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The doctoral habilitation thesis and the abstract of the thesis can be consulted at the library of Nicolae Testemitanu State University of Medicine and Pharmacy and on the website of ANACEC (https://anacec.md/ro/technical-staff/evaluations).

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SOCIO-DEMOGRAPHIC AND REGIONAL DISPARITIES OF MORTALITY IN THE REPUBLIC OF MOLDOVA

331.03. SOCIAL MEDICINE AND MANAGEMENT

Abstract of the Doctoral Habilitation Thesis in Medical Sciences

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ABBREVIATIONS

CI – confidence interval

CUATM – Classification of Territorial-Administrative Division

e_0 – life expectancy at birth

FAI – fundamental associations of items

FSU – former Soviet Union

HCD – Human Cause-of-Death Database

HMD – Human Mortality Database

ICD – International Classification of Diseases and Causes of Death

INED – French Institute for Demographic Studies

IQR – interquartile range

MI – Moran's index

NAPH – National Agency for Public Health

NBS – National Bureau of Statistics of the Republic of Moldova

RD – rate difference

RR – rate ratio

SC – Soviet Classification of Causes of Death

SDR – standardised death rate (direct method)

SMR – standardised mortality ratio/rate (indirect method)

TCSU – Central Statistical Administration

CONCEPTUAL RESEARCH FRAMEWORK

Mortality analysis is the primary approach to assessing population health in demography and public health. Over the centuries, mortality has been the main determinant factor of population change and remains so in many developing countries [1]. For decision-making and the evaluation of health policies, mortality analysis has been and continues to be indispensable. In recent years, as all countries have faced an unprecedented COVID-19 pandemic, it has become especially critical. The availability of mortality data in conjunction with the population register or census has facilitated many studies of social and regional differences in mortality trends and patterns. A number of large international projects are looking at international differences in mortality at the regional level, contrasting national borders with "health" borders [2].

"Disparities" or "inequalities" in health are defined in the literature as differences in health outcomes, such as mortality or morbidity rates, or in the distribution of health determinants among different population groups (e.g., by sex, place of residence, level of education or marital status) [3]. Sociodemographic and regional disparities in mortality within a country or region are well-known and very persistent in many countries, even in the highly developed states of Western Europe [4]. Significant differences in health were found between socioeconomic groups of the population, with people with lower levels of education, occupation or income being at greater risk of premature death [5]. Health inequalities result from differences between population groups in a wide range of health determinants, such as living conditions, education, occupation and income; health-related behaviours; health care, disease prevention and health promotion services; and public policies that influence the quantity, quality and distribution of these factors [6].

The issue of high mortality is critical for the Republic of Moldova (or Moldova), which ranks last in Europe for life expectancy at birth. In 2019, these figures were 66.8 years for men and 75.0 years for women, 13.0 and 10.4 years, respectively, lower than in France and 12.0 and 8.3 years lower than in Germany. High mortality has significant negative consequences for any country. It accelerates the process of depopulation, devalues investment in education and training of skilled workers, hampers economic growth and limits the possibilities for insuring pensioners. Previous studies on mortality show that, in spite of large fluctuations in the late 1980s and 1990s, life expectancy at birth in Moldova is at the same level as in the mid-1960s for men and the late 1970s for women [7]. The lack of significant progress in life expectancy stems from persistent differences in health status between different demographic, regional and social groups of the Moldovan population. For these reasons, analysis of mortality at the national level alone is often insufficient to develop effective interventions to overcome the current public health crisis. Reducing inequalities in population health is the main objective outlined in all major national and international health policy documents. An effective solution to the problem of high mortality in Moldova should aim to reduce mortality in a manner that also addresses disparities between regions and various socio-demographic groups.

In the case of Moldova, the objective analysis of demographic processes is complicated by the lack of reliable population estimates for the years preceding the last census conducted in 2014, which has led to an information and scientific vacuum regarding the evolution of the main demographic processes in the country. Several researchers have addressed the issue of mortality in Moldova in different contexts: maternal and infant mortality (Gh. Paladi and C. Etco), socio-medical aspects of old-age mortality (D. Tintiuc), epidemiological aspects of cancer mortality (T. Grejdean), mortality related to cerebrovascular diseases (E. Zota and L. Spinei); socio-medical aspects of mortality in the working-age population in urban (O. Lozan) and rural areas (N. Bologan), trends in premature mortality from various cardiovascular diseases (E. Raevschi), the evolution of mortality (O. Gagauz et al.) and demographic processes (C. Matei, V. Sainsus) after the proclamation of independence. Although a large number of studies have been conducted in the field of mortality analysis in Moldova, no in-depth analyses of socio-demographic and regional differences in mortality have been carried out in the context of assessing the quality of primary statistical data.

The ***aim*** of the thesis is to examine the long-term trends and social and regional differences in mortality in the Republic of Moldova in the context of a data quality assessment and to elaborate recommendations for improving mortality monitoring and reducing disparities in mortality.

Objectives of the study: 1) To assess the quality of population and mortality data at the national, sub-national and district levels and to propose methods for correcting problematic data; 2) To reconstruct the continuity of mortality series according to ICD-10 in Moldova for the period 1965-2020; 3) To analyse changes in long-term trends and patterns of mortality by age and cause of death in Moldova and to determine their commonalities and peculiarities in comparison with Romania and Ukraine; 4) To evaluate excess mortality by age groups and leading causes of death in Moldova compared with the European model; 5) To examine changes in overall and cause-specific mortality by place of residence (rural/urban); 6) To examine disparities in overall and cause-specific mortality by marital status and the level of education; 7) To analyse the geographical profile of life expectancy and cause-specific mortality; 8) To identify clusters of districts with similar levels of mortality by cause of death based on the spatial autocorrelation analysis; 9) To elaborate practical recommendations for improving mortality monitoring and reducing mortality disparities in Moldova.

The ***hypothesis*** of the study is that the high level of overall mortality in Moldova coexists with significant differences in mortality by cause of death between different social groups of the population and between districts. Different population groups at the sub-national and district levels have progressed differently along the epidemiologic transition pathway, which determines interregional differentiation and social inequalities in the face of death.

Novelty and scientific originality: 1) Systematisation of the main data quality issues on population and mortality and data harmonisation at the national, sub-national and district levels; 2) Reconstruction of the continuity of mortality series according to a fixed classification of causes of death in Moldova for the period 1965-2020; 3) Elaboration of life tables by socio-demographic characteristics at the national, sub-national and district levels; 4) Identification of the vanguard and laggard subpopulations in terms of life expectancy and cause-specific mortality according to the place of residence, marital status, level of education and geographical area of residence; 5) Determination of the components of the interregional differentiation in life expectancy by age and cause of death and assessment of their changes during the period of independence; 6) Detection of the spatial clusters with similar low or high mortality by cause of death based on spatial autocorrelation.

Scientific problem solved in the thesis. The study presents a new approach to the analysis of the long-term trends and social and regional disparities in mortality by cause of death in Moldova, taking into account the assessment of the quality of primary data. The time series of deaths, reconstructed according to the fixed classification of diseases for 1965-2020, meet the international requirements of comparability, completeness and regularity of data. Comparative analysis of the reconstructed series ensures data compatibility between countries over time.

Theoretical and applicative significance of the thesis. The thesis presents a comprehensive study of the long-term trends and social and regional disparities in mortality by cause of death in Moldova, focusing on data quality issues. Changes in cause-specific mortality at the national, sub-national and district levels are examined through the prism of the epidemiologic transition theory and its subsequent interpretations, including the health transition theory. These theories seek to elucidate variations in mortality trends and patterns over time and across different populations.

The results of the study can form the basis for strengthening public health policies to increase population life expectancy and reduce mortality disparities. The results of the spatial analysis of interregional differentiation in mortality can have applications in regional development policies. The results of the study can be used in research and teaching in the fields of demography, public health and public health.

Summary of research methodology and justification of chosen research methods. The study is population-based and transversal. The *object* of the study is mortality in Moldova. The *subject* of the study is long-term trends and patterns of mortality by cause of death and social and regional differentiation of mortality by cause of death. The study has three *levels*: national (Moldova), sub-national (place of residence, marital status, level of education) and district (second level of territorial-administrative division). The study covers the *period* 1965-2020 at the national level and the period of independence (1991-2020) at the sub-national and district levels.

The study used archival data on mortality and causes of death (statistical forms 5, 5b, etc.) collected from the National Archive of the Republic of Moldova (1959-1969), the NBS (1970-1990), the depersonalized database of medical death certificates provided by the NAPH (1991-2020), the depersonalized database of the statistical forms nr. 3 “Death” provided by the NBS (1998-2014). We used the continuous mortality series reconstructed under the ICD-10 for some European countries retrieved from the HCD database for comparative analysis. The hospital death records were collected from the official website of the MH during the pandemic period. The study classifies the methods into two groups. The first group includes the methods adapted or developed within the study to solve specific problems of data quality. The second group includes the demographic and statistical methods for analysing the reconstructed mortality series after preliminary corrections at three study levels.

Implementation of scientific results. The database of reconstructed mortality series for Moldova has been integrated into the international database, The Human Cause-of-Death Database (HCD, https://www.causesofdeath.org/cgi-bin/main.php), coordinated by the French Institute for Demographic Studies (INED) and the Max Planck Institute for Demographic Research in Germany. The HCD database presents reconstructed series for 16 industrially developed countries, including Moldova. The created database ensures comparability of mortality data by cause of death in Moldova over the period 1965-2020 and between Moldova and other countries for which the mortality series have been reconstructed.

Approbation of scientific results. The main results of the thesis were presented at the following international and national scientific conferences: European Population Conference 2022 (29 June – 2 July 2022, Groningen, the Netherlands); the 11th International Conference on Population Geographies (25-27 August 2022, Tokyo, Japan); IUSSP International Population Conference (5-10 December 2021, Hyderabad, India); European Population Conference (25-28 June 2014, Budapest, Hungary); International Conference "Low fertility and low mortality: observable reality and visions of the future" dedicated to the 25th anniversary of the Institute of Demography (31 October – 1 November 2013, Moscow, Russia); XXVII IUSSP International Population Conference (26-31 August 2013, Busan, South Korea); the National scientific conference with international participation "One Health approach in a changing world" (4-5 November 2021, Chisinau); National scientific conference "Cercetarea în Biomedicină și Sănătate: Calitate, Excelență și Performanță" (20-22 October 2021, Chisinau); Congress dedicated to the 75th anniversary of the establishment of the State University of Medicine and Pharmacy "Nicolae Testemitanu" of the Republic of Moldova (21-23 October 2020, Chisinau); International conference "Economic growth in the conditions of globalisation" (12-13 October 2022; 15-16 October 2021; 15-16 October 2015; 16-17 October 2014; 17-18 October 2013, Chisinau).

Publications on the research topic. The results of the thesis were published in 41 scientific papers, including two monographs, five articles in international journals, 15 in national journals, five in the proceedings of international conferences held abroad and six in the proceedings of the international conferences held in the Republic of Moldova.

Summary of chapters of the thesis. The thesis consists of an introduction, six chapters, conclusions and recommendations, a bibliography and 18 annexes. The *first chapter* discussed the epidemiologic transition theory proposed by A. Omran and its main interpretations. The results of studies on long-term mortality trends and social and regional disparities in mortality in the FSU countries were presented. The *second chapter* presented the material and methods used in the study. The *third chapter* assessed the quality of population and mortality data according to the three levels of the study and presented the corresponding correction methods. The *fourth chapter* examined mortality trends and patterns based on the reconstructed data by sex, age and cause of death at the national level for the period 1965-2020. A comparative analysis of mortality trends in

Moldova, Romania and Ukraine was presented. The excess mortality in Moldova compared to the European model was examined. The *fifth chapter* was devoted to the analysis of social disparities in mortality at the sub-national level during the period of independence. Differences in overall and cause-specific mortality were analysed by place of residence (rural/urban), marital status and level of education. The *sixth chapter* examined regional differences in all-cause and cause-specific mortality. The global and local spatial autocorrelation results of the mortality analysis were presented for all-cause and cause-specific mortality. The evolution of regional mortality differentiation since independence was examined.

THESIS CONTENT

1. POPULATION HEALTH REFLECTED IN MORTALITY TRENDS, PATTERNS AND DISPARITIES (LITERATURE REVIEW)

The *epidemiologic transition* theory proposed by A. Omran is the main theoretical framework to explain the increase in life expectancy and the drastic changes in age- and cause-specific mortality profiles that occurred in developed countries between the middle of the 18th century and late 1960 [8]. The essence of the epidemiologic transition is that once a society has reached a certain level of development, there is a rapid replacement, relative to historical standards, of one pattern of diseases and causes of death by another. In the “old” mortality pattern, infectious and respiratory diseases and malnutrition-related diseases occupy an essential place. In the aetiology of the “old” pathologies, exogenous factors play a decisive role. The “new” mortality pattern is dominated by diseases and causes of death caused mainly by endogenous factors associated with natural senility and the age-related decline in vitality [9].

Subsequent interpretations of the theory have attempted to explain the changes that occurred in the second half of the last century and the beginning of the 21st century. In our study, we accepted the *health transition* theory proposed by Vallin and Meslé, according to which all countries go through phases of divergence and convergence in mortality trends. Advances in public health inevitably lead to diverging trends in mortality as the wealthiest segments of the population first gain access to new benefits, such as better social conditions, medical advances or lifestyle changes. Then, as the less affluent populations are caught up in the modernisation process, the phase of mortality convergence and its homogenisation in society begins [10].

By the mid-1960s, all industrialised countries, including the FSU countries, had completed the *first stage* of the health transition, with mortality from infectious and acute respiratory diseases, especially in infancy, falling substantially. The successful reduction of the high mortality from infectious diseases during the first stage was made possible by massive, low-cost and effective preventive measures [10]. By the 1960s, the difference in life expectancy at birth between industrialised countries was minimal, and “degenerative and man-made diseases”, as defined by Omran [11], emerged as a new public health challenge in the developed world.

The *second stage* of the health transition refers to a new phase of diverging mortality trends that began in the late 1960s between East and West, between the socialist and capitalist worlds. During this stage, a spectacular increase in life expectancy in Western countries was mainly associated with a reduction in mortality from chronic non-communicable diseases, mainly diseases of the circulatory system, known as the *cardiovascular revolution*. The sustained progress in life expectancy in Western countries has been made possible by a new public health strategy to promote healthy lifestyles and prevent the major risk factors associated with chronic noncommunicable diseases. In contrast, the countries of Central and Eastern Europe, including the republics of the FSU, have experienced decades of unfavourable mortality trends [12]. Following the economic and political transitions in Central Europe in the late 1980s, many post-socialist countries began a steady trend towards convergence with Western countries. Life expectancy growth recovered in the Czech Republic in 1990, in Poland in 1992, in Hungary in 1994 and in Romania in 1997 [13]. Among the FSU countries, the Baltic States were the first to show signs of improving population health in the mid-1990s, but since 2000 there has been some divergence between the three countries [14]. Studies show that significant progress in life expectancy in these countries has been achieved through substantial reductions in cardiovascular mortality in the working and older age groups. In some FSU countries, including Moldova, progress began only after 2005. For Moldovan women, a steady increase in life expectancy began in 2005 and, as for men, accelerated after 2010. Some of the most developed countries, such as France and Japan, have entered the *third stage* of the health transition - slowing down the ageing process.

Researchers have highlighted two key features of the contemporary mortality model underlying the historical backwardness of the FSU compared to Western countries: very high cardiovascular mortality among the middle-aged and very high mortality from external causes of death among the young and middle-aged [15]. These two causes of death have played a crucial role in the long-term negative trend in life expectancy and its temporary fluctuations during the anti-alcohol campaign of 1985 and the socio-economic crisis of the 1990s in Ukraine [16], Russia [15], Belarus [17] and the Baltic countries [14]. Several explanations have been proposed for the negative population health trends in this region, such as psychosocial stress, income inequality, inadequate medical care, unhealthy lifestyles and failing political and economic systems [18]. Risky patterns of alcohol consumption, particularly among men, contribute significantly to the life expectancy gap between East and West [19].

Demographers have emphasised that the gap between the FSU countries and the Western world is not general but concerns a specific range of causes of death and age groups [20]. These groups can be considered as risk groups responsible for the high mortality in these countries compared to Western countries. The risk groups can be identified by comparing the mortality pattern in a problem country with that of a Western country or an average model calculated for a group of countries with high life expectancy. The selected Western country or model is set as a threshold, and exceeding it can be considered as *excess* mortality [21].

From a methodological point of view, two different types of studies on *social disparities* in mortality can be distinguished. The first type refers to studies based on census and death data for years close to the census (unlinked studies). Based on aggregated mortality statistics and census data, social disparities in mortality over different time periods were analysed in Russia [22], Estonia [23, 24] and Lithuania [25]. The second type is a census-linked study. In this case, a death certificate recorded by a statistical office is linked to an individual census form, and information on the social characteristics of the deceased is taken from the census data. Several studies showed that education level and marital status have a significant impact on mortality disparities in the FSU countries. Married populations, urban residents and populations with higher education were associated with a lower risk of death from various causes and at various ages in these countries [26–28]. However, studies not linked to the census may overestimate mortality rates in the most disadvantaged social groups, especially with regard to educational attainment.

In the FSU countries, such as Ukraine, Belarus, Russia and Lithuania, diseases of the circulatory system and deaths due to injuries and poisoning were not only the main determinants of changes in life expectancy at the national level but also accounted for *interregional disparities in* mortality. Mortality from external causes, which in these countries is closely linked to hazardous alcohol consumption, had a more critical effect on geographical disparities than cardiovascular mortality.

2. DATA AND METHODS

According to the objectives of the study, population and mortality data were collected at national, sub-national and district levels. At the national level, data for the period 1959-2020 were analysed. At the sub-national level, mortality analysis was carried out according to place of residence (rural/urban), marital status and level of education. At the district level, the mortality analysis was carried out according to the second level of the country's administrative division (districts, municipalities, ATU Gagauzia and Transnistria). The period of analysis at the sub-national and district levels varied according to the variable, but always included years adjacent to the two most recent conducted in 2004 and 2014. The study is populational and transversal.

Data. For the period 1959-1990, *mortality data* for Moldova are only available at the national level. We used the original statistical forms No 5 and 5b on the distribution of deaths by sex and age and the Soviet Classification of Causes of Death (SC) revised in 1965, 1970, 1981 and 1988. INED provided the corresponding computerised statistical forms. In addition, statistical forms No. 4 (deaths by sex, age and place of residence) and No 4a (infant deaths by sex and age) were collected and computerised for the period 1959-1990.

For the period 1991-2020, we used two de-identified databases of individual death records provided by the NAPH and the NBS. The NAPH provided the database of medical death certificates (form 106/e). For each death record in the NAPH database, the following information was provided: 1) year of death registration; 2) exact date of death (year, month and day); 3) exact date of birth (year, month and day); 4) sex; 5) underlying causes of death according to the 4-digit ICD-9 code (1991-1995) or ICD-10 code (1996-2020); 6) district code of residence of the deceased; 7) locality code of residence of the deceased according to CUATM. The place of residence (urban/rural) was identified on the basis of the locality code.

The NBS provided the database of statistical form No 3 for the period 1998-2014. The following variables were provided for each death record in the NBS database: 1) year of death registration; 2) exact date of death (year, month and day); 3) exact date of birth (year, month and day); 4) sex; 5) locality code of residence of the deceased according to CUATM; 6) marital status; 7) level of education.

We merged the two databases by sex, exact date of birth, exact date of death and locality code. In this way, we created a new database of death records by sex, age, locality code, marital status, level of education and underlying cause of death. The percentage of unlinked deaths was less than 2%. Deaths with an unknown cause of death (unlinked death records) were redistributed proportionally by marital status or educational level.

The analysis of mortality due to COVID-19 was based on two data sources. The first was the NAPH database of medical death certificates (deaths in 2020 with underlying cause U07.1). The second was the COVID-19 hospital death records published daily by the MH between 18 March 2020 and 19 April 2022 and computerised by the author. In both data sources, deaths were laboratory confirmed.

Reliable official *population data* at the national level, including by place of residence, refer to the usual resident population and are only available from 2014 onwards. Official population data for earlier periods were checked for data quality and re-estimated. Population data by place of residence, marital status and level of education were the respondent population according to the 2004 and 2014 censuses and were corrected to be in line with the usual resident population. Population data at the district level were the official annual estimates based on the 1989 census (1991-1995 years), the *de facto* population estimates according to the 2004 census and the post-census estimates of the usual resident population for the period 2014-2020.

For comparative analysis, we used the reconstructed cause-of-death mortality series for Ukraine and Romania since 1965 and for the Czech Republic, England & Wales, Germany and Poland since 2001 [29].

Methods. We distinguish two groups of methods used in the study. The first group consists of methods adapted or specially developed to address specific methodological problems in the assessment of the quality of population and mortality data. The justification for the use of these methods in the context of data quality was discussed in Chapter 3. The second group includes the demographic and statistical methods used to analyse the mortality data at the three study levels after their preliminary assessment and correction (Table 2.1). Social disparities in mortality were analysed using absolute (rate difference or RD) and relative (rate ratio or RR) differences with 95% CIs. The reference groups were the urban population, the married population and the population with higher education.

The data were analysed in R (version 4.1.0) and RStudio (version 1.4.1717).

Table 2.1. Methods used for the analysis of mortality data according by study level

Study level	Time period	Cause of death	Age groups	Methods
National	1965-2020	Mortality series reconstructed according to ICD-10 (212 items)	All ages and broad age groups	SDR, decomposition method, life tables, multiple decrement life tables
Sub-national: the place of residence (urban/rural)	1991-1993; 2003-2005; 2014-2016; 2017-2019; 2020	Unreconstructed mortality series aggregated by the short list of causes of death (15 categories)	All ages	Life tables with 95% CI, SDR with 95% CI, RD and RR with 95% CI
Sub-national: marital status and level of education	2003-2005; 2013-2014		Population aged 30+	
District level	1991-1995; 2002-2006; 2012-2016		All ages and broad age groups	Life tables with 95% CI, SMR with 95% CI, decomposition method, thematic maps, spatial autocorrelation (global and local), LISA maps.

Source: author's elaboration

3. ASSESSING THE QUALITY OF POPULATION AND MORTALITY DATA AT THE NATIONAL, SUB-NATIONAL AND DISTRICT LEVEL

The study presented in Chapter 3 aimed to assess the quality of primary statistical data and to develop correction methods at national, sub-national and district levels (*objectives 1 and 2*). The following data quality issues were addressed: 1) the lack of intercensal population estimates for the years before 2014; 2) incomplete coverage of infant deaths and underestimation of old-age mortality in the 1960s and 1970s; 3) discontinuities in the mortality time series caused by periodic changes in the classification of causes of death; 4) the increase in mortality from ill-defined causes of death in the 1990s. The above data quality problems were identified at the national level and were therefore also evident at the sub-national and district levels. For each problem identified, an appropriate correction method was proposed or adapted.

3.1. Population data quality

3.1.1. Population data at the national level

The results of the study showed that the official annual population estimates for the years prior to the 1979 census were problematic at older ages because of the age-heaping effect. The official population data for the period 1980-1989 were consistent and referred to intercensal estimates. For the post-independence period, no official intercensal estimates were produced based on the 1989, 2004 and 2014 censuses. Instead, *de jure* population estimates ("populația stabilă") based on the 1989 census, vital statistics and highly incomplete migration statistics were used. In our study, we used official data on the usual resident population compiled by the NBS for the years following the 2014 census. For earlier years, we used population estimates calculated using the

HMD method in collaboration with Jdanov and Grigoriev for the period 1959-2004 [30], supplemented by our own intercensal estimates for the period 2005-2013 (Fig. 3.1).

The results of the study showed that the use of official *de jure* population estimates led to a significant underestimation of death rates. The impact of the systematic "numerator–denominator" bias was initially negligible in the 1990s but had a cumulative effect over time. In 1995, the difference between life expectancy at birth based on intercensal population estimates and that based on de jure population estimates was 0.19 years for men and 0.2 years for women. This gap increased to 1.06 years for men and 0.72 years for women in 2005 and reached 3.24 years for men and 2.58 years for women in 2019.

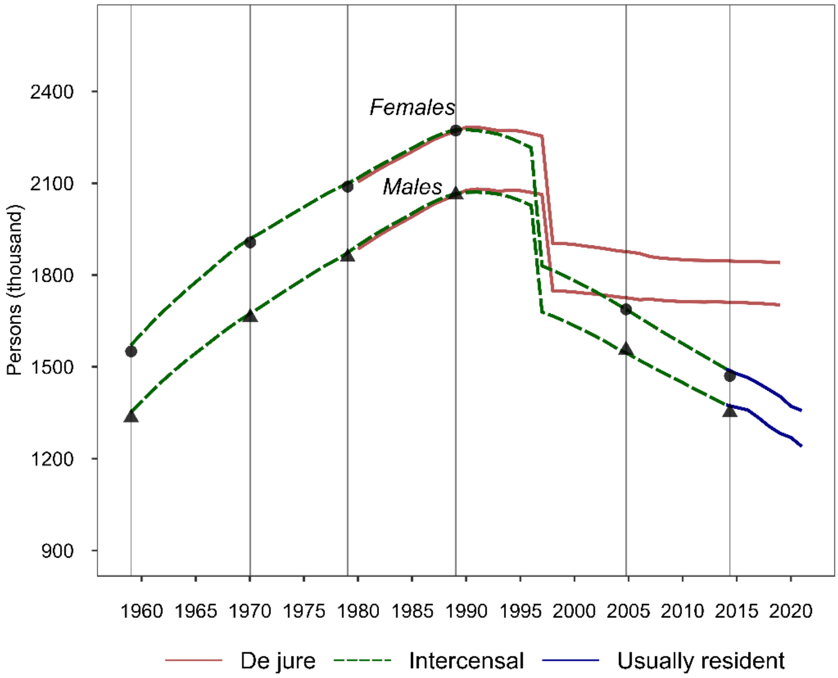

Fig. 3.1 Population estimates in Moldova: 1981-2019 de jure population; 2014-2020 usual resident population; 1959-2013 intercensal population

Note: Vertical lines refer to the census dates: 15/01/1959, 15/01/1970, 17/01/1979, 12/01/1989, 05/10/2004 and 12/05/2014. Since 1998 official population statistics do not include Transnistria.

Source: official estimates – NBS; intercensal 1959-2003 estimates – Penina, Jdanov and Grigoriev [30]; intercensal 2004-2013 estimates – author's calculations.

3.1.2. Population data at sub-national and district level

In this study, population estimates from the 2004 and 2014 censuses were used to analyse mortality at sub-national and district levels. Data on census results by social variable (place of residence, marital status and education level) were preliminarily processed. The structure of the respondent population by sex, age and social variables according to the census was applied to the adjusted national population estimates for 2004 and 2014. This ensured consistency between national and sub-national population estimates. Population estimates at the district level for the 2004 and 2014 censuses referred to the usual resident population. For the 2014 census, data were adjusted by the NBS for the municipality of Chisinau. According to the 2014 census, the average population size at the district level was 81 thousand persons (including the municipality of Chisinau) and 63 thousand persons (excluding the municipality of Chisinau). The minimum population size was 19 thousand people in the Basarabeasca district, and the maximum was 676 thousand people in the municipality of Chisinau.

3.2. Mortality data quality

Two distinct problems have been identified in relation to the quality of mortality data at the national level. The first problem concerns the quality of registration of infant and old-age deaths. The second concerns reconstructing the continuity of the time series of deaths, interrupted by periodic changes in the classification of causes of death. In the analysis of data at subnational and district levels for the period of independence, these two methodological issues were rightly omitted. First, the under-registration of infant deaths during the period of independence was of minor importance, while the quality of death registration in old age has been satisfactory since the 1980s. Second, the mortality analysis at the sub-national and district levels was limited to the main causes of death, which are considered robust to changes in the classification of causes of death. However, the issue of increasing deaths due to "senility" in the 1990s was addressed and resolved at all three levels of analysis.

3.2.1. Assessing age-specific mortality profile at the national level

Infant mortality correction. In assessing trends in infant mortality since 1959, two types of underestimation of infant deaths have been distinguished. The first was due to incomplete registration of infant deaths before 1973. The second was related to the use of the Soviet definition of live birth before 2008, which differed from WHO recommendations. Similar problems have been described for other FSU countries, but the degree of under-registration in Moldova before the mid-1970s was much more pronounced [31].

The *first correction* of the infant mortality rate for the years before 1973 was made by sex and place of residence for the neonatal and post-neonatal components. Two different approaches were used. The first was an "absolute correction", where the absolute difference between the 1972 and 1973 rates was applied to the early and late neonatal mortality rates. The second was a "relative correction", in which a relative difference in the mortality rates between 1972 and 1973 was applied to the post-neonatal mortality rates [32]. The *second correction* of infant mortality rates was necessary because of the change in the definition of live birth in 2008. We drew on the experience of the Baltic countries, where the transition from the Soviet definition to WHO recommendations in the early 1990s led to a 50% increase in early neonatal mortality [33]. A 50% correction was applied to early neonatal mortality for all years before 2008, and the rate was interpolated for 2008 and 2009. According to our results, the infant mortality rate had to be increased by 47% in 1959, 56% in 1965 and 61% in 1972. After 1973, the adjustment coefficient varied between 7% and 23%.

Old-age mortality correction. The underestimation of old-age mortality in the 1960s and 1970s was primarily caused by inaccurate reporting of age at death. To address this issue, the study used the Coale-Demeny model life tables to correct life expectancy at age 60. The appropriate level in one of the four model families (North, South, West and East) was determined using the five-year moving average of the corrected infant mortality rate.

In 1960, the observed life expectancy at age 60 in Moldova was 4.7 years higher in females and 3.8 years higher in males compared to the average model. By 1965, the gap had been reduced to 2.1 years in females and 1.5 years in males. The quality of data on old-age mortality improved after 1980. Regardless of the regional model chosen, the model life expectancy at age 60 consistently exceeded the observed one. In 1980, the average model showed 2.2 years higher life expectancy in males and 1.5 years higher in females compared to Moldova. By 2020, the gap widened to 5.7 years in males and 3.5 years in females. In the study, new death rates in old age were calculated using the average life expectancy at age 60 for the four regional models, covering the period 1959-1969 for males and 1959-1979 for females.

Re-assessment of life tables since 1959. Abridged life tables were computed by sex, covering the period from 1959 to 2020. The first infant mortality correction had a maximum impact on life expectancy at birth in 1959, resulting in a decrease of 1.7 years for males and 1.9 years for females. The second correction for infant mortality had a minor effect, ranging between 0.13 and 0.25 years. The correction for old-age mortality had a maximum impact in 1960, with life expectancy at birth decreasing by 2.72 years for males and 3.8 years for females. The combined effect of both corrections on life expectancy at birth reached its maximum in 1960, leading to a decrease of 4.5 years for males and 5.6 years for females. By 1965, the combined effect decreased to 2.5 years for males and 3.1 years for females. The correction for infant and old-age mortality not only significantly reduced life expectancy at birth but also changed its trend in the 1960s and 1970s.

3.2.2. Reconstruction of the continuity of mortality series according to ICD-10 in Moldova in 1965-2020

Disruptions in time series caused by changes in the classification of causes of death complicate the analysis of mortality over time for any country. We used a special method developed by Vallin and Meslé [34] to reconstruct coherent time series of deaths according to a fixed classification for Moldova for the period 1965-2020. Four transitions were made: 1) from 1965-SC to 1970-SC; 2) from 1970-SC to 1988-SC; 3) from 1988-SC to ICD-9; 4) from ICD-9 to ICD-10. Each transition from an old classification to a new one involved three steps: establishing correspondence tables, constructing fundamental associations of items and computing transition coefficients.

Based on the medical definitions, a *correspondence table* was constructed between items of the old classification and items of the new classification. Based on the correspondence table, *fundamental associations of items* (FAIs) were constructed that included old and new items with the same medical content and deaths in the transition years. The FAIs constructed on the basis of the medical correspondence of the items were checked for *statistical coherence*. For each FAI, we checked if the total number of deaths under the old classification was close to that under the new classification. To ensure statistical consistency, we examined the annual trends in SDR for each FAI over the years under the old and new classifications. Figure 3.2 shows the results of the statistical consistency check for some FAIs constructed during the first transition. In some cases, however, an interruption in the time series was detected in the transition year, indicating a discrepancy between the medical content of the items and the codification practices. When such a disruption was detected for an association, it was necessary to find the item corresponding to the actual coding practices (statistical correspondence of items).

Transition coefficients were computed in the framework of each FAI to redistribute deaths classified under an old classification among items of a new classification. The reconstructed time series of deaths were prolonged with the observed time series under the new classification. The reconstructed mortality series were checked for statistical consistency in the same way as the FAIs. In some cases, the transition coefficients had to be adjusted by age. We created a database of the reconstructed mortality series for the period 1965-2020 by sex, age and 211 ICD-10 groups of causes of death. Additional adjustments were made *a posteriori* to eliminate discontinuities in the mortality time series due to changes in coding practices unrelated to the adoption of a new classification.

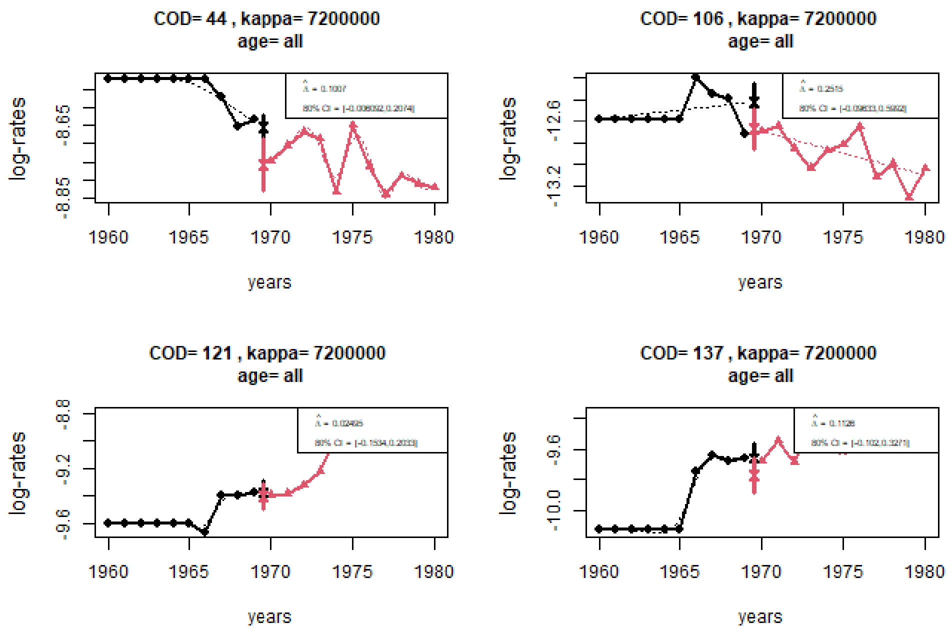

Fig. 3.2 Checking the statistical consistency of FAIs 44, 106, 121 and 137 built between 1965-SC (1965-1969) and 1970-SC (1970-1980), Moldova (log rate)

Source: author’s calculations based on the data of TCSU of the USSR (archived data provided by INED) [7]

Our database met the criteria of comparability, completeness and consistency and was integrated into the international database, The Human Cause-of-Death Database (https://www.causesofdeath.org/cgi-bin/main.php), coordinated by INED and Max Planck Institute for Demographic Research [29].

3.2.3. Redistribution of deaths from senility and other ill-defined causes

The increase in the number of deaths due to senility in the 1990s was the result of changes in the instructions for coding causes of death in old age adopted in 1989. As a result, the number of deaths from senility accounted for 17% of all deaths in 1993 (12% for men and 21% for women). On the other hand, the number of deaths from some cardiovascular diseases declined sharply. We applied a special proportional distribution of deaths due to senility within the three main groups of diseases of the circulatory system. This correction changed the trends in mortality from circulatory system diseases in the 1990s and early 2000s, making them more consistent with the overall mortality trend. The redistribution of ill-defined deaths was carried out at the sub-national and district level using the coefficients computed at the national level.

4. CHANGES IN MORTALITY TRENDS AND PATTERNS IN MOLDOVA IN 1965-2020

The study presented in Chapter 4 aimed to examine long-term trends and patterns of mortality by age and cause of death and to identify their similarities and differences with Romania and Ukraine. It also sought to identify the main risk groups responsible for excess mortality in Moldova compared to the European model (*objectives 3 and 4*). Our hypothesis was that the limited progress in life expectancy at birth in Moldova over the past 55 years has been influenced by different trends in age- and cause-specific mortality. While unfavourable mortality trends have been observed across various causes of death, the historical gap between Moldova and Western countries can be attributed to specific causes of death and age groups. For the analysis, we used the continuous time series of deaths reconstructed according to ICD-10 in the previous step, covering the period from 1965 to 2020.

4.1. Mortality trends and patterns in Moldova compared to Romania and Ukraine

In Moldova and Ukraine, life expectancy experienced continuous declines during the 1970s and early 1980s. However, compared to Ukrainian women, Moldovan women witnessed a particularly sharp drop in life expectancy during the 1970s. The *long-term deterioration in population health* in both countries only came to a halt following the implementation of the *anti-alcohol campaign* in 1985. This campaign, with its restrictive measures, led to a considerable but short-lived increase in life expectancy between 1985 and 1987 (3.3 years in males and 2.4 years in females in Moldova). The termination of the campaign in 1987 slowed down the life expectancy growth or then even reversed the positive trend (Figure 4.1).

The dissolution of the USSR resulted in a severe *socioeconomic crisis* in the newly independent states, brought on by the abrupt transition to a market economy. In the early 1990s, life expectancy, which had already been declining since the late 1980s, saw an accelerated decrease, especially among males. After a post-crisis recovery in the late 1990s, life expectancy remained largely stagnant until 2005, followed by a period of *improvement*.

In Romania, during the communist regime, life expectancy either stagnated or declined moderately, with the deterioration among men accelerating after the 1989 revolution. Only after 1996 did life expectancy in Romania start to rise steadily. Between 1965 and 2019, male life expectancy at birth increased by just one year in Moldova (from 65.6 years in 1965 and 66.6 years in 2019) and even decreased by 0.5 years in Ukraine. In contrast, Romanian males gained 5.6 years over the same period. For women, the increase in life expectancy was 5.1 years in Moldova (from 69.9 years in 1965 to 75 years in 2019), 2.5 years in Ukraine and 9.1 years in Romania. Between

2019 and 2020, life expectancy in Moldova fell by 0.8 years in men and 1.1 years in women as a result of the COVID-19 pandemic. Similar reductions were observed in the other two countries.

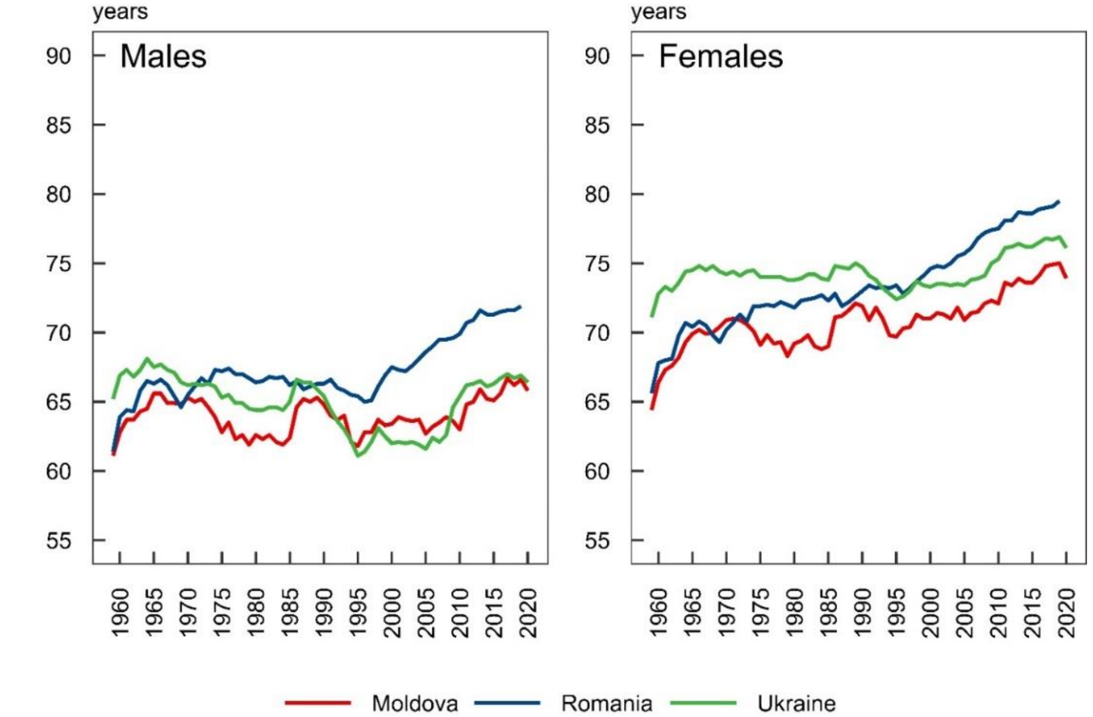

Fig. 4.1 The evolution of life expectancy at birth by sex in Moldova compared to Ukraine and Romania since 1959

Source: author's calculations based on the HCD database, the Romanian National Institute of Statistics data and the State Statistics Service of Ukraine data.

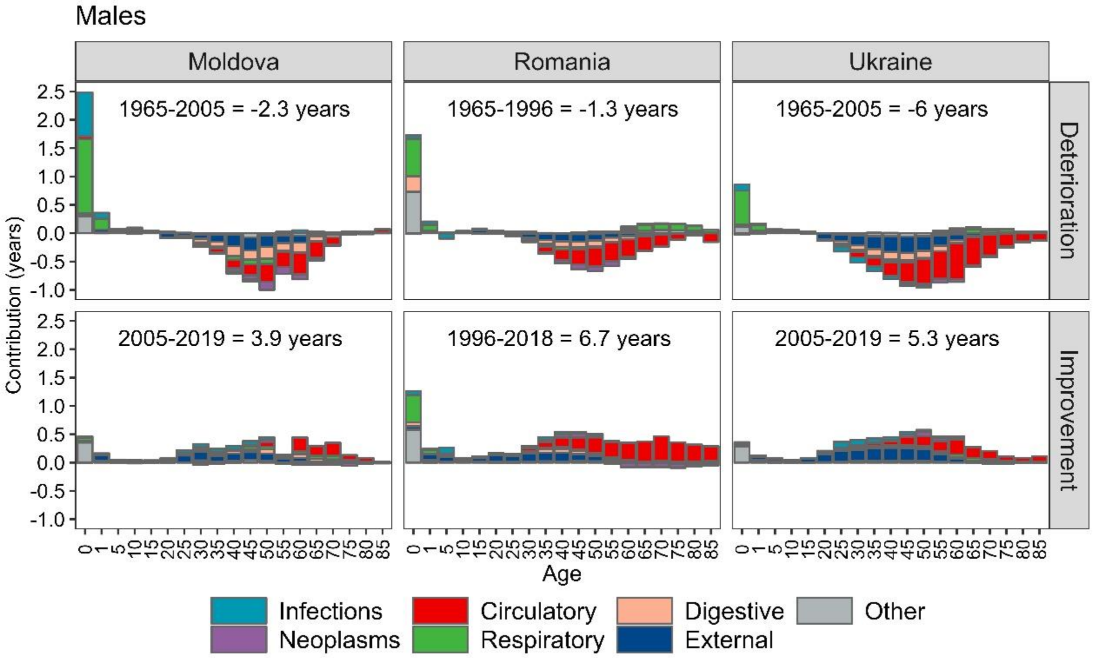

Fig. 4.2 Contributions to the changes in life expectancy at birth by age and cause of death during a period of deterioration and a period of improvement in Moldova, Romania and Ukraine, males

Source: author's calculations based on the HCD database, the Romanian National Institute of Statistics data and the State Statistics Service of Ukraine data.

The changes in life expectancy at birth in the periods of deterioration and improvement were broken down by age and cause of death for the three countries (Figure 4.2). In the deterioration period, the loss in male life expectancy at birth was higher in Ukraine (6 years) compared to Moldova and Romania (2.3 years and 1.3 years, respectively). However, in the latter two countries, the increase in adult mortality was offset by a decrease in infant mortality from respiratory and infectious diseases. Excluding mortality for those under 15, male life expectancy decreased by 7.0 years in Ukraine, 5.3 years in Moldova between 1965 and 2005 and 3.2 years in Romania between 1965 and 1996. Increased mortality from circulatory system diseases, external causes of death and digestive system diseases among adults was responsible for the decline in life expectancy throughout the period of deterioration. Middle-aged males were the most vulnerable group. The same groups of causes of death accounted for the increase in life expectancy during the improvement period. Notably, the impact of digestive system diseases on the decline in life expectancy during the first period was much more pronounced in Moldova than in Ukraine or Romania.

4.2. Mortality trends by age and cause of death in Moldova

This sub-chapter focused on analysing mortality trends by detailed causes of death across five main age groups during the period 1965-2020. Improvements in *infant mortality* were primarily registered for the post-neonatal component, attributed to pneumonia and acute intestinal infections. On the other hand, mortality from conditions originating in the perinatal period remained stagnant until the turn of the millennium, after which a marked decline occurred, mainly related to birth trauma. In *children and adolescents*, the overall downward trend in mortality was also reflected in the detailed causes of death, such as transport accidents, pneumonia and acute respiratory conditions.

Mortality among *young adult* males, dominated by external causes of death, was sensitive to the 1985 anti-alcohol campaign. The pattern of external causes of death in this age group was strongly influenced by suicide and transport accidents. In Moldova, the socio-economic crisis of the 1990s did not have a noticeable impact on mortality from injuries and poisoning among young adults, as was the case in Ukraine [16] or Russia [35]. On the contrary, since the early 1990s, mortality from external causes of death among young men has declined moderately, with the exception of the war conflict in Transnistria in 1992. The socio-economic crisis caused a deep decline in mortality from transport accidents. Recent improvements in mortality among young adult males have been attributed to various external causes of death, but with no significant progress in suicide mortality.

The long-term health deterioration in the health status of *middle-aged* adults (40-64 years) up to 2005 was associated with an increase or stagnation in mortality from the main causes of death (Figure 4.3). The exception is infectious diseases, where mortality declined steadily during the Soviet period, but the trend has been reversed since the late 1980s. Since 2005, there has been a moderate improvement in mortality from cerebrovascular diseases, pneumonia, cirrhosis of the liver, some external causes of death and tuberculosis. However, the long-term trend in mortality from cardiovascular diseases in middle-aged men remains extremely unfavourable, especially from heart diseases.

Mortality among middle-aged men was very sensitive to the anti-alcohol campaign of 1985 and the socio-economic crisis of the 1990s, especially for ischaemic heart disease, cerebrovascular disease, pneumonia, cirrhosis of the liver, homicide and suicide. However, mortality from transport accidents decreased during the socioeconomic crisis of the 1990s. Over the same period, there was a fall in lung cancer mortality, contrasting with a huge increase in deaths from diseases of the circulatory system and external causes. To explain this phenomenon, we considered the competing risks hypothesis proposed by Shkolnokov et al., suggesting that the rapid increase in mortality from diseases of the circulatory system and external causes of death during the socio-economic crisis of the 1990s heightened the risk of death from these causes among people with cancer [36, 37]. Mortality from cirrhosis of the liver increased dramatically throughout the period analysed, especially before the 1985 anti-alcohol campaign, and this trend was particularly pronounced in women. It is important to note that the sex ratio for this cause of death was close to one for most of the study period, with a maximum of 1.5 in the mid-1960s and at present (Figure 4.4).

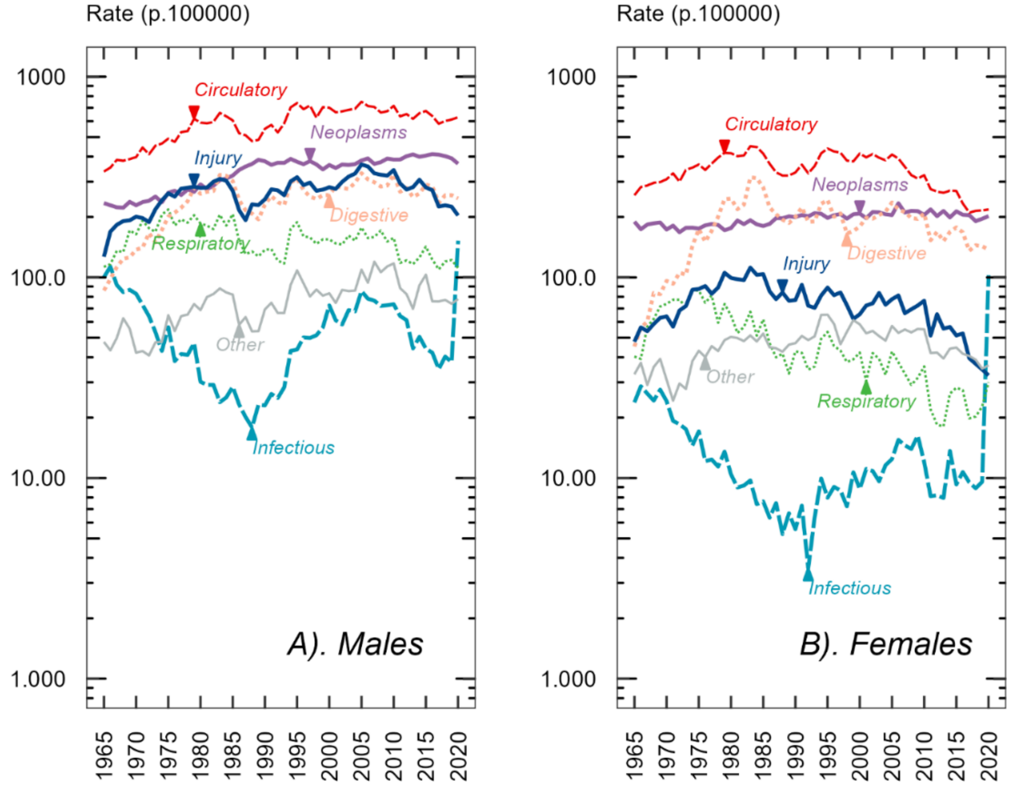

Fig. 4.3 Trends in SDR at age 40-64 by main cause of death and sex in Moldova in 1965-2020 (per 100000, semi-logarithmic scale)

Source: author’s calculations based on NAPH and NBS data.

The mortality trends among *older adults* have been much less affected by the events of the 1980s and 1990s. Since 2005, there have been marked improvements in mortality among older people for cerebrovascular disease, chronic obstructive pulmonary disease, cirrhosis of the liver and some external causes of death. The recent progress in cardiovascular mortality among the elderly can be attributed to a decrease in mortality from cerebrovascular disorders. Nevertheless, mortality from heart disease and other diseases of the circulatory system has remained persistently high for several decades. The low differentiation of cardiovascular mortality, particularly heart diseases, has also been observed in other FSU countries [38]. Our study showed a common practice during the Soviet period of attributing ill-defined heart diseases in old age to a condition called “atherosclerotic cardiosclerosis” (coded as I25.0-I25.1 under ICD-10), which has also been highlighted by other researchers [16]. After the introduction of ICD-9 in 1991, deaths previously coded as “atherosclerotic cardiosclerosis” were gradually reclassified as unspecified ischaemic heart disease (coded as I25.8 under ICD-10).

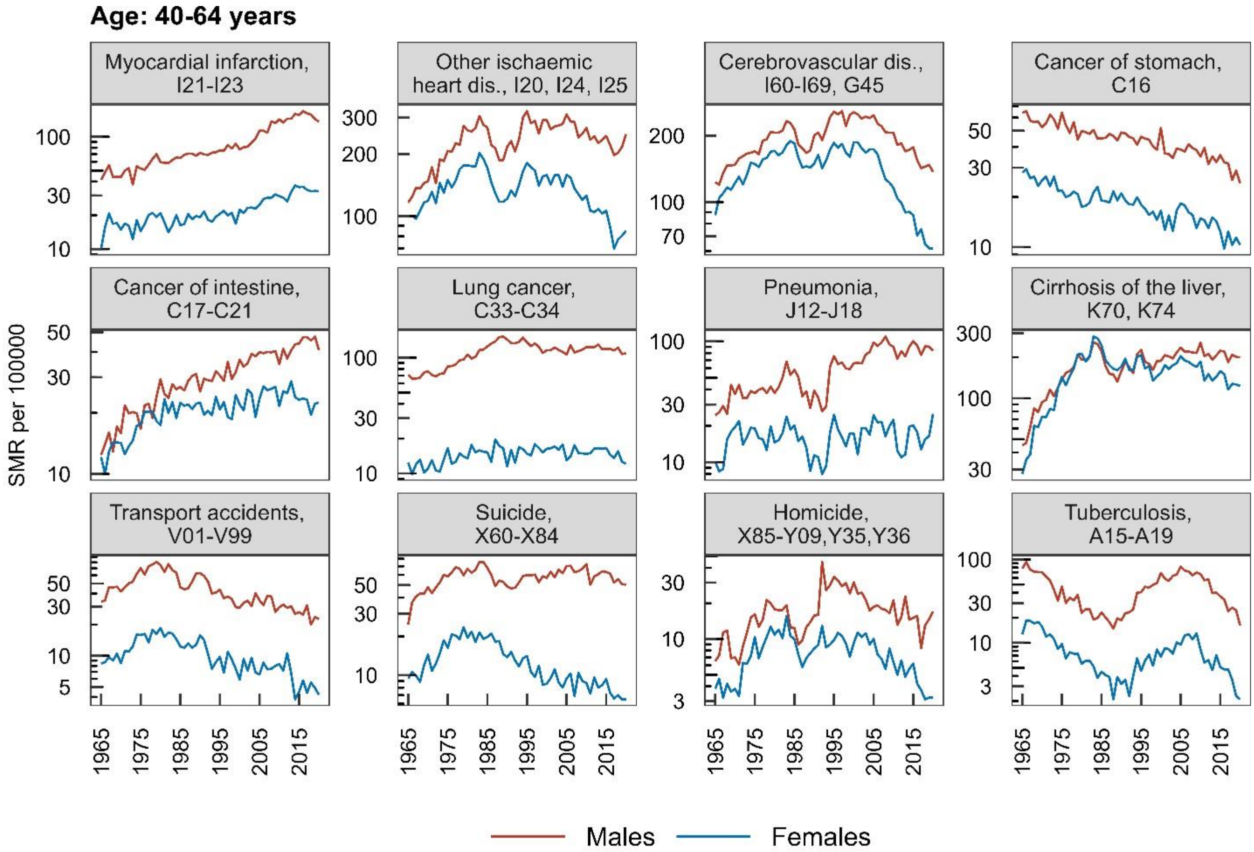

Fig. 4.4 Trends in SDR at age 40-64 by some detailed cause of death and sex in Moldova in 1965-2020 (per 100000)

Source: author’s calculations based on NAPH and NBS data.

4.3. COVID-19 mortality in Moldova

During the pandemic, the COVID-19 death registration system in Moldova was limited to laboratory-confirmed cases recorded in hospitals or at home. In 2020, the statistics based on hospital death records were consistent with those based on medical death certificates, where COVID-19 was listed as the underlying cause of death. Standardised death rates from COVID-19 for all ages were slightly higher for males than for females in the four waves, particularly in the first and last waves. However, the difference in median age at death by sex was not statistically significant: 69.0 years in males (IQR=62-76 years) and 70.0 years in females (IQR=63-77 years).

The maximum weekly standardised mortality rate associated with COVID-19 was 129 deaths per 1 million for males during the third wave.

The study showed that COVID-19 deaths were under-reported in 2020, especially among older people. Excess mortality at older ages, defined as the ratio of the weekly probability of death in 2020 to the average of the previous three years (2017-2019), was attributed to diseases of the circulatory system during the first wave. The pandemic had a significant impact on life expectancy at birth in 2020. The decrease in this indicator was mainly attributed to infectious diseases (0.6 years for males and 0.8 years for females) and diseases of the circulatory system (0.2 years for both sexes).

4.4. Excess mortality in Moldova compared to the European model

Excess mortality in Moldova was compared to the European model, represented by the average death rates calculated for two Central European countries (the Czech Republic and Poland) and two Western European countries (Germany and England and Wales) for the period 2001-2019. Using multiple decrement life tables, we compared the distribution of life table deaths in Moldova to the selected model in order to identify the *risk groups of excess mortality* by age and cause of death.

The study's findings revealed that, among men, one in two deaths recorded in 2019 occurred before the age of 70, corresponding to 52057 deaths per 100000 deaths at all ages. Among these deaths, 27% were considered as excess deaths compared to the selected model, totalling 26686 per 100000 deaths (Table 4.1). The distribution of *life table deaths* by cause mirrored the cause-specific mortality pattern, with diseases of the circulatory system (37%) and neoplasms (21%) being the most prevalent. Conversely, the distribution of *excess deaths* in males was dominated by diseases of the circulatory system (45%), diseases of the digestive system (17%) and external causes of death (17%) [39]. Neoplasms did not significantly contribute to excess mortality in Moldova compared with the model (10%), despite being the second most common cause of death. However, the negative contribution of this group of causes of death to excess mortality has increased in the last decade and is expected to accelerate in the future, as unfavourable trends in Moldova contrast with the progress observed in developed countries [40, 41].

The distribution of life table deaths by age group revealed that the excess deaths among men in Moldova, compared to the model, were concentrated between the ages of 40 and 70 for diseases of the circulatory system, digestive system, respiratory system and external causes of death. In contrast, the age profiles of neoplasm mortality in Moldova and the European model were nearly identical up to the age of 60.

Despite the increase in life expectancy at birth in Moldova after 2005, there was an increase in excess mortality among males under 70 years of age between 2001 and 2019 compared to the selected model (from 22782 to 26686 deaths per 100000 deaths). This increase was mainly attributed to a rise in excess deaths from diseases of the circulatory system and neoplasms. However, excess mortality from other causes of death, including external causes, decreased. Over the same period, excess all-cause mortality among women decreased significantly, mainly due to the cardiovascular component.

Table 4.1. Life table deaths and excess deaths under 70 in Moldova compared to the European model by cause of death in 2001 and 2019, males, per 100000 deaths (abs., %)

Cause of death	Life table deaths (d_x^{RM})		Excess deaths ($d_x^{RM} - d_x^{model}$)	
	2001	2019	2001	2019
Infections	1983 *4%)*	1093 *(2%)*	1661 *(7%)*	827 *(3%)*
Neoplasms	9120 *(16%)*	10966 *(21%)*	-1905 *(-8%)*	2620 *(10%)*
Circulatory	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 causes	10358 (13%)	7755 (15%)	6472 (28%)	4465 *(17%)*
Other causes	3674 (7%)	2829 (5%)	589 *(3%)*	210 *(1%)*
All causes of death	***56328 (100%)***	***52057 (100%)***	***22782 (100%)***	***26686 (100%)***

Source: author's calculations based on NBS and NAPH data.

5. SOCIAL DISPARITIES IN MORTALITY BY PLACE OF RESIDENCE, MARITAL STATUS AND LEVEL OF EDUCATION

The study presented in Chapter 5 aimed to investigate the disparities in all-cause and cause-specific mortality by place of residence (rural/urban), marital status and level of education (*objectives 5 and 6*). The principal hypothesis of the study was that the high mortality at the national level coexists with high social disparities in mortality. Moreover, different population subgroups have responded differently to socio-economic perturbations, such as the crisis of the 1990s, and have contributed differently to the recent life expectancy growth in Moldova.

5.1. Mortality disparities by place of residence

The study's results showed a positive and statistically significant urban-rural gradient in life expectancy at birth across the five study periods (Table 5.1). The maximum difference in life expectancy for both sexes was observed in the early 1990s (3 years). The gap between the urban and rural populations was minimal but statistically significant in 2003-2005 and 2020 due to an increase in mortality among the urban population, especially among males. The rural-urban disparities in age-specific probabilities of death decreased with age and were almost negligible in old age, especially for males. These discrepancies were most pronounced among young adults (15-29 and 30-44 years). The excess of deaths among children (0-14 years) in rural areas was also marked.

Absolute (rate difference, RD) and relative (rate ratio, RR) disparities in standardised mortality rates by cause of death and sex were analysed in 1991-1993 and 2017-2019. The findings revealed a positive and statistically significant rural-urban gradient in standardised mortality rates for all causes of death, diseases of the circulatory system, diseases of the respiratory system, diseases of the digestive system and external causes of death. However, a negative rural-urban gradient was observed for neoplasms. For men, both absolute and relative disparities decreased in 2017-2019 compared to 1991-1993 for diseases of the circulatory system and neoplasms. The narrowing gap between the two areas was attributed to the faster decrease in mortality from diseases of the circulatory system and the faster increase in mortality from neoplasms in rural areas compared to urban areas. On the other hand, disparities in diseases of the respiratory system and external causes of death have increased due to faster progress in urban areas than in rural areas, where mortality has fallen more slowly or stagnated. The absolute and relative differences in mortality from diseases of the digestive system remained statistically unchanged over the analysed period due to the stagnation of mortality rates in both rural and urban areas. Thus, because of the divergent trends in mortality rates from different causes of death for men in the two areas, the absolute and relative differences in mortality from all causes of death did not show statistically significant changes between the periods 1991-1993 and 2017-2019 (Table 5.2).

Table 5.1 Life expectancy at birth and 95% CI by place of residence and sex in Moldova in 1991-2020 (years)

Period	Urban	Rural	Total	Urban-rural difference
Males				
1991-1993[1]	65.79 (65.6-65.97)	62.82 (62.66-63)	64.22 (64.1-64.35)	2.96*
2003-2005	64.53 (64.3-64.75)	63.41 (63.24-63.58)	63.82 (63.69-63.96)	1.12*
2014-2016	66.92 (66.71-67.13)	64.25 (64.08-64.41)	65.24 (65.1-65.37)	2.67*
2017-2019	68.18 (67.97-68.38)	65.61 (65.43-65.78)	66.57 (66.43-66.71)	2.57*
2020	66.86 (66.54-67.21)	65.2 (64.92-65.51)	65.89 (65.65-66.13)	1.67*
Females				
1991-1993[1]	73.24 (73.08-73.42)	70.26 (70.09-70.42)	71.5 (71.39-71.61)	2.98*
2003-2005	72.79 (72.58-73)	70.74 (70.58-70.9)	71.48 (71.35-71.62)	2.05*
2014-2016	75.39 (75.18-75.58)	72.74 (72.58-72.9)	73.73 (73.61-73.86)	2.64*
2017-2019	76.52 (76.32-76.7)	73.98 (73.82-74.14)	74.99 (74.86-75.11)	2.53*
2020	74.81 (74.49-75.15)	73.22 (72.9-73.52)	73.9 (73.69-74.11)	1.59*

[1]With Transnistria. * p-value < 0.05.

Source: author's calculations based on NBS and NAPH data.

The evolution of mortality inequalities by place of residence after 1991 went through several distinct phases: a period of socio-economic crisis (between 1991-1993 and 2003-2005), a period of improvement (between 2003-2005 and 2014-2016), a period of recent changes (between 2014-2016 and 2017-2019) and the impact of the COVID-19 pandemic (2020).

The socioeconomic crisis of the 1990s affected rural and urban populations differently. Between 1991-1993 and 2003-2005, the urban population experienced a greater deterioration in health than the rural population, as evidenced by a significant increase in cardiovascular mortality. Consequently, the differences in cardiovascular mortality between the two settings disappeared, especially for men ($RR_{1991\text{-}93}$=1.27, $RR_{2003\text{-}05}$=1.08, $p<0.05$). At the same time, the socio-economic crisis led to a sharp increase in mortality from diseases of the respiratory system in the rural population, affecting both men ($RR_{1991\text{-}93}$=1.19, $RR_{2003\text{-}05}$=1.57, $p<0.05$) and women ($RR_{1991\text{-}93}$=1.30, $RR_{2003\text{-}05}$=1.93, $p<0.05$). The dramatic increase in urban cardiovascular mortality during the 1990s reflects the enormous stress experienced by the adult population following the abrupt transition to a market economy and the associated social and economic upheaval. On the other hand, the rural population, although not exposed to an increase in cardiovascular mortality, experienced a substantial rise in mortality from respiratory and digestive diseases, likely linked to an increase in alcoholism and a deterioration in access to health services during the socio-economic crisis.

Table 5.2 Absolute (DR) and relative (RR) differences in mortality by cause of death and 95% CI between rural and urban areas in 1991-1993 and 2017-2019, males

Cause of death	1991-1993		2017-2019	
	DR (IÎ 95%)	RR (IÎ 95%)	DR (IÎ 95%)	RR (95% CI)
Infections	0.59 (-2.4;3.6)	1.03 (0.87;1.2)	-1.92 (-5.65;1.82)	0.92 (0.76;1.08)
Neoplasms	-115.17 (-131.0;-99.3)*	0.69 (0.65;0.74)*	-77.53 (-95.93;-59.12)*	0.83 (0.78;0.87)*
Circulatory	411.86 (363.8;459.9)*	1.27 (1.24;1.3)*	290.95 (247.08;334.83)*	1.2 (1.17;1.23)*
Respiratory	25.99 (14.0;37.95)*	1.19 (1.11;1.27)*	53.2 (42.49;63.9)*	1.53 (1.43;1.62)*
Digestive	39.69 (29.32;50.05)*	1.27 (1.2;1.33)*	44.45 (33.51;55.38)*	1.3 (1.23;1.37)*
External causes	22.05 (11.44;32.67)	1.11 (1.06;1.16)	47.02 (37.49;56.55)*	1.37 (1.3;1.43)*
Other causes	-26.09 (-34.08;-18.1)*	0.74 (0.65;0.82)*	3.6 (-4.01;11.2)	1.05 (0.95;1.15)
All causes of death	358.92 (304.18;413.65)*	1.14 (1.12;1.16)*	359.77 (308.19;411.36)*	1.15 (1.13;1.17)*

RD - rate difference (rural-urban) per 100000 population.
RR - rate ratio (rural/urban), times.
* p-value < 0.05 compared to the urban area.

1991-1993	2017-2019	DR or RR decreases (p<0.05)
1991-1993	2017-2019	DR or RR increases (p<0.05)

The progress in life expectancy observed at the national level after 2005 was not consistent according to place of residence. Between 2003-2005 and 2014-2016, the urban population, whose health status in the 1990s was affected more seriously than the rural population, experienced a faster decline in mortality from diseases of the circulatory system, external causes of death and diseases of the digestive system. On the other hand, the relative differences for neoplasms decreased due to a faster increase in mortality in rural areas than in urban areas. As a result, the absolute and relative disparities in all-cause mortality increased again in 2014-2016 for both men ($RR_{2003-05}$=1.05, $RR_{2014-16}$=1.15, $p<0.05$) and women ($RR_{2003-05}$=1.12, $RR_{2014-16}$=1.2, $p<0.05$).

During the period of recent changes, the differences for all-cause mortality stagnated for men ($RR_{2014-16}$=1.15, $RR_{2017-19}$=1.15, $p>0.05$), while for women, the rural-urban gradient narrowed due to a decrease in the differences for diseases of the circulatory system. During the COVID-19 pandemic, the rural-urban gradient virtually disappeared, which was associated with a much sharper increase in mortality from infectious diseases, as well as diseases of the respiratory and circulatory systems in urban areas compared with rural areas.

5.2. Mortality disparities by marital status

Absolute and relative differences in all-cause and cause-specific mortality by marital status were analysed for the two periods adjacent to the 2004 (2003-2005) and 2014 (2013-2014) censuses, with the married population serving as the reference group.

The study revealed that married men and women had the highest life expectancy at age 30, whereas never-married women and divorced men had the lowest life expectancy. The maximum difference between these two population subgroups was approximately 13 years for both men and women in the second study period. The differences in life expectancy at age 60 were smaller than those at age 30 but remained statistically significant ($p<0.05$), except for divorced women in 2003-2005. The improvements in population health observed at the national level between the two censuses were not evenly reflected across marital status categories. The gains in life expectancy at age 30 were most pronounced for married women (3.7 years) and men (2.6 years), as well as widowed men (3.7 years). However, changes in mortality were least unfavourable for divorced men and women, with their life expectancy at 30 or 60 decreasing by more than two years (Table 5.3).

Table 5.3 Life expectancy at ages 30 and 60 with 95% CI by marital status and sex in 2003-2005 and 2013-2014 in Moldova (years)

	2003-2005		2013-2014	
	Males	**Females**	**Males**	**Females**
At age 30				
Never married	28.41 (27.88-28.96)*	35.81 (35.35-36.23)*	30.54 (30.05-31.07)*	34.87 (34.39-35.38)*
Married	38.29 (38.17-38.41)	44.0 (43.88-44.13)	40.91 (40.76-41.07)	47.71 (47.51-47.9)
Divorced	26.26 (25.83-26.67)*	42.69 (42.23-43.16)*	27.72 (27.29-28.16)*	40.33 (39.95-40.73)*
Widowed	27.21 (26.19-28.22)*	41.23 (40.81-41.63)*	30.91 (29.47-32.2)*	43.97 (43.53-44.44)*
Difference	*12.04*	*8.19*	*13.19*	*12.84*
At age 60				
Never married	12.51 (11.76-13.26)*	13.41 (13.1-13.75)*	13.63 (13-14.29)*	12.4 (12.05-12.74)*
Married	14.94 (14.85-15.03)	17.48 (17.35-17.6)	16.15 (16.02-16.3)	20.38 (20.18-20.55)
Divorced	10.74 (10.29-11.21)*	17.52 (17.09-17.99)	9.61 (9.31-9.92)*	14.7 (14.39-15.03)*
Widowed	10.96 (10.79-11.16)*	16.94 (16.83-17.04)*	12.1 (11.85-12.34)*	18.64 (18.49-18.78)*
Difference	*4.19*	*4.07*	*6.54*	*7.97*

Note: without Transnistria. * p-value < 0.05 compared to married males and females.

Source: author's calculations based on NBS and NAPH data.

The maximum *absolute differences* in all-cause mortality among males were associated with widowed status in the first period (RD=2569 per 100000 population, $p<0.05$) and divorced status in the second period (RD=4587 per 100000 population, $p<0.05$). Never-married females showed the most significant absolute differences in all-cause mortality during both study periods ($RD_{2013-14}$=4693 per 100000 population, $p<0.05$). The absolute differences in all-cause mortality between the non-married (never-married, widowed or divorced) and married populations were mainly driven by a higher risk of death from diseases of the circulatory system in both females (64-77%) and males (40-63%). Additionally, the impact of external causes of death and diseases of the respiratory system was most pronounced in never-married males (25% and 17%, respectively). Diseases of the digestive system significantly contributed to the absolute differences in all-cause mortality between married and widowed persons, with a more pronounced effect in females (15%) than in males (9%). Excess mortality from neoplasms was more strongly associated with divorced status for both males (13%) and females (18%) than for other non-married categories (Table 5.4).

Table 5.4 Impact of absolute differences by marital status and cause of death on absolute differences in all-cause mortality in 2013-2014 in Moldova, by sex (%)

Cause of death	Impact of RD, males (%)			Impact of RD, females (%)		
	Never-married	Divorced	Widowed	Never-married	Divorced	Widowed
Infections	6.82	2.49	3.64	0.65	0.82	1.15
Neoplasms	-3.95	12.88	0.76	6.08	18.51	0.19
Circulatory	39.69	56.08	62.75	77.26	64.26	74.00
Respiratory	17.50	4.78	8.04	4.96	2.86	4.11
Digestive	7.80	8.51	9.21	5.03	7.06	14.97
External causes	24.96	12.18	12.98	4.39	2.75	4.55
Other causes	7.62	3.16	3.07	1.65	3.77	1.41
All causes of death	100.00	100.00	100.00	100.00	100.00	100.00

RD - rate difference per 100000 population. Reference group – married population.
The impact of RD in mortality from a cause i on RD in all-cause mortality was calculated: RD a cause i / RD all causes x 100.
Source: author's calculations based on NBS and NAPH data.

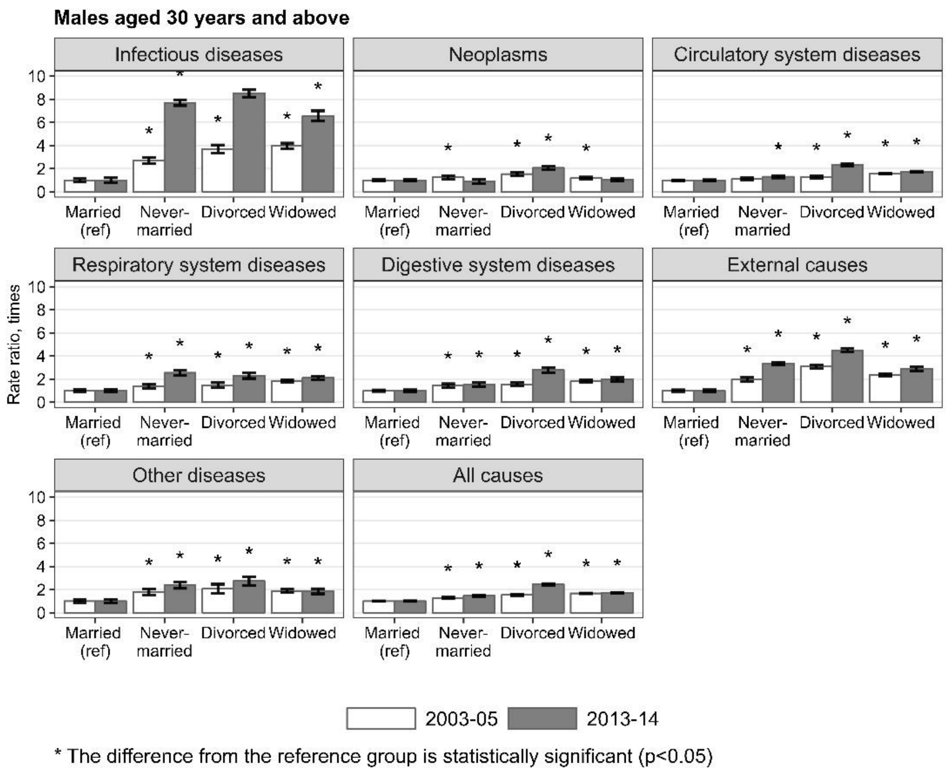

Figure 5.1 Mortality rate ratio by main cause of death and marital status in 2003-2005 and 2013-2014, Moldova, males aged 30 years and over (times)

Note: reference group (ref.) – married males.
Source: author's calculations based on NBS and NAPH data.

In 2013-2014, among males, the largest *relative differences* in all-cause mortality were observed for divorced males (RR=2.5, $p<0.05$), while for the other categories, they were less marked but still statistically significant. Specifically, the highest RR was observed for divorced males concerning infectious diseases (RR=7.8, $p<0.05$) and external causes of death (RR=4.0, $p<0.05$). For diseases of the respiratory system, excess mortality had the maximum values for divorced and never-married males (RR=3.0, $p<0.05$). Relative differences for diseases of the circulatory and digestive systems, as well as other causes of death, ranged from 1.5 to 2.8 times ($p<0.05$). Additionally, mortality from neoplasms showed statistically significant differences between married and divorced men (RR=2.0, $p<0.05$). Between 2003-2005 and 2013-2014, the relative disparities in all-cause mortality among males did not change significantly, except for divorced males. Among this group, the most considerable changes in RR occurred for infectious diseases (130%, $p<0.05$) and diseases of the circulatory, digestive and respiratory systems (more than 50%, $p<0.05$) (Figure 5.1).

In 2013-2014, the most significant differences in all-cause mortality among females were observed for never-married females (RR=3.3, $p<0.05$). For this category of women, the risk of death was eight times higher for infectious diseases and five times higher for external causes and diseases of the respiratory system compared to married females ($p<0.05$). The mortality disadvantage among never-married females for chronic diseases was less marked and varied between 2.1 (neoplasms) and 3.4 (circulatory system diseases). Notably, the excess of deaths from neoplasms was highest among divorced females (RR=2.9, $p<0.05$).

5.3. Mortality disparities by the level of education

Mortality disparities by level of education were examined for two periods around the 2004 and 2014 censuses, with the population with higher education serving as the reference group. The largest disparity in life expectancy at age 30 between the population with higher education and the population with primary or lower education was observed for both men and women in the two study periods. However, inequalities in mortality at age 60 by educational attainment were less pronounced. The increase in life expectancy at age 30 between the two study periods was mainly associated with a decrease in mortality among men with higher education (2.4 years, $p<0.05$) and among the population with primary or lower education (1.8 years in males and 1.4 years in females, $p<0.05$) (Table 5.5). Similar to marital status, the relative differences in death probabilities by level of education were more pronounced among younger adults and decreased with increasing age.

Absolute differences in all-cause mortality by educational level were essentially related to diseases of the circulatory and digestive systems for both sexes and diseases of the respiratory system and external causes of death for males. Over the two periods analysed, the *relative differences* in all-cause mortality were most notable among men and women with primary education or less, where the risk of dying was twice as high as in the group with higher education ($p<0.05$). Additionally, the risk of death was approximately 40% higher for both men and women with secondary education compared to the reference group.

Table 5.5 Life expectancy at age 30 and 60 and 95% CI by the level of education and sex in 2003-2005 and 2013-2014 in Moldova (years)

	2003-2005		2013-2014	
	Males	**Females**	**Males**	**Females**
At age 30				
Primary or lower	31.82 (31.26-32.35)*	39.49 (38.94-40.02)*	33.59 (32.9-34.25)*	40.92 (40.14-41.62)*
Secondary	36.68 (36.53-36.84)*	45.29 (45.11-45.49)*	37.48 (37.3-37.66)*	45.89 (45.72-46.06)*
Higher	41.88 (41.55-42.22)	50.77 (50.31-51.2)	44.31 (43.93-44.73)	50.75 (50.38-51.16)
Difference	*10.06*	*11.28*	*10.72*	*9.83*
At age 60				
Primary or lower	12.63 (12.5-12.77)*	16.11 (16.02-16.22)*	11.92 (11.6-12.25)*	16.41 (16.18-16.67)*
Secondary	15.35 (15.19-15.51)*	19.95 (19.75-20.13)*	15.5 (15.35-15.66)*	19.78 (19.64-19.93)*
Higher	16.9 (16.6-17.21)	23.48 (23.03-23.94)	18.54 (18.21-18.86)	23.07 (22.71-23.4)
Difference	*4.27*	*7.36*	*6.62*	*6.65*

Note: without Transnistria. * p-value < 0.05 compared to the population with higher education.
Source: author's calculations based on NBS and NAPH data.

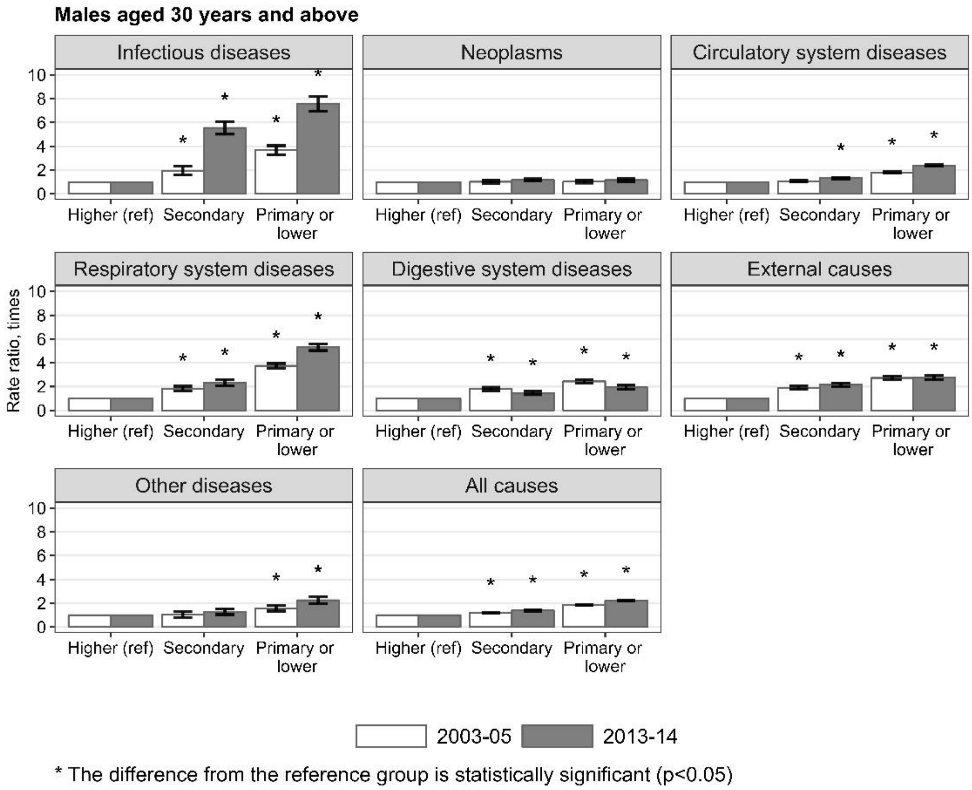

Figure 5.2 Mortality rate ratio by main cause of death and the level of education in 2003-2005 and 2013-2014, Moldova, males aged 30 years and over (times)

Note: reference group (ref.) – males with higher education.
Source: author's calculations based on NBS and NAPH data.

In 2013-2014, relative mortality disparities were most pronounced among men with primary education or less, particularly concerning infectious diseases (RR=7.6, $p<0.05$), diseases of the respiratory system (RR=5.3, $p<0.05$) and external causes of death (RR=2.8, $p<0.05$). The relative differences in mortality among women with primary education or less were particularly notable for infectious diseases (RR=7.7, $p<0.05$) and diseases of the respiratory system (RR=4.1, p<0.05). For other causes of death, excluding neoplasms, the rate ratio ranged from 2.4 to 2.7 times. Differences in neoplasm mortality by education level were not statistically significant, except for lung cancer in men (Figure 5.2).

6. REGIONAL MORTALITY DISPARITIES

The study presented in Chapter 6 was dedicated to regional mortality disparities and aimed to investigate the interregional variations in all-cause and cause-specific mortality, both at present and since independence (*objectives 7 and 8*). The study hypothesised that the high mortality observed at the national level in Moldova coexists with significant regional inequalities in life expectancy and mortality by cause of death and age.

6.1. Regional disparities in all-cause mortality

The results of the study revealed differences between the municipality of Chisinau and the northern districts, where relatively high values of life expectancy were recorded, and the districts mainly located in the centre, with relatively low values of the indicator [42]. Districts with life expectancy value classified as "very low" for males (less than 63.1 years) and "very low" and "low" for females (less than 71.3 years) were identified as *the red belt of high mortality*, stretching from the district of Soldanesti in the northeast to the district of Cantemir in the southwest (Figure 6.1) [43]. The most affected area covered eleven districts, seven in the central region (Soldanesti, Rezina, Telenesti, Orhei, Calarasi, Nisporeni and Hincesti) and four in the southern region (Cantemir, Leova, Cimislia and Basarabeasca). The mortality pattern in the red belt of high mortality contrasted sharply with that in the north of the country, where life expectancy was largely classified as "medium" and "high" for males and "high" and "very high" for females. This *north-centre mortality gradient* was particularly pronounced for life expectancy at ages 25 and 45 for both males and females. The interregional differentiation in life expectancy at age 65 was less pronounced for males but evident for females [44, 45].

Differences in life expectancy at birth between each administrative unit and Moldova were decomposed by main age groups. The results showed that regional variations in life expectancy were mainly attributable to differences in mortality among young males (20-44 years), middle-aged males and females (45-64 years) and older females (65 years and over). The impact of old-age mortality on interregional disparities in life expectancy was much less pronounced for males than for females [46].

The gain in life expectancy at birth for *females* from the municipality of Chisinau, compared to the national average, was 3.1 years, with the contribution of older age groups being 1.3 years (44%) and middle-age groups 0.9 years (29%). In the most lagging districts situated in the red belt of high mortality, more than 70% of the losses in life expectancy were attributable to higher mortality among middle-aged and older females. Regarding *males*, the higher life expectancy at birth in the municipality of Chisinau, compared to the national average (3.4 years), was mainly due to a lower risk of dying among middle-aged men (1.1 years), young adults (1.0 years) and, to a lesser extent, older men (0.8 years). In contrast, losses in life expectancy in the most backward districts were mainly explained by higher-than-average death rates among young and middle-aged adult men. For example, men from the Hincesti district lost 2.2 years out of 2.4 years due to higher mortality in these two age groups.

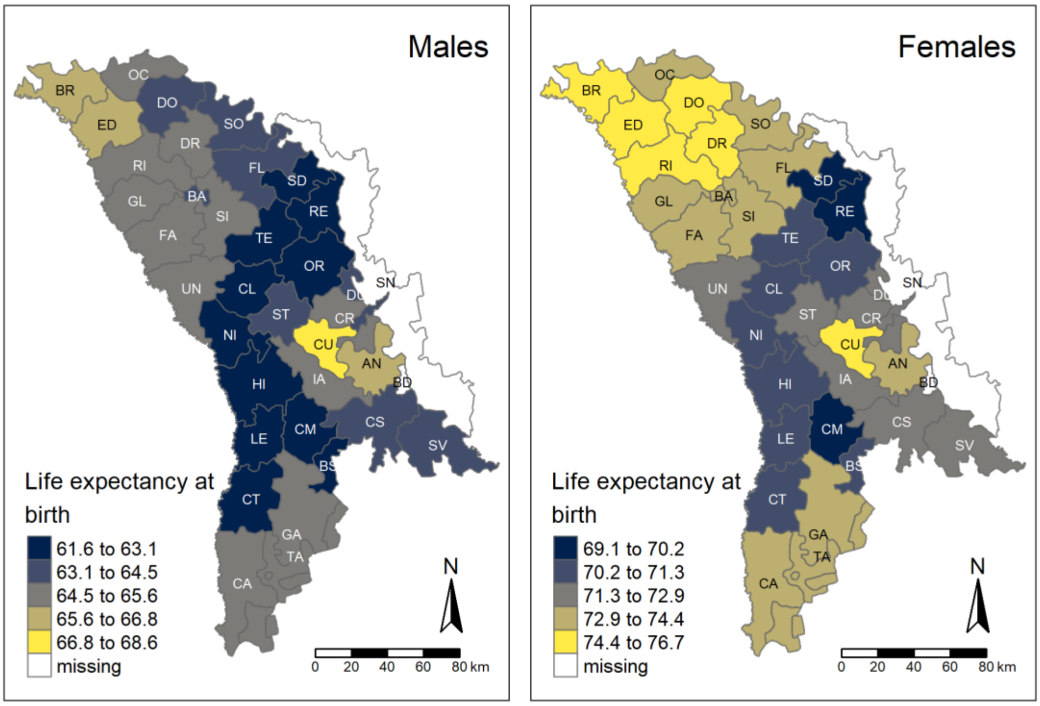

Fig. 6.1 Regional profile of life expectancy at birth by sex in Moldova in 2012-2016 (years)

Note: Jenks' optimization method of classification was used.
Source: author's calculations based on NBS and NAPH data.

6.2. Regional disparities in cause-specific mortality

Differences in life expectancy at birth between each district and the national average were analysed, and their decomposition was conducted based on the main groups of causes of death. Geographic variations in life expectancy were explained by unequal mortality from diseases of the circulatory and digestive systems for both sexes, as well as from external causes of death for males.

Among males from the municipality of Chisinau, more than 60% of the gains in life expectancy compared to the national level (3.4 years) were attributed to external causes of death (1.1 years) and diseases of the circulatory system (0.8 years). The positive contribution of lower mortality from external causes of death, compared to the national level, was observed exclusively in the capital, whereas in the other districts, this contribution was either negligible or negative (indicating higher mortality). The districts of Cantemir, Leova and Cimislia and Stefan Voda showed the most significant negative contribution from external causes of death, exceeding 45% and even 90% in some cases. Furthermore, the negative impact of diseases of the digestive system was most pronounced in the lagging central districts, such as Hincesti, Calarasi and Orhei. The influence of other causes of death on interregional disparities in life expectancy was of minor importance. The only exception was the municipality of Balti, where the higher mortality from neoplasms, compared to the national average, had a significant impact on the disparities in life expectancy.

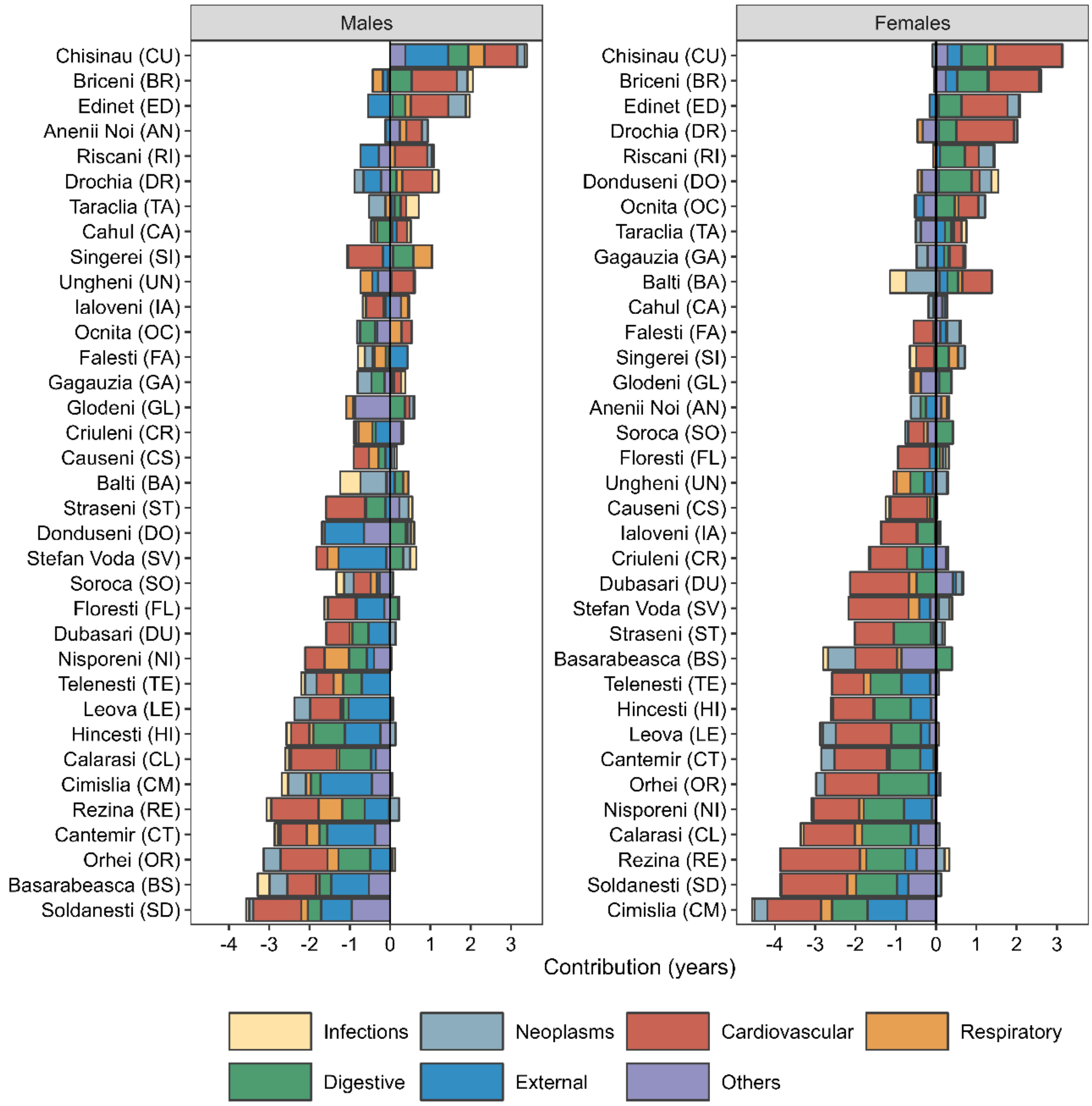

Fig. 6.2 Contribution of mortality by cause of death to differences in life expectancy at birth between Moldova and 35 administrative units in 2012-2016, by sex (years)

Note: Life expectancy at birth in Moldova in 2012-2016 was 65,2 years in males and 73,7 years in females.
Source: author's calculations based on NBS and NAPH data.

Among females from the municipality of Chisinau and the northern districts of Briceni and Edinet, lower mortality rates from diseases of the circulatory system have contributed to life expectancy gains of 50-60% compared to the national average. The contribution of lower mortality from diseases of the digestive system among females ranged from 25% (0.4 years) in Drochia to 72% (0.8 years) in Donduseni, with the total difference in life expectancy compared to the national average of 1.6 and 1.1 years, respectively. In contrast, the health of the female population in the most backward districts was severely affected by high mortality from diseases of the circulatory and digestive systems. For example, in the central districts of Calarasi or Orhei, higher death rates from these two causes accounted for 80% of the total losses in life expectancy compared to the national level.

Thematic maps for SMR by main cause and some detailed causes of death were analysed using the Jenks' optimisation method, which identified five categories of mortality ranging from "very low" to "very high". The north-central gradient in mortality was most pronounced for diseases of the digestive system, particularly cirrhosis of the liver. Mortality from diseases of the circulatory system was also consistently higher in the central districts and the southern districts bordering the central region. Further analysis revealed that higher cardiovascular mortality was mainly associated with heart diseases in the centre and cerebrovascular disorders in the south. On the other hand, neoplasm mortality tended to be higher in the southern and lower central districts, including the municipality of Chisinau, and lower in the northern and upper central districts. The same distribution was observed for cancers of different sites, such as digestive, breast, genitourinary and others, with the exception of respiratory cancer. In the context of this analysis, the municipality of Balti stood out, recording the highest mortality from neoplasms for both sexes and was identified as a "statistical outlier", i.e., an atypical value compared to the other administrative units analysed [43].

6.3. Spatial mortality disparities

Our findings on the spatial autocorrelation of mortality were based on the use of the first-order Queen's contiguity matrix, which yielded a more significant global index (Moran's index) than the four nearest neighbours' matrix. Moran's index (MI), which only indicates the presence of clusters in the data, was positive and statistically significant for males (MI=0.426, $p<0.001$) and females (MI=0.540, $p<0.001$). The results revealed the presence of "high-high" or "low-low" mortality clusters or both types of clusters. As a result, we rejected the null hypothesis that supported a random spatial distribution of mortality and accepted the alternative hypothesis that suggested the presence of clusters in the all-cause mortality data.

The global spatial autocorrelation was particularly significant in the middle-aged groups (45-64 years) and was more pronounced in females (MI=0.537, $p<0.001$) than in males (MI=0.512, $p<0.001$). All-cause mortality clustering in old age was more significant in females (MI=0.491, $p<0.001$) than in males (MI=0.248, $p<0.05$). For young adults (20-44 years), the global autocorrelation index was higher for males (MI=0.241, $p<0.01$) than for females (MI=0.236, $p<0.01$). In the case of infant mortality and mortality among children and adolescents (1-19 years), there was insufficient evidence to reject the hypothesis of spatial randomness ($p>0.05$).

Global spatial autocorrelation showed statistically significant results for three groups of causes of death: diseases of the circulatory and digestive systems for both sexes and external causes of death for males. Digestive system diseases had the highest values, more pronounced in females (MI=0.597, $p<0.001$) than in males (MI=0.422, $p<0.001$). Circulatory system diseases had almost the same effect on spatial disparities in mortality in males (MI=0.319, $p<0.01$) and females (MI=0.300, $p<0.01$). The global autocorrelation index computed for external causes of death showed statistically significant results only for males (MI=0.162, $p<0.05$).

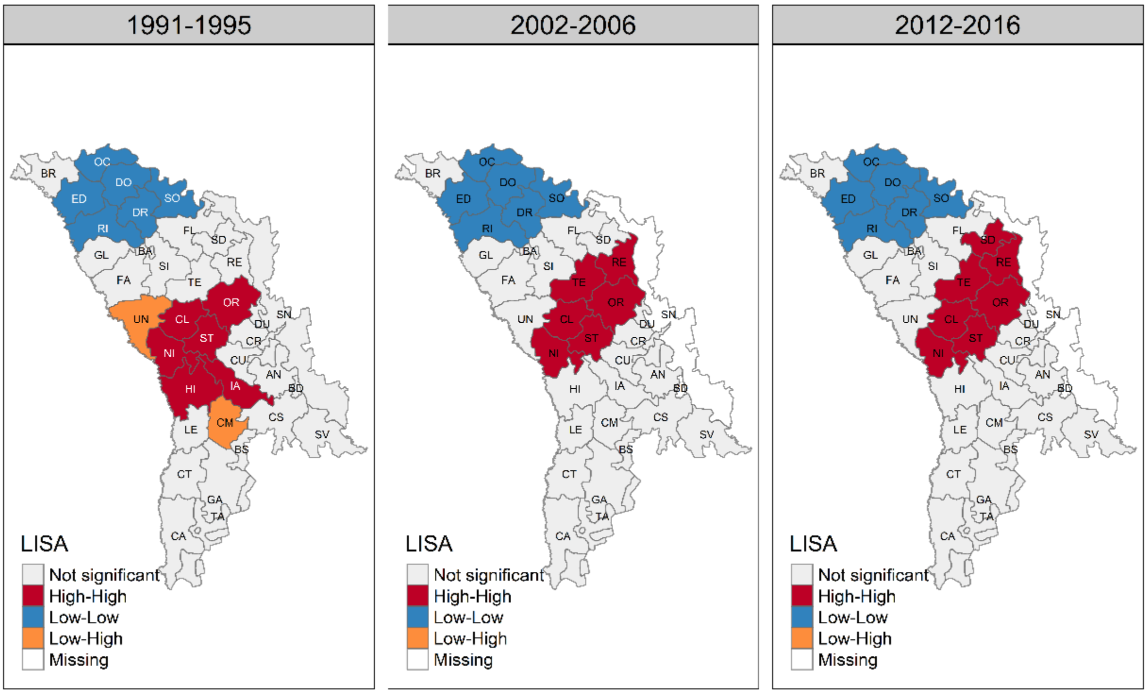

Fig. 6.3 LISA map for SMR from liver cirrhosis in Moldova in 1991-1995, 2002-2006 and 2012-2016, both sexes

Note: p-value < 0.001 (number of permutations = 9999)
Source: author's calculations based on NBS and NAPH data.

Local spatial autocorrelation techniques were utilized to detect "high-high" and "low-low" mortality clusters, referring to districts with either high or low mortality rates surrounded by districts with the same levels of mortality. "Hot" spots or "high-high" mortality clusters were identified in the central region for all causes of death, as well as for diseases of the digestive and circulatory systems. In contrast, "cold" spots or "low-low" mortality clusters were observed in the northern region. The municipality of Chisinau was identified as a spatial outlier for all-cause mortality, positioned in a "low-high" quadrant of Moran's scatterplot, signifying a locality with low mortality surrounded by localities with high mortality. The most prominent "high-high" mortality cluster, with the highest Moran's I, was found for cirrhosis of the liver in the central region and included the following districts: Soldanesti, Rezina, Telenesti, Orhei, Calarasi, Straseni and Nisporeni (Figure 6.3).

A "high-high" mortality cluster was detected in the southern region for cerebrovascular diseases and in the central region for heart diseases. The clustering of male mortality from external causes was primarily driven by deaths from suicide, homicide and undetermined injuries. The districts with "high-high" mortality from these external causes of death were mainly located on the border between the central and southern regions, encompassing the districts of Hincesti, Leova and Cimislia.

6.4. Evolution of regional mortality disparities after independence

The evolution of regional disparities in mortality by cause of death was analysed for three five-year periods: 1991-1995, 2002-2006 and 2012-2016. In the first period, life expectancy at birth exceeded the national average (66.9 years for both sexes) by two years or more in the capital and some northern districts (Rascani, Briceni), as well as in the municipality of Balti (Figure 6.4). Conversely, in the central and some southern districts (Calarasi, Straseni, Soldanesti, Dubasari, Basarabeasca), the values of this indicator were about three years lower than the national average and even five years lower than in the capital. Between 1991-1995 and 2002-2006, life expectancy at birth did not change considerably at the national level (67.3 years) and the regional level. Changes in life expectancy in 2002-2006 were broadly within the 1991-1995 confidence intervals for most districts, including the capital. The exception was the municipality of Chisinau, where the situation worsened considerably (68.9±0.3 years in 1991-1995 compared to 67.2±0.4 in 2002-2006).

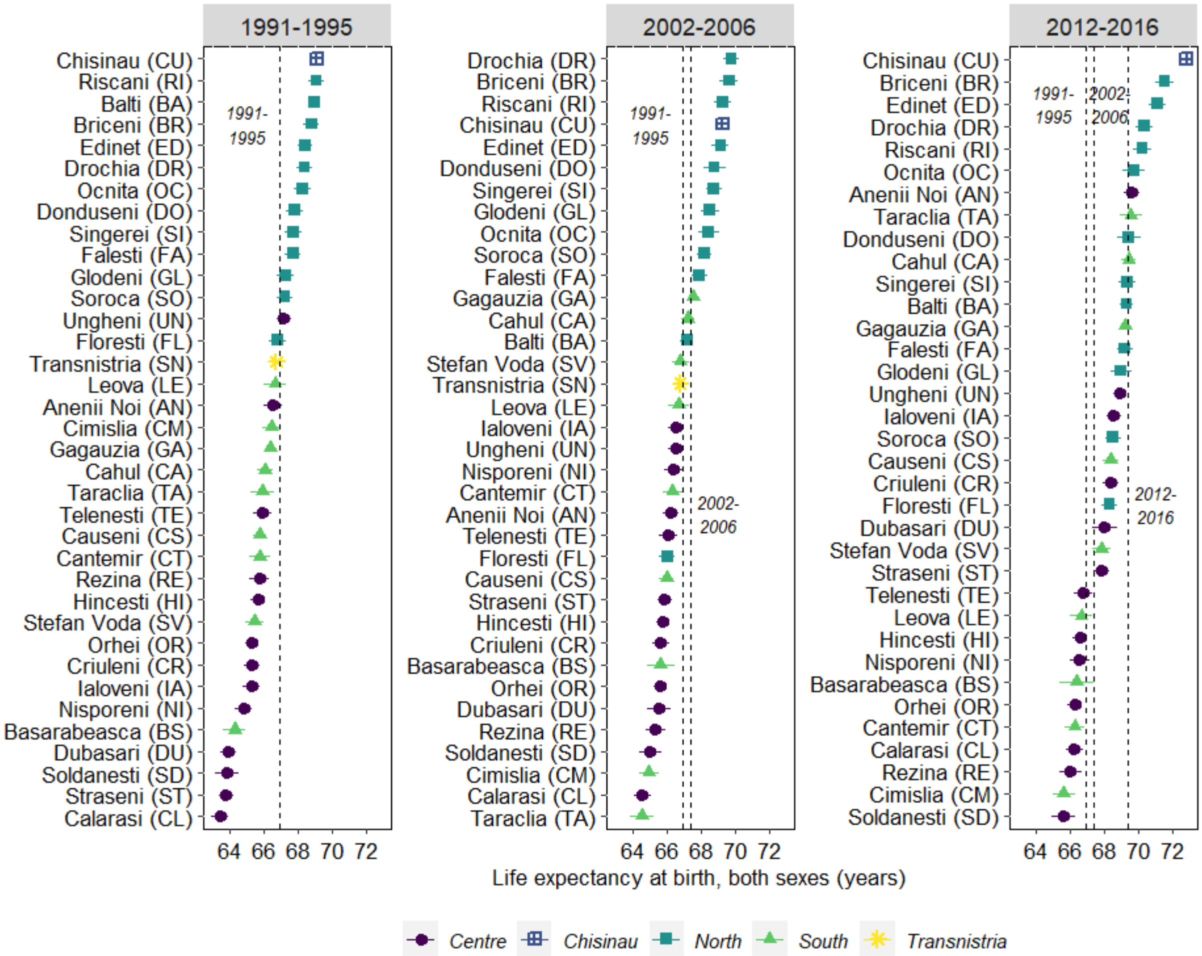

Fig. 6.4 Life expectancy at birth by district in 1991-1995, 2002-2006 and 2012-2016, Moldova, both sexes (years)

Note: Vertical lines refer to life expectancy in Moldova over three periods.
Source: author's calculations based on NAPH, NBS and Transnistrian statistical office data.

In the period 2012-2016, compared to 2002-2006, life expectancy at birth experienced a nationwide increase of two years (69,4 years), but the progress was not uniform across the country. The most significant gains in the indicator (more than three years) were achieved in the municipality of Chisinau, as well as in some districts directly adjacent to it (Anenii Noi, Criuleni) and in Taraclia, which held the last position in the early 2000s. However, in the rest of the country, including the northern districts, progress in life expectancy has been much more moderate.

Nevertheless, due to their better initial positions, the health situation of the population in the north of the country in 2012-2016 remained better than in the southern or central districts. Recent progress barely reached the districts in the red belt of high mortality, where life expectancy matched the level observed in the early 1990s or was even lower.

Based on the hierarchical analysis of age-specific life expectancies, three population clusters were identified. In the first two study periods, the best-off group included most of the northern districts and the capital ($e_{0,\ 1991\text{-}95}$=69.0±0.3 years), while the worst-off group covered mainly the central and some southern districts ($e_{0,\ 1991\text{-}95}$=65.2±0.4 years). In the third period, the best-performing group was restricted to the capital and two northern districts (Briceni and Edinet), where the lower limits of life expectancy at birth were higher than the national level ($e_{0,\ 2012\text{-}16}$=72.5±0.3 years). At the same time, the worst-performing group extended to eleven districts, thus forming the red belt of high mortality ($e_{0,\ 2012\text{-}16}$=66.3±0.4 years) (Figure 6.5).

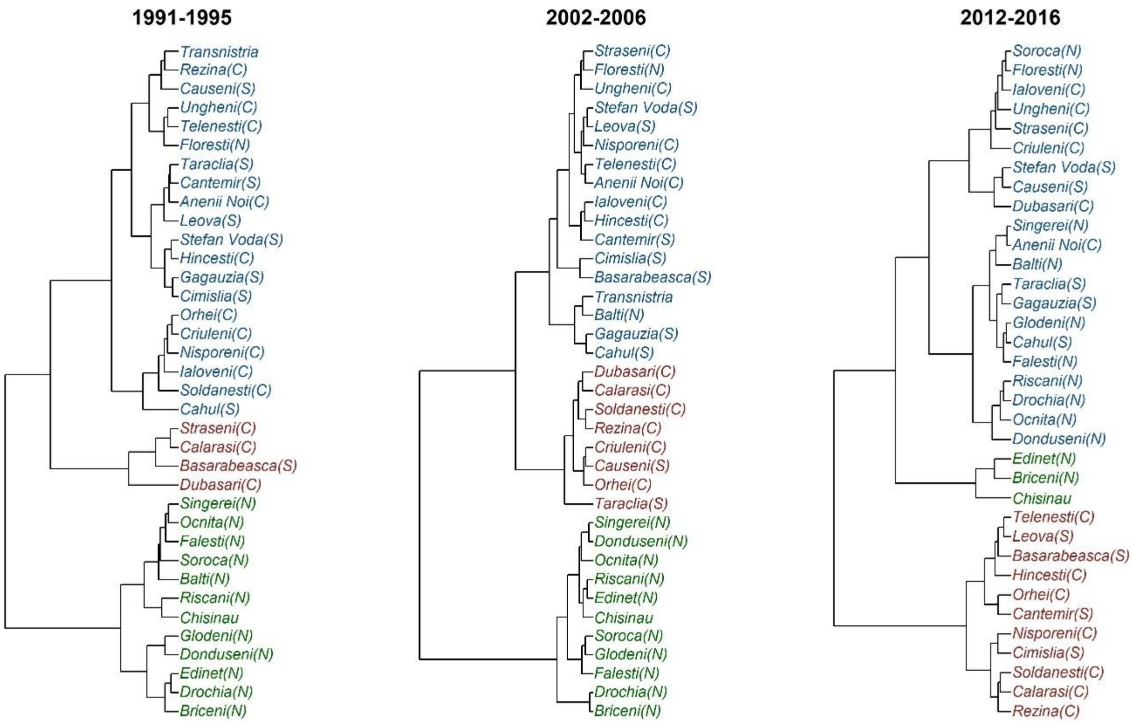

Fig. 6.5 Dendrogram based on hierarchical analysis of life expectancy by age in 36 administrative units for three periods, both sexes

Note: Data for Transnistria are missing for 2012-2016. N=North, C=Centre, S=South.
Source: author's calculations based on NAPH, NBS and Transnistrian statistical office data.

The difference in life expectancy at birth between 1991-1995 and 2012-2016 in the identified three clusters was decomposed by age and cause of death. Progress in the *lagging cluster* (1.1 years) was mainly associated with a reduction in infant mortality from diseases of the respiratory system and external mortality among young adults. However, this improvement was partly offset by increased mortality from neoplasms among middle-aged adults. Concurrently, in the *leading cluster*, the increase in life expectancy at birth (3.5 years) was associated with a decrease in mortality from diseases of the circulatory system among the elderly, external causes of death among young and middle-aged adults and infant mortality from the residual group of causes.

The decline in cardiovascular mortality decline among older adults in the best-off population subgroup provides evidence of the beginning of the cardiovascular revolution in this geographical area. However, no similar changes have occurred during the independence in the laggard area, where high adult mortality from diseases of the circulatory system continues to remain the principal component of low life expectancy.

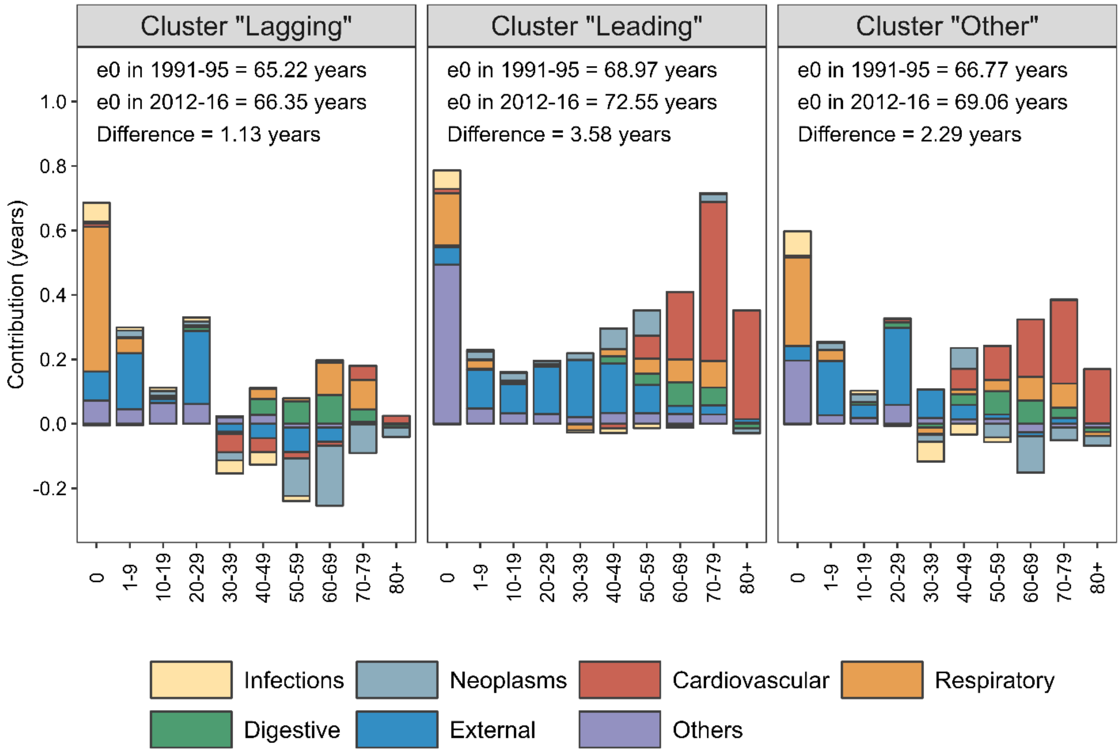

Fig. 6.6 Contributions of changes in mortality by age and cause of death to the difference in life expectancy at birth (e_0) between 1991-1995 and 2012-2016 in three geographical clusters, Moldova, both sexes

Source: author's calculations based on NAPH, NBS and Transnistrian statistical office data.

FINAL CONCLUSIONS

According to the study's objectives, the following results were obtained:

1) At the national level, the intercensal population estimates according to the HMD methodology for 1959-2003 (in collaboration with D. Jdanov and P. Grigoriev) were supplemented with intercensal population estimates for 2004-2013 and official post-census population estimates for 2014-2020. The use of official "de jure" population estimates leads to a progressive underestimation of post-independence mortality rates, thereby distorting the overall trend. In 2019, the difference in life expectancy at birth computed based on the "de jure" and usual resident population reached 3.24 years for males and 2.58 years for females. Population estimates by place of residence, marital status and level of education were adjusted using census and HMD-like data.

To address data quality issues, infant and old-age mortality were adjusted at the national level, particularly due to severe problems observed in the 1960s and 1970s. The combined impact of corrections for infant and old-age mortality on life expectancy at birth amounted to 4.5 years for males and 5.6 years for females in 1960. However, after 1977, the effect of these corrections was less than 0.2 years.

The continuous series of deaths were reconstructed according to ICD-10 for the period 1965-2020 at the national level, covering 211 causes of death. A special distribution method was introduced for deaths coded as "Senility" within the categories of cardiovascular diseases in the 1990s, and this approach was replicated at both sub-national and district levels. The resulting database was then integrated into the international HCD database. The primary practical value of this study lies in providing researchers with reliable data on population and causes of mortality, essential for analysing the long-term trends in mortality in Moldova since 1965 (*objectives 1 and 2, sections 3.1 and 3.2, implementation acts in annexes 16-18*).

2) Despite the large fluctuations in mortality induced by the 1985 anti-alcohol campaign and the socio-economic crisis of the 1990s, life expectancy at birth declined for males (-2.3 years) or stagnated for females (+1.9 years) from 1965 until 2005, followed by moderate improvements (+3.9 years for males; +4.1 years for females between 2005 and 2019). The decomposition of the difference in life expectancy at birth showed that the period of deterioration (1965-2005) was associated with a substantial increase in mortality among adults aged 15 years and over, especially in males (-5.3 years), partly offset by progress in infant mortality (+2.5 years). The improvement period (2005-2019) was mainly attributable to a decrease in mortality from cardiovascular diseases (+0.9 years for males and +2.0 years for females) and external causes of death for males (+1.1 years). Between 1965 and 2020, the standardised death rates among the middle-aged increased for ischaemic heart diseases (2.4 times in males), suicide (2.0 times in males), homicide (2.6 times in males), undetermined injury (16 times in males), liver cirrhosis (4.4 times in males and females), malignant neoplasms of the lung (50% in males), breast (2.2 times in females) and intestine (3.4 times in males). At the same time, visible reductions were achieved in mortality from stomach cancer (2.7 times in males), uterus cancer (48%) and tuberculosis (4.9 times). In contrast to Ukraine or Romania, in Moldova, where a hazardous type of Mediterranean drinking culture is widespread, cirrhosis of the liver had a significant negative impact on life expectancy during the Soviet period, especially among middle-aged women. The COVID-19 pandemic reduced life expectancy at birth by about one year and impacted the cause-of-death mortality pattern in 2020. Based on standardised weekly death rates, four waves were detected with peak values in mid-December 2020, March 2021, October 2021 and February 2022.

The study's theoretical significance lies in the fact that, based on the reconstructed mortality series, we have examined long-term mortality trends through the prism of health transition theory. The high adult mortality from non-communicable diseases and "man-made" diseases, as defined by A. Omran (cardiovascular diseases, neoplasms, external causes of death), indicates that the second stage of the health transition in Moldova is still incomplete. The cardiovascular revolution has not yet occurred at the national level (*objective 3, sub-chapters 4.1, 4.2 and 4.3*).

3) Excess mortality in Moldova, compared to the European model, was concentrated between the ages of 40 and 70 in men and 50 and 80 in women. In 2019, 27% of deaths under the age of 70 in males and 13% in females were excessive compared to the model. Circulatory system diseases accounted for 45% of excess deaths in men and 55% in women under age 70. Digestive system diseases accounted for 17% of excess deaths in males and 26% in females. Excess mortality before age 70 from external causes of death was 17% among men. The influence of other causes, including neoplasms, was 10% or less. Between 2001 and 2019, excess mortality increased by 17% in males and declined by 28% in females. In males, the increase in excess mortality was primarily due to the cardiovascular component, fully offsetting the moderate progress in external causes of death (*objective 4, sub-chapter 4.4*).

4) During the period of independence, the urban population, on average, lived 2.5 years longer than the rural population, except for the period 2003-2005 and the COVID-19 pandemic (2020), when the advantage of living in urban areas decreased. A positive rural-urban mortality gradient was found for all major causes of death except neoplasms. Inequalities regarding all-cause mortality were highest among young adults and decreased with age. Diseases of the circulatory and digestive systems in both men and women, external causes of death and respiratory system diseases in men were the main factors contributing to the absolute differences in mortality between rural and urban areas.

Between 1991-1993 and 2017-2019, the rural-urban gradient in all-cause mortality decreased for women (RD was reduced by 24.7%, p-value<0.05), but it stagnated for men. For both sexes, a more rapid reduction in mortality from circulatory system diseases and a more rapid increase in mortality from neoplasms in rural areas compared to urban areas narrowed the gap between the two settings. Conversely, faster improvements in mortality from respiratory system diseases and external causes of death in urban males compared to rural males accentuated the rural-urban mortality differentials. During the 1990s, the socio-economic crisis had a more significant impact on the urban population, primarily leading to an increase in cardiovascular mortality (RD decreased by 66% in males and 41% in females between 1991-1993 and 2003-2005, p<0.05). Conversely, the rural population experienced a notable rise in mortality from respiratory system diseases during the same period (RR increased by 30% in males and 45% in females, p<0.05).

The recent improvement in life expectancy observed at the national level since 2005 was accompanied by growing health inequalities between rural and urban populations. The reduction in cardiovascular mortality and external causes of death between 2003-2005 and 2014-2016 was more significant in urban areas than in rural ones. While cancer mortality consistently remained higher in urban areas, both absolute and relative differences have been decreasing recently due to a faster deterioration in rural areas. However, the COVID-19 pandemic levelled absolute and relative differences in all-cause mortality between the two settings *(objective 5, sub-chapter 5.1)*.

5) Marital status and level of education had significant effects on all-cause and cause-specific mortality for both men and women. The most disadvantaged groups were divorced men, never-married women and those with primary education or less. Conversely, marital status and higher education had a protective effect for both sexes. In 2013-2014, the difference in life expectancy at age 30 between divorced men or never-married women and their married counterparts was more than 12 years. On the other hand, the difference between those with a higher education and those with a primary or lower education was more than ten years for men and nine years for women. Mortality disparities by marital status and education were most pronounced among young adults and diminished with age.

The *absolute differences* in all-cause mortality by marital status were primarily attributable to a higher risk of dying from circulatory system diseases among non-married males (40-63%) and females (64-77%). The impact of external causes of death and respiratory system diseases was especially pronounced for never-married males. Excess mortality from neoplasms was more strongly associated with divorced status for both sexes (13% in males and 18% in females) than with other non-married categories. The absolute differences in all-cause mortality by level of education were explained by higher mortality from circulatory system diseases for both sexes, external causes of death and respiratory system diseases for men and digestive system diseases for women. Neoplasm mortality was not differentiated statistically significantly by the level of education, except for lung cancer in males. The most striking *relative differences* in mortality were attributable to infectious diseases (RR exceeded 7.0 times in 2013-2014, $p<0.05$), respiratory system diseases and external causes of death in divorced males, never-married females and the population with primary or lower education.

In the period between the two censuses, the increase in life expectancy at 30 years, observed at the national level, was registered among married and widowed persons, as well as among men with higher education and the population with primary education or less. At the same time, the situation worsened significantly for divorced women (-2.36 years, $p<0.05$), while it remained virtually unchanged for the other marital and educational categories *(objective 6, sections 5.2 and 5.3)*.

6) The mortality gradient was evident between the northern districts and the municipality of Chisinau, where life expectancy was relatively high, and the central districts, where life expectancy was relatively low. The north-central mortality gradient was more pronounced in females than males and decreased with age. The following eleven backward districts, where life expectancy at birth in 2012-2016 was lower than the national average in 1991-1995, fall into the *red belt of high mortality*: Soldanesti, Rezina, Telenesti, Orhei, Calarasi, Nisporeni and Hincesti (central region) and Cantemir, Leova, Cimislia and Basarabeasca (southern region). Interregional differentiation of life expectancy at birth was mainly attributed to mortality differences among young and middle-aged adult males and middle-aged and older adult females. Diseases of the circulatory and digestive systems for both sexes and external causes of death for men contributed to the regional variation in life expectancy *(objective 7, sections 6.1 and 6.2)*.

7) The hierarchical analysis of life expectancies by age identified three geographical subgroups of the population. The two extreme subgroups each contained around 20% of the population. In 2012-2016, the best-off group was represented by the municipality of Chisinau and the two northern districts of Briceni and Edinet (e_0=72.5±0.3 years). The worst-off group included eleven districts falling into the red belt of high mortality (e_0=66.3±0.4 years). In 2012-2016, compared to 1991-1995, most of the northern districts and the municipality of Balti lost their leading position in terms of life expectancy and were classified as a residual subgroup of the population. The increase in life expectancy at the national level after 2005 was accompanied by an increase in interregional inequalities in mortality. The difference in life expectancy at birth between the two extreme population subgroups increased from 3.69 years in 2002-2006 to 6.21 years in 2012-2016, mainly due to the cardiovascular mortality component (from 1.13 years vs 2.24 years).

Between 1991-1995 and 2012-2016, the growth of life expectancy at birth in the best-off group (change in e_0=+3.58 years) was due to reductions in cardiovascular mortality among older adults and in external causes of death among young and middle-aged adults. In the worst-off group (change in e_0=+1.13 years), the moderate decrease in infant mortality associated with respiratory diseases was offset by increased mortality from external causes and neoplasms in middle-aged people. There has been no progress in cardiovascular mortality in the laggard population subgroup *(objective 7, section 6.4)*.

8) The global spatial autocorrelation index was positive and statistically significant for standardised mortality rates from all causes of death combined (Moran's I was 0.474 in males and 0.441 in females, $p<0.001$), from diseases of the digestive system and diseases of the circulatory system for both sexes and from external causes of death for men. The highest values were found for females aged 45-64 years (MI=0.537, $p<0.001$) and for diseases of the digestive system (MI=0.597 in women, $p<0.001$). In the central region, "high-high" mortality clusters were found for all causes of death, diseases of the digestive system, diseases of the circulatory system, cirrhosis of the liver and heart diseases. "Low-low" mortality clusters for the same causes of death were found in the northern region. In the south, a "high-high" mortality cluster was found for cerebrovascular disease and cancer of the digestive system. In the districts on the border between the central and southern regions (Hâncești, Leova, Cimislia), a "high-high" mortality cluster was found for external causes of death, including deaths from suicide, homicide and undetermined injuries. The municipality of Balti was found to be a spatial outlier for infectious diseases and cancers of various sites *(objective 8, section 6.3)*.

9) The *scientific problem addressed in the thesis* is the presentation of a new direction in the analysis of long-term trends and social and interregional differentiation of mortality by cause of death in the Republic of Moldova, taking into account the assessment of the quality of primary data. The time series of deaths, reconstructed according to ICD-10 for the period 1965-2020, meet the international requirements of comparability, completeness and regularity of data. Comparative analysis of the reconstructed series ensures data compatibility across countries over time.

RECOMMENDATIONS

The following recommendations to monitor/investigate mortality data and to reduce the social and regional disparities in mortality in Moldova were elaborated *(objective 9)*.

To the National Bureau of Statistics, NAPH, MH, interested scientific institutions:

1) The reconstructed mortality series in the HCD Database are recommended to monitor/analyse all-cause and cause-specific mortality in Moldova. The population counts provided in the database are recommended to be used to analyse demographic and social phenomena in the country since 1965 (based on the results presented in Chapter 3, implementing acts in annexes 16-18).

2) Reducing excess mortality up to the age of 70 in Moldova compared to European countries, and consequently reducing the gap in life expectancy at birth, can be achieved by reducing adult mortality from diseases of the circulatory system, cirrhosis of the liver (in both sexes), external causes of death (in men), and neoplasms (based on the results presented in subchapter 4.4).

To NAPH and MH

3) Disparities by place of residence can be narrowed by reducing mortality in rural areas from circulatory and digestive system diseases among men and women and external causes of death and respiratory system diseases among men (based on the results presented in subchapter 5.1).

4) Social disparities by marital status and by the level of education can be addressed by reducing mortality among social groups identified as most vulnerable: divorced men, never-married women and the adult population with primary education or less aged 30 and over. In these social groups, especially between 30 and 49 years of age, attention should be paid to preventive measures to combat risk factors for infectious diseases, respiratory diseases, liver cirrhosis and external causes of death (based on the results presented in subchapters 5.2 and 5.3).

5) Regional disparities in life expectancy at birth can be lessened by reducing adult mortality in the following districts identified as „the red belt of high mortality”: Soldanesti, Rezina, Telenesti, Orhei, Calarasi, Nisporeni and Hincesti, Cantemir, Leova, Cimislia and Basarabeasca. In this group of districts, it is necessary to strengthen preventive measures targeting the main risk factors for cardiovascular disease and liver cirrhosis for both sexes and external causes of death for men. The municipality of Balti must be a priority administrative unit in the health programs aimed at reducing cancer mortality (based on the results presented in Chapter 6).

Suggestions for future research:

6) Long-term mortality series reconstructed according to ICD-10 can be used for the analysis of other aspects of mortality in the Republic of Moldova, such as avoidable mortality, analysis of mortality by demographic cohorts and demographic forecasting of life expectancy.

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LIST OF SCIENTIFIC AND SCIENTIFIC-METHODICAL PUBLICATIONS

1. Monographs

1.1. ***single-author monographs***

1.1.1. **PENINA, O**. *Regional mortality disparities in the Republic of Moldova*. Chisinau: CEP *Medicina*, 2022. 116 p. ISBN 978-9975-82-234-3. https://library.usmf.md/ro/library/medicina-sociala-si-management/penina-o-regional-mortality-disparities-republic-moldova

1.2. ***Collective monographs***

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Adnotare

Penina Olga
Disparitățile socio-demografice și regionale ale mortalității în Republica Moldova
Teză de doctor habilitat în științe medicale
Chișinău, 2023

Structura tezei: introducere, șase capitole, concluzii generale și recomandări practice, bibliografie (212 surse), 18 anexe, 247 pagini de text de bază, 119 figuri și 35 tabele. Rezultatele obținute sunt publicate în 41 de lucrări științifice.

Cuvinte-cheie: mortalitate, cauze de deces, diferențiere regională, disparități sociale, stare civilă, nivel de educație, exces de mortalitate, tranziție epidemiologică.

Scopul lucrării: examinarea tendințelor de lungă durată și a diferențelor sociale și regionale ale mortalității în Republica Moldova în contextul evaluării calității datelor și elaborarea recomandărilor privind îmbunătățirea monitorizării mortalității și reducerea disparităților în materie de mortalitate.

Obiectivele cercetării: 1) Evaluarea calității datelor privind populația și mortalitatea la nivel național, subnațional și raional și propunerea metodelor de corecție pentru datele problematice; 2) Reconstituirea continuității seriilor de mortalitate conform CIM-10 în Republica Moldova pentru perioada 1965-2020; 3) Analiza schimbărilor în tendințele și modelele pe termen lung ale mortalității după vârstă și cauze de deces în Republica Moldova și determinarea trăsăturilor comune și a particularităților acestora în comparație cu România și Ucraina; 4) Evaluarea mortalității excesive după vârstă și principalele cauze de deces în Republica Moldova în comparație cu modelul european; 5) Examinarea schimbărilor în mortalitatea generală și specifică pe cauze de deces în funcție de mediul de reședință; 6) Examinarea disparităților în mortalitatea generală și specifică pe cauze de deces în funcție de starea civilă și nivelul de educație; 7) Analiza profilului geografic al speranței de viață și al mortalității după vârstă și cauze de deces; 8) Detectarea clusterelor de raioane cu niveluri similare de mortalitate pe cauze de deces prin analiza autocorelației spațiale; 9) Elaborarea de recomandări practice pentru îmbunătățirea monitorizării mortalității și reducerea disparităților în materie de mortalitate în Republica Moldova.

Noutatea și originalitatea științifică: 1) Sistematizarea principalelor probleme de calitate a datelor privind populația și mortalitatea și armonizarea datelor la nivel național, subnațional și raional; 2) Reconstituirea continuității seriilor de mortalitate conform unei clasificări fixe a cauzelor de deces în Republica Moldova pentru perioada 1965-2020; 3) Elaborarea tabelelor de mortalitate în funcție de caracteristicile socio-demografice la nivel național, subnațional și raional; 4) Identificarea subgrupurilor de populație fruntașe și rămase în urmă în ceea ce privește speranța de viață și mortalitatea în funcție de mediul de reședință, starea civilă, nivelul de educație și localizarea geografică; 5) Determinarea componentelor după vârstă și cauză de deces ale diferențierii interregionale a speranței de viață și evaluarea modificărilor acestora pe parcursul perioadei de independență; 6) Detectarea clusterelor spațiale cu mortalitate similară scăzută sau ridicată după cauza de deces în baza autocorelației spațiale.

Problema științifică soluționată în teză: Studiul propune o nouă abordare în analiza evoluției tendințelor pe termen lung și a disparităților sociale și regionale în mortalitatea după cauza de deces în Republica Moldova, având în vedere evaluarea calității datelor primare. Seriile cronologice ale deceselor, reconstituite conform CIM-10 pentru perioada 1965-2020, corespund cerințelor internaționale de comparabilitate, completitudine și regularitate a datelor. Analiza comparativă a seriilor reconstituite asigură compatibilitatea datelor între țări de-a lungul timpului.

Semnificația teoretică: Teza reprezintă un studiu comprehensiv al tendințelor pe termen lung și al disparităților sociale și regionale în ceea ce privește speranța de viață și mortalitatea după cauza de deces în Republica Moldova, cu accent pe aspectele legate de calitatea datelor. Modificările mortalității specifice pe cauze de deces la nivel național, subnațional și raional sunt examinate prin prisma teoriei tranziției epidemiologice și a interpretărilor ulterioare, cum ar fi teoria tranziției în domeniul sănătății, care vizează explicarea diferențelor în tendințele și modelele mortalității în timp și între populații.

Valoarea aplicativă: Rezultatele studiului pot constitui baza pentru consolidarea politicilor de sănătate publică în vederea creșterii speranței de viață a populației și reducerii disparităților în mortalitate. Rezultatele analizei spațiale a diferențierii interregionale a mortalității pot fi aplicate în cadrul politicilor de dezvoltare regională. Rezultatele studiului pot fi utilizate în cercetarea și predarea în domeniile demografiei și sănătății publice.

Implementarea rezultatelor științifice: Baza de date a seriilor de mortalitate reconstituite pentru Republica Moldova a fost integrată în baza de date internațională, The Human Cause-of-Death Database, coordonată de Institutul Național pentru Studii Demografice din Franța și Institutul Max Planck pentru Cercetări Demografice din Germania.

Аннотация

Пенина Ольга

Социально-демографические и региональные различия смертности в Республике Молдова

Диссертация доктор хабилитат медицинских наук, Кишинев, 2023

Структура диссертации: диссертация состоит из введения, шести глав, общих выводов и практических рекомендаций, библиографии (212 ссылок), 18 приложений, 247 страниц основного текста, 119 рисунков и 35 таблиц. Полученные результаты опубликованы в 41 научной работе.
Ключевые слова: смертность, причины смерти, региональная дифференциация, социальные различия, семейное положение, уровень образования, избыточная смертность, эпидемиологический переход.
Цель исследования: изучение долгосрочных тенденций, социальных и региональных различий в смертности в Республике Молдова в контексте оценки качества данных и разработка рекомендаций по совершенствованию мониторинга смертности и сокращению её неравенства.
Задачи исследования: 1) Оценить качество данных о населении и смертности на национальном, субнациональном и районном уровнях и предложить методы коррекции проблемных данных; 2) Восстановить непрерывность рядов смертности по МКБ-10 в Республике Молдова за 1965-2020 годы; 3) Проанализировать изменения в долгосрочных тенденциях и структуре смертности по возрасту и причинам смерти в Республике Молдова и определить их общие черты и особенности по сравнению с Румынией и Украиной; 4) Оценить избыточную смертность по возрастным группам и основным классам причин смерти в Республике Молдова по сравнению с европейской моделью; 5) Изучить изменения общей смертности и смертности по причинам смерти в зависимости от типа поселения (сельская/городская); 6) Изучить различия в общей смертности и смертности от отдельных причин смерти в зависимости от семейного положения и уровня образования; 7) Проанализировать географический профиль ожидаемой продолжительности жизни и смертности по возрасту и причинам смерти; 8) Выявить кластеры районов со схожим уровнем смертности в зависимости от причины смерти на основе анализа пространственной автокорреляции; 9) Разработка практических рекомендаций по совершенствованию мониторинга смертности и снижению неравенства в смертности в Республике Молдова.
Новизна и научная оригинальность: 1) Систематизация основных вопросов качества данных о населении и смертности и гармонизация данных на национальном, субнациональном и районном уровнях; 2) Восстановление непрерывности рядов смертности по фиксированной классификации причин смерти в Республике Молдова за 1965-2020 годы; 3) Разработка таблиц смертности по социально-демографическим характеристикам на национальном, субнациональном и районом уровнях; 4) Выявление ведущих и отстающих групп населения по уровню продолжительности жизни и смертности в зависимости от типа поселения, семейному положению, уровню образования и географическому расположению; 5) Определение компонентов межрегиональной дифференциации продолжительности жизни по возрасту и причинам смерти и оценка их изменений за период независимости; 6) Выявление пространственных кластеров с одинаково низкой или высокой смертностью по причинам смерти на основе пространственной автокорреляции.
Научная проблема, решаемая в диссертации: Исследование представляет новое направление в анализе эволюции долгосрочных тенденций, социальной и межрегиональной дифференциации смертности по причинам смерти в Республике Молдова с учетом оценки качества первичных данных. Временные ряды смертности, реконструированные в соответствии с МКБ-10 за 1965-2020 годы, отвечают международным требованиям сопоставимости, полноты и регулярности данных. Сравнительный анализ реконструированных рядов обеспечивает сопоставимость данных между странами во времени.
Теоретическая значимость: Диссертация представляет собой комплексное исследование долгосрочных тенденций, социальных и региональных различий в смертности по причинам смерти в Республике Молдова с акцентом на вопросы качества данных. Изменения в смертности по причинам смерти на национальном, субнациональном и районном уровнях рассматриваются сквозь призму теории эпидемиологического перехода и ее последующих интерпретаций, направленных на объяснение различий в тенденциях и моделях смертности во времени и между популяциями.
Прикладное значение: Результаты исследования могут служить основой для укрепления политики общественного здравоохранения, направленной на увеличение продолжительности жизни населения и сокращение неравенств в смертности. Результаты пространственного анализа межрегиональной дифференциации смертности могут быть применены в политике регионального развития. Результаты исследования могут быть использованы в исследовании и преподавании в области демографии и общественного здравоохранения.
Внедрение научных результатов: База данных реконструированных рядов смертности для Молдовы была интегрирована в международную базу данных The Human Cause-of-Death Database, координаторами которой являются Национальный институт демографических исследований во Франции и Институт демографических исследований Макса Планка в Германии.

Annotation

Penina Olga
Socio-demographic and Regional Disparities of Mortality in the Republic of Moldova
Doctoral Habilitation Thesis in Medical Sciences
Chisinau, 2023

Structure of thesis: the thesis consists of an introduction, six chapters, general conclusions and practical recommendations, a bibliography (212 references), 18 annexes, 247 pages of the main text, 119 figures and 35 tables. The obtained results are published in 41 scientific papers.

Keywords: mortality, causes of death, regional differentiation, social disparities, marital status, level of education, excess mortality, epidemiological transition.

Aim of the study: To examine the long-term trends and social and regional differences in mortality in the Republic of Moldova in the context of data quality assessment and to develop recommendations to improve mortality monitoring and reduce disparities in mortality.

Study's objectives: 1) To assess the quality of population and mortality data at the national, sub-national and district levels and to propose the methods of correction of the problematic data; 2) To reconstruct the continuity of mortality series according to the ICD-10 in the Republic of Moldova for the period 1965-2020; 3) To analyse changes in long-term trends and patterns in mortality by age and cause of death in Moldova and to determine their commonalities and peculiarities compared to Romania and Ukraine; 4) To evaluate excess mortality by age and main cause of death in the Republic of Moldova compared to the European model; 5) To examine changes in overall and cause-specific mortality by place of residence (rural/urban); 6) To examine overall and cause-specific mortality disparities by marital status and the level of education; 7) To analyse the geographical profile of life expectancy and mortality by age and cause of death; 8) To detect clusters of districts with similar levels of mortality by cause of death based on spatial autocorrelation analysis; 9) To develop practical recommendations for improving mortality monitoring and reducing mortality disparities in the Republic of Moldova.

Novelty and scientific originality: 1) Systematization of main data quality issues on population and mortality and data harmonization at the national, sub-national and district levels; 2) Reconstruction of the continuity of mortality series according to a fixed classification of causes of death in Moldova in 1965-2020; 3) Elaboration of life tables by socio-demographic characteristics at the national, sub-national and district levels; 4) Identification of the vanguard and laggard sub-populations in terms of life expectancy according to the place of residence, marital status, level of education and geographical area of living; 5) Determination of the components by age and cause of death of the inter-regional differentiation in life expectancy and assessment of their changes over independence; 6) Detection of the spatial clusters with similar low or high mortality by cause of death based on spatial autocorrelation.

Scientific problem solved in the thesis: The study presents a new direction in analysing the evolution of the long-term trends and social and interregional differentiation of mortality by cause of death in Moldova, taking into account the assessment of the quality of primary data. The time series of deaths, reconstructed according to ICD-10 for the period 1965-2020, meet the international requirements of comparability, completeness and regularity of data. Comparative analysis of the reconstructed series ensures data compatibility across countries over time.

Theoretical significance: The thesis represents a comprehensive study of the long-term trends and social and regional disparities in mortality by cause of death in the Republic of Moldova, focusing on data quality issues. Changes in cause-specific mortality at the national, sub-national and district levels are examined through the prism of the epidemiologic transition theory and its subsequent interpretations aimed at explaining differences in mortality trends and patterns over time and between populations.

Applicative value: The study results can form the basis for strengthening public health policies to increase population life expectancy and reduce mortality disparities. The results of the spatial analysis of interregional differentiation of mortality can be applied to regional development policies. The results of the study can be used for research and teaching in the field of demography and public health.

Implementation of scientific results: The reconstructed mortality series database for the Republic of Moldova has been integrated into the international database, The Human Cause-of-Death Database, coordinated by the National Institute for Demographic Studies in France and the Max Planck Institute for Demographic Research in Germany.

PENINA OLGA

SOCIO-DEMOGRAPHIC AND REGIONAL DISPARITIES OF MORTALITY IN THE REPUBLIC OF MOLDOVA

331.03. SOCIAL MEDICINE AND MANAGEMENT

Abstract of the Doctoral Habilitation Thesis in Medical Sciences

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