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Causes of excess mortality in the Republic of Moldova as compared to the European model

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Abstract

Background: Disregarding the recent rise in life expectancy in Moldova, the gap with Western countries is very high. The aim of the study is to identify the causes of death and the age groups responsible for excess mortality in Moldova in relation to the European average model in 2001-2019. Mortality beyond the European model set as a threshold was considered excessive.
Material and methods: Data were retrieved from the Human Cause-of-Death Database and the WHO mortality database. Multiple decrement life tables by cause were computed for Moldova and the model (Germany, England and Wales, Czech Republic, Poland).
Results: 27% of all deaths in males and 13% of all deaths in females under the age of 70 are excessive compared with the model. 80% of excess deaths were attributable to cardiovascular and digestive diseases (both males and females) and external causes (males). Excess deaths were mainly concentrated between the ages of 40 and 70 in men and 50 and 80 in women. Over the study period, cardiovascular diseases contributed the most to the decline in excess mortality in females, but not males. For the latter, excess mortality increased because of the cardiovascular component, completely compensating for moderate progress in external causes of death.
Conclusions: Narrowing the life expectancy gap between Moldova and Western countries should be possible through better control of the key risk factors behind the identified causes of death.
Key words: causes of death, excess deaths, life expectancy, cardiovascular component.

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Introduction

Life expectancy at birth in Moldova, despite its wide fluctuations in the 1980s and 1990s, failed to progress much in the total over the last half a century. After 55 years of evolution, male life expectancy in 2019 (66.6 years) was just one year higher than in 1965. Female life expectancy gained 5.0 years over the same period and reached 75.0 years in 2019. Most of these gains have occurred in the recent period (since 2010 in men and 2005 in women) [1]. The general stagnation in life expectancy in Moldova contrasts strongly with the progress made in western countries. The difference in life expectancy between Moldova and Japan is currently 15 years for males and 13 years for females, while between Moldova and France, it is 13 and 11 years respectively. The same long-term unfavourable trends were observed in other former Soviet Union (FSU) countries, followed by recent improvements started in the 1990s – early millennium [2-4].

Demographic experts have emphasised that the gap between FSU countries and the western world is not "generalized", but concerns a very specific range of causes of death and age groups [5]. These groups can be considered as risk groups responsible for high mortality in these countries compared to western countries. To identify them, it is useful to compare the mortality pattern in a problem country (Moldova) with that of a western country or an average model computed for a group of countries with a high life expectancy. The selected western country or model is set as the threshold and its exceedance may be considered as *excess mortality* [6]. If a problem country succeeds in reducing excess deaths from the identified causes, then it will succeed in reducing the gap in life expectancy.

The paper is aimed at identifying the age- and cause-specific components of excess mortality in Moldova compared to the European model. The research questions are as follows:

1. What are the age groups and causes of death responsible for the excess mortality in Moldova relative to the selected European model?

2. How has excess mortality by age and cause changed in Moldova since 2001?

Material and methods

Mortality data were retrieved from the Human Cause-of-Death (HCD) Database that provides access to reconstructed mortality time series with a constant classification of causes according to the 10th revision of the International Classification of Diseases (ICD-10) [7]. The mortality data were retrieved for Moldova (2001-2014), the Czech Republic (2001-2017), Poland (2001-2016), Germany (2001-2016) and England and Wales (2001-2019) according to an intermediate list of causes of death, identical for all countries. Reconstructed time series were extended with WHO mortality data until 2019 [8]. As the selected countries were seriously affected by the COVID-19 pandemic [9], 2019 was used as the last year of observation instead of 2020. Mortality data were aggregated by seven major causes of death. Ill-defined causes of death (R00-R99 under ICD-10) were redistributed proportionally. Population counts were extracted from the HCD and WHO mortality databases. For Moldova, were used the intercensal estimates [1] and since 2014 the official post-census usually resident estimates [10].

The model was computed as a simple mean of age- and cause-specific death rates for the Czech Republic, Poland, Germany and England and Wales. The mean of death rates weighted by population counts were not applied so that the experience of each country would be equally reflected in the model. Life tables and multiple decrement life tables were computed for each country and the model for 2001-2019.

Life expectancy at birth and in age x is calculated with the help of a life table for a hypothetical cohort (the radix of the life table) usually equal to 100000. In a life table, the membership in a cohort is terminated by a single attrition (exclusion) factor, i.e., a death. In a multiple decrement life table, there are two and more attrition factors, for example, a death due to different causes i (i_1, i_2, i_n) [11].

Life table deaths or table deaths (d_x) in the age group x are the function of a life table. Life table deaths due to a specific cause i $(d_{x,i})$ were computed as follows:

$$d_x \times C_{xi} \quad (1)$$

Where C_{xi} – the proportion of deaths from a cause i in the age group x in the total of deaths;

d_x – life table deaths in the age group x.

Excess deaths due to a cause i were computed as the difference between d_{xi} for Moldova and the model:

$$d_{xi}^{Moldova} - d_{xi}^{Model} \quad (2)$$

Life table deaths unlike *observed deaths* are not influenced by the population age structure and reflect the intensity of mortality in the compared populations. Table deaths by age or/and by cause computed for two populations can be safely compared. The sum of table deaths from all causes and in all ages is equal to the radix of the life table, and the differences between the sum for Moldova (100000) and the sum for the model (100000) is equal to zero. The statistical package R was used.

Results

Figure 1 illustrates life expectancy at birth in Moldova compared with that of four European countries and the model for the 2001-2019 periods. In Moldova, the indicator remained stagnant until 2005 in females and 2010 in males, followed by moderate growth. Between 2001 and 2019, life expectancy increased by 2.7 years in males (from 63.9 to 66.6) and 3.6 years in females (from 71.4 to 75.0). In 2019, Moldovan women lived 7.0 years less than in Poland or the Czech Republic and even 9.0 years less than in England and Wales. For males, the gap was varied between 7.0 years (Poland) and 13 years (England and Wales). Between 2001 and 2019, the gap between Moldova and the model increased from 9.0 to 11.0 years in males, while in females, it varied around 8.0 years.

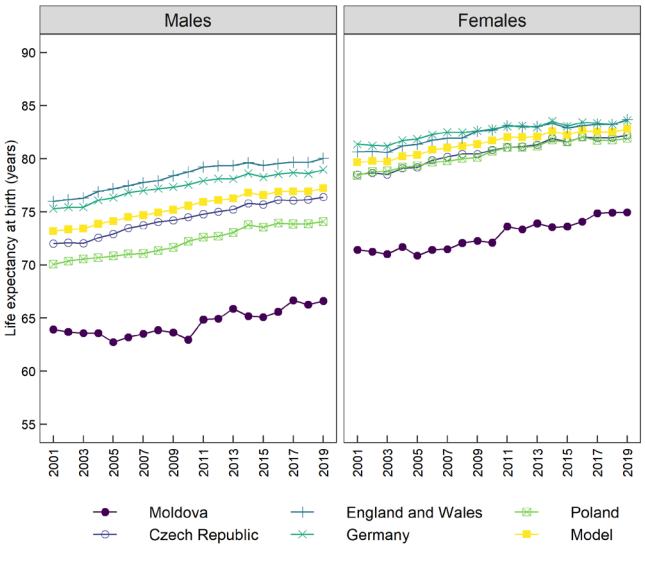

Fig. 1. Life expectancy at birth in Moldova compared to four European countries and their average model, 2001-2019, by sex

Figure 2 shows the distribution of life table deaths by age from all causes d_x in Moldova and the model. In the model, table deaths were shifted towards older age groups, especially to the last age group 85+. While in the model, in 2019, 64% of deaths in men and 80% in women were concentrated in the age group 75 years and over, in Moldova, the corresponding figures were 36% and 62%. The impact of the last age group was especially evident in females. In 2019, more than 50% of life table deaths in females were attributed to this age group in the model compared to 25% in Moldova. Table deaths in Moldova were excessive compared to the model (the difference was more than zero) mainly in the age interval between 30 and 70 years old in males and between 50 and 80 years old in females. In the model, the changes

from 2001 to 2019 were characterised by a redistribution of table death from older age groups (60+) to more advanced ages, particularly 85+. The similar dynamics, although far less pronounced, was observed among Moldovan females. At the same time, no important changes were found in Moldovan males, where the two curves in 2001 and 2019 almost overlapped.

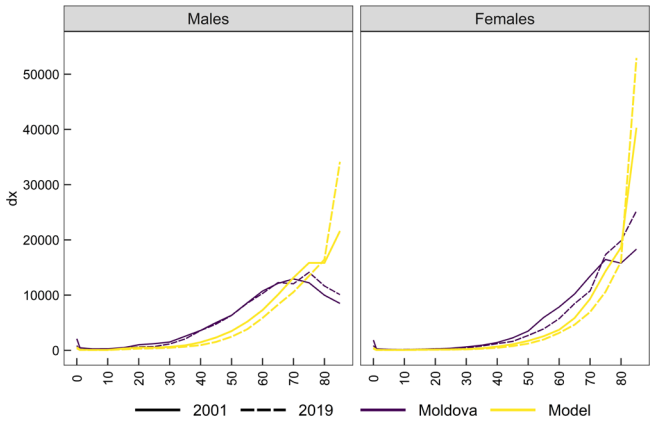

Fig. 2. Distribution of life table deaths from all causes in Moldova and the model in 2001 and 2019, by age and sex

Note: The sum of life table deaths per year is equal to 100000 (life table radix)

Table 1 illustrates the distribution of life table deaths and excess deaths $d_x^{Moldova} - d_x^{Model}$ in 2001 and 2019 by cause for the age group before 70. The data refer to the life table radix equal to 100000. The latter can be interpreted as 100000 newborns or 100000 persons dying from all causes and in all ages (hypothetical cohort). In Moldova, from 100000 male newborns, 52057 will die before 70 if age-specific death rates remain the same as in 2019 during their life (or 52%). Among females, this figure was 26813 or 27%. Between 2001 and 2019, the number of table deaths from all causes decreased insignificantly in males (8%), while in females, the reduction was 26%. In 2001 and 2019, the distribution of life table deaths by cause was characterised by the predominance of cardiovascular diseases followed by neoplasms, external causes in males and digestive diseases.

Excess deaths constituted 26686 in males and 13352 in females per 100000 deaths. It means that in Moldova, for every 100000 deaths about 27 thousand deaths in males and 13 thousand deaths in females can be considered as an excess if compared to the model. Taking into account that the radix of life table (100000) is the number of a hypothetical cohort, one can say that 27% of male newborns and 13% of female newborns in Moldova die under the age of 70 excessively compared with the model. In 2019, cardiovascular diseases accounted nearly for every second excess death (45% in males and 55% in females). Among males, the other two leading causes were digestive diseases (17%) and external causes of death (17%). Among females, excess deaths from digestive diseases contributed 26% to overall excess mortality. The impact of other causes, including neoplasms, was 10% or less. Over the study period, excess mortality increased in males by 17%, while in females, it reduced by 28%. Excess deaths decreased for all causes except for neoplasms for both sexes and cardiovascular diseases in males. In 2001, excess deaths from neoplasms were even negative, which means that under-70 mortality from this cause was lower in Moldova than in the model (the values kept negative until 2008 for both sexes).

Table 1. Life table deaths $d_{x,i}^{Moldova}$ and excess compared to the model deaths $d_{x,i}^{Moldova} - d_{x,i}^{Model}$ under 70 years old by cause and sex in Moldova per 100000 newborns, 2001 and 2019 (abs, %)

Cause of death	Life table deaths		Excess deaths	
	2001	2019	2001	2019
Males				
Infections	1983 (4%)	1093 (2%)	1661 (7%)	827 (3%)
Neoplasms	9120 (16%)	10966 (21%)	-1905 (-8%)	2620 (10%)
Cardiovascular	19623 (35%)	19039 (37%)	7963 (35%)	11964 (45%)
Respiratory	4384 (8%)	3680 (7%)	2841 (12%)	2026 (8%)
Digestive	7187 (13%)	6694 (13%)	5163 (23%)	4575 (17%)
External	10358 (13%)	7755 (15%)	6472 (28%)	4465 (17%)
Other	3674 (7%)	2829 (5)	589 (3)	210 (1%)
All causes	56328 (100%)	52057 (100%)	22782 (100%)	26686 (100%)
Females				
Infections	525 (1%)	472 (2%)	348 (2%)	323 (2%)
Neoplasms	6419 (18%)	7031 (26%)	-1197 (-6%)	708 (5%)
Circulatory	15242 (42%)	9991 (37%)	10273 (55%)	7391 (55%)
Respiratory	1456 (4%)	1020 (4%)	659 (4%)	67 (0%)
Digestive	6010 (17%)	4523 (17%)	5055 (27%)	3537 (26%)
External	3044 (8%)	1571 (6%)	2088 (11%)	696 (5%)
Other	3303 (9%)	2205 (8%)	1384 (7%)	630 (5%)
All causes	35998 (100%)	26813 (100%)	18610 (100%)	13352 (100%)

Figure 3 illustrates the distribution of life table deaths by age in males for cardiovascular diseases, digestive diseases, external causes and neoplasms. Among Moldovan males, the table deaths from cardiovascular diseases began to increase at 40 years old with the peak around age 70, followed by a decline. In the model, the increase in the corresponding curve was much smoother, with a peak at 85+. For digestive diseases, the divergence between Moldova and the model began even from 20 years old, while for external causes even from age 0. For the latter two causes, the increase in Moldovan mortality was very abrupt with a peak at age 50 years old. In the model, male mortality even from external causes was shifted to the most advanced age group; although, two classical peaks in the age groups around 20 and 50 years old were preserved. The distribution of table deaths from neoplasms among Moldovan and European males up to the age of 60 was nearly identical. However, after this age, the concentration of deaths declined sharply in Moldova but continued to grow steadily in the model.

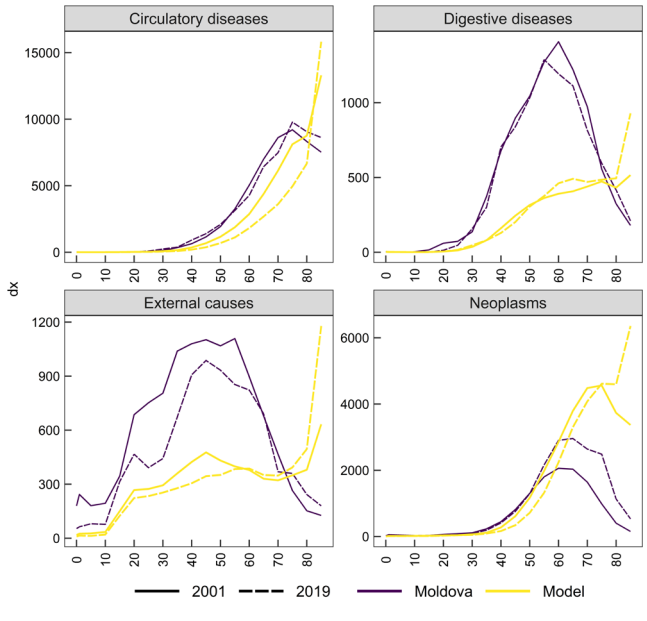

Fig. 3. Distribution of life table deaths by age from circulatory diseases, digestive diseases, external causes of death and neoplasms in Moldova and the model in 2001 and 2019, males

Table deaths from cardiovascular and digestive diseases among Moldovan males in 2001 and 2019 had the same age profile. Deaths from external causes decreased in young and middle-aged people, while table deaths from neoplasms increased after age 50 in 2019 relative to 2001, but the age pattern remained unchanged.

Discussion

This study addressed the issue of excess mortality in Moldova compared to the European model in 2001-2019. The selected model let us take into account not only the experience of the Western European countries (Germany and England and Wales) benefited from the cardiovascular revolution in the 1970s [12] but also that of the Central European countries (the Czech Republic and Poland) where the health improvements started much later [13]. Despite recent advances in population health in Moldova, the gap in life expectancy with the model widened among men and stagnated among women. Comparing the distribution of life table deaths in Moldova to the model, excess deaths by age and cause were identified. These age groups and causes of death can be considered as risk groups of excess mortality, as they are responsible for Moldova's lag behind the European model.

The distribution of life table deaths by cause reflected the cause-specific mortality profile in the country, with cardiovascular diseases and neoplasms as the two leading causes of death [14]. However, the distribution of excess deaths showed another pattern. The lion's share of excess deaths was attributable to cardiovascular diseases, digestive diseases (both sexes) and external causes of death (only in males). In other studies, the same groups of causes of death were identified as the key factors responsible for unfavourable long-term trends in Moldovan life expectancy [1, 15]. Neoplasms did not play a crucial role in the formation of excess mortality in Moldova as compared to the European model, although this pathology is the second most common cause of death. However, neoplasms have begun to contribute to excess under-70 mortality since 2008. It is highly likely that the negative impact of cancer mortality will only increase in the future, as adverse trends in Moldova stand in contrast to progress in advanced countries [16, 17].

The obtained findings showed that the recent rise in life expectancy at birth in Moldova was accompanied by a decrease in excess mortality among women, but not among men. Among females, cardiovascular component was the main contributor to this progress. The shift in the distribution of table deaths towards older ages is a good sign for sustainable growth in female life expectancy in the future. At the same time, men have advanced mainly in mortality from external factors, while the increase in cardiovascular mortality continues to widen the gap between Moldovan and European men.

Conclusions

High adult mortality from cardiovascular diseases, digestive diseases (both sexes) and external causes of death (males) played a crucial role in the formation of excess mortality in Moldova compared to the European model. Excess table deaths from these causes were mainly concentrated between the ages of 30 and 70 in men and 50 and 80 in women. Over the study period, excess deaths among women fewer than 70 years of age decreased primarily due to cardiovascular diseases. Among men, excess mortality increased at the expense of the cardiovascular component, fully offsetting progress in external causes of death. Reducing the major risk factors behind the identified risk groups is expected to reduce excess mortality and hence the gap with Western countries.

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Authors' contributions

OP conceptualized the idea, conducted literature review, collected the data, interpreted the data and wrote the manuscript; GO collected the data and revised the manuscript critically. ER collected the data and revised the manuscript critically. All the authors revised and approved the final version of the manuscript.

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Ethics approval and consent to participate

No approval was required for this study.

Conflict of Interests

There is no known conflict of interests to declare.