reduction in presented causes of death might be achieved through improving the quality of services provided within the medical system, as well as through introducing policies and national programmes aimed at improving population's health and its lifestyle (reducing tobacco and alcohol consumption, etc.). The mentioned actions might also have a direct or indirect impact on reducing mortality from cancer, external and other causes of death.

Considering that state programs aimed to reduce morbidity and mortality from diseases of cardiovascular diseases (including the regular increase in the health system budget) were introduced back in the 1990s, we can emphasize that in this regard some improvements have been achieved, especially in recent years. However, on a country level, we still register significant differences in the accessibility of the healthcare services across urban and rural population, especially in cases requiring urgent and qualified medical care. Implemented policies that are focused on population health have to consider aspects related to the place of residence of the population, which determine factors that are influencing individual health status. Other important factors, such as population well-being, access to the social and medical infrastructure, and other socioeconomic characteristics, have an important role in the health of the population. These factors also influence the individual mortality risks.

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