SOCIO-DEMOGRAPHIC DETERMINANTS OF MORTALITY IN THE REPUBLIC OF MOLDOVA

Olga PENINA, Habilited doctor in medicine,
***Nicolae Testemitanu* State University of Medicine and Pharmacy, Moldova,**
https://orcid.org/0000-0002-3884-2751, olga.penina@usmf.md

DOI: https://doi.org/10.36004/nier.cecg.2023.17.6

Abstract. *The study examines the influence of socio-demographic determinants, particularly marital status and educational attainment, on disparities in overall and cause-specific mortality in Moldova.* ***Material and methods****: Based on the depersonalised databases of death records, which include detailed ICD-10 cause-of-death data categorised by marital status and educational attainment, we analysed mortality patterns for the population aged 30 years and over during two periods around the 2004 and 2014 censuses. Absolute and relative differences in standardised death rates with 95% CIs were calculated. The reference groups were the married population and the population with higher education.* ***Results****: Significant differences in all-cause and cause-specific mortality according to marital status and educational level were found for both sexes. Particularly vulnerable groups included divorced men, never-married women and men and women with primary education or less. Marriage and higher education had a protective effect on mortality 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. The difference between those with higher education and those with primary education or less was more than ten years for men and nine years for women. Mortality disparities associated with marital status and education were most pronounced among young adults and decreased with age.* ***Conclusions****: Targeted preventive measures aimed at reducing mortality among vulnerable subgroups are essential, focusing on risk factors associated with infectious and respiratory diseases, liver cirrhosis and external causes of death.*
Keywords*: life expectancy, cause of death, marital status, level of education, health disparities, Republic of Moldova*
JEL*: A14, A20, J10, J31*
UDC: *314.14(478)*

Introduction. Persistent health disparities related to socioeconomic factors are evident in many nations, including well-developed Western European countries (Mackenbach, 2012; Mackenbach et al., 2018). Substantial variations in health outcomes exist among different socioeconomic groups, with individuals possessing lower levels of education, occupation, or income facing a heightened risk of premature death. To illustrate, in Lithuania, men with higher education experience a life expectancy of 11.0 years longer than their counterparts with only primary education (Jasilionis et al., 2006).

These health disparities can be attributed to differences between population groups in various health determinants, including living conditions, education,

occupation, income, health-related behaviours, healthcare accessibility, disease prevention, health promotion services, and public policies influencing the distribution and quality of these factors (Commission of the European Communities, 2009).

The issue of high mortality is of great concern in the Republic of Moldova (Moldova), which holds the lowest life expectancy at birth in Europe. In 2019, life expectancies were 66.8 years for men and 75.0 years for women (Biroul National de Statistica, 2022), marking a 13.0 and 10.4 years difference from France, and a 12.0 and 8.3 years difference from Germany (Max Planck Institute for Demographic Research (Germany) et al., 2021).

The stagnation in life expectancy improvement can be attributed to persistent disparities in health among different demographic, regional, and social groups within the Moldovan population. Therefore, solely analysing mortality at the national level is often inadequate for developing effective interventions to address the ongoing public health crisis. Reducing disparities in population health is a primary goal outlined in major national and international health policy documents. To effectively combat high mortality in Moldova, efforts must be directed towards reducing mortality while also addressing inequalities between socio-demographic groups. Notably, no studies have been conducted in Moldova regarding population-level differences in mortality by marital status and educational level.

The aim of the study is to examine disparities in overall and cause-specific mortality by marital status and the level of education. The hypothesis underlying this research is that the high mortality at the national level coexists with significant social disparities in mortality. Additionally, various social population subgroups contribute differently to the life expectancy improvements observed in Moldova since 2005.

Literature review. From a methodological perspective, two distinct types of studies examining social inequalities can be identified. The first type involves research conducted using unlinked mortality and population data. For instance, in the Former Soviet Union (FSU) countries, including Moldova, during the Soviet era, statistical offices compiled additional tables detailing the distribution of deaths based on social characteristics such as marital status, educational level, and ethnicity for a few years surrounding the census year. Social disparities in mortality were analysed over various time periods in Russia (Shkolnikov et al., 2022), Estonia (Leinsalu et al., 2003, 2004) and Lithuania (Kalediene et al., 2007). The second type of study involves census-linked research or studies based on population registers. In these cases, a death certificate recorded by a statistical office is linked to an individual census form, and information about the social characteristics of the deceased is extracted from the census data.

To our knowledge, the only studies providing evidence on social mortality disparities based on both census-linked and census-unlinked data in Eastern Europe originate from investigations in Lithuania and Estonia (Jasilionis et al., 2012; Jasilionis & Leinsalu, 2021; Shkolnikov et al., 2007). Shkolnikov et al. assessed the differences in life expectancy estimates derived from census-linked and unlinked mortality data in Lithuania between 2001 and 2004. Their findings indicated that

unlinked data tend to overestimate mortality in disadvantaged groups and underestimate it in advantaged groups. The discrepancies between these two data sources were notably more pronounced concerning educational attainment compared to marital status (Shkolnikov et al., 2007).

Jasilionis et al. conducted an analysis of the registration of the ethnicity of deceased individuals in Lithuania using data from both the census and death registry. Their study revealed significant discrepancies in the recording of deaths for Russian, Polish, and other ethnicities, which were underestimated, while Lithuanian ethnicity was overestimated. Consequently, this bias resulted in the underestimation of mortality rate ratios among the three minority ethnic groups (Jasilionis et al., 2012).

In unlinked census studies, information about the social characteristics of the deceased is gathered from two different sources (Jasilionis et al., 2006). On the one hand, the distribution of deaths by social characteristics is based on death records provided by a relative of the deceased, known as a proxy informant. On the other hand, the distribution of population counts by the same social characteristics is reported by individuals during the census. This discrepancy, referred to as the "numerator-denominator" bias, can be avoided in census-linked or longitudinal studies.

Research methodology. In accordance with international recommendations, both absolute and relative mortality differences based on socio-demographic characteristics such as marital status and level of education were employed. The reference groups were defined as the married population (marital status) and the population with higher education (level of education). To calculate the absolute or rate difference (RD), the difference between standardised death rates (SDR) in the population group under consideration and SDR in the reference group was computed. Meanwhile, the relative difference or rate ratio (RR) was assessed as the ratio of SDR in the population group under consideration to SDR in the reference group. Both rate ratio and rate difference are weighted averages calculated as the ratio or difference of directly standardised death rates (Schoenbach & Rosamond, 2000).

To determine statistical significance, 95% confidence intervals (95% CI) were used for comparing an estimate (e.g., SDR in divorced males) against a reference value (e.g., SDR in married males). When the reference value fell outside the 95% CI for the estimate (non-overlapping CI), it indicated a statistically significant difference ($p<0.05$). Non-overlapping confidence intervals for both RD and RR indicated a statistically significant difference ($p<0.05$) (APHO, 2010). The estimation of 95% CIs for RD and RR was performed using the R package "dsr" (version 0.2.2) (Kumar, 2019/2022). Life tables and 95% CIs by marital status and level of education for the population aged 30 years and older were computed using an R function (Camarda, n.d.).

Main results. In the years 2003-2005 and 2013-2014, life expectancy at age 30 exhibited noteworthy variations among different marital status categories. Among these categories, the highest life expectancy was observed for married men and women, while the lowest life expectancy was found among never-married women and divorced men. During the first period, the disparity in life expectancy

between the two categories was more pronounced among males, with a difference of 12 years, compared to females, who had an 8.2-year difference. In the second period, this difference increased for both sexes, with almost 13 years separating the two groups ($p<0.05$).

The greatest gains in life expectancy at age 30 between the two periods were experienced by married women and widowed men, with an increase of 3.7 years. Moreover, life expectancy at age 30 showed significant improvements, increasing by over two years for married and never-married men, as well as 2.7 years for widowed women ($p<0.05$) from 2003-2005 to 2013-2014. However, the changes in mortality were most unfavourable for divorced individuals, particularly divorced women. Their life expectancy at the age of 30 decreased considerably, by more than two years, during this time period (*Table 1*).

Table 1. **Life expectancy at age 30 by marital status and the level of education in Moldova in 2003-2005 and 2013-2014, by sex (years)**

	2003-2005		**2013-2014**	
	Males	**Females**	**Males**	**Females**
By marital status				
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 (max.-min.)	12.04	8.19	13.19	12.84
By the level of education				
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 (37.31-37.66)*	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 (max.-min.)	10.06	11.28	10.72	9.83

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

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

In both study periods, the most significant disparity in life expectancy at age 30 was observed between individuals with higher education and those with primary or lower education for both men and women. In the second period, the difference in life expectancy between men with higher education and men with secondary education was 6.8 years, whereas the gap widened to 10.7 years between men with higher education and men with primary or lower education. From 2003-2005 to 2013-2014, the life expectancy difference at age 30 between men with higher education and men with secondary education increased by more than one year, while it remained relatively constant between men with higher education and men with primary or lower education.

For women, the difference in life expectancy at age 30 between those with higher educational attainment and those with secondary and primary or lower educational attainment was 4.8 and 9.8 years, respectively ($p<0.05$). Between the two censuses, the longevity gap between women with higher education and women with primary or lower education decreased by 1.5 years (from 11.3 years in 2003-2005, $p<0.05$). At the same time, the difference between women with higher education and women with secondary education remained largely consistent over the study period (5.3 years in 2003-2005, $p<0.05$).

Table 2 provides information regarding the contribution of the absolute difference (RD, rate difference) for a specific cause of death, expressed as a percentage, to the absolute difference in mortality from all causes of death combined in 2013-2014.

***Table 2*. Impact of absolute differences by marital status and the level of education and cause of death on absolute differences in all-cause mortality in 2013-2014. Moldova, by sex (%)**

	By the level of education		By marital status (%)		
	Primary or lower	**Secondary**	**Never-married**	**Divorced**	**Widowed**
Males					
Infectious diseases	2.01	3.65	6.82	2.49	3.64
Neoplasms	1.29	8.79	-3.95	12.88	0.76
Circulatory system diseases	67.65	52.42	39.69	56.08	62.75
Respiratory system diseases	11.53	10.17	17.50	4.78	8.04
Digestive system diseases	5.91	8.27	7.80	8.51	9.21
External causes	8.12	14.44	24.96	12.18	12.98
Other diseases	3.48	2.19	7.62	3.16	3.07
All causes of death	100.00	100.00	100.00	100.00	100.00
Females					
Infectious diseases	1.03	1.26	0.65	0.82	1.15
Neoplasms	-5.47	-5.12	6.08	18.51	0.19
Circulatory system diseases	82.55	76.92	77.26	64.26	74.00

	By the level of education		By marital status (%)		
	Primary or lower	**Secondary**	**Never-married**	**Divorced**	**Widowed**
Respiratory system diseases	5.53	3.10	4.96	2.86	4.11
Digestive system diseases	9.20	16.50	5.03	7.06	14.97
External causes	3.27	4.44	4.39	2.75	4.55
Other diseases	3.87	2.83	1.65	3.77	1.41
All causes of death	100.00	100.00	100.00	100.00	100.00

RD - rate difference per 100000 populations. Reference population: married males and males with higher education. The impact of RD in mortality from a cause i on RD in all-cause mortality was calculated as follows: RD for a cause i / RD for all causes x 100

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

The impact of circulatory system diseases was most pronounced for the non-married population and individuals with primary or lower education and secondary education, both among males and females. Among these groups, the influence was strongest among females with primary or lower education (83%) and weakest among males with secondary education (52%). Interestingly, neoplasms were the second leading cause of death in terms of specific mortality patterns for various educational categories, but they did not explain the differences in mortality related to education level. In contrast, in 2013-2014, diseases of the respiratory system, diseases of the digestive system, and external causes of death accounted for more than 30% of the absolute differentiation in mortality for men with secondary education and over 25% for men with primary or lower education. Among women, diseases of the digestive system ranked as the second leading cause of death, contributing to all-cause mortality differences between those with higher education and those with secondary or primary education.

For the non-married population, circulatory system diseases were the primary cause of death responsible for absolute inequalities in overall mortality compared to their married counterparts. In 2013-2014, the contribution of this category varied, ranging from 40% for never-married males to 63% for widowed males. Among females, the impact was even higher, with figures ranging from 64% for divorced females to 77% for never-married females. Neoplasms had the most significant impact on divorced males (13%) and females (18%). The contribution of external causes of death to overall mortality inequalities varied from 12% for divorced and widowed males to 25% for never-married males during the second period. Digestive system diseases played a considerable role in the absolute inequalities among widowed females (15%), while diseases of the respiratory system played a significant role in the disparities among never-married males (17%).

In 2013-2014, the largest relative differences (RR, rate ratio) in all-cause mortality among males were observed for divorced males (RR=2.5, $p<0.05$), while

for the other marital categories, these differences were somewhat less pronounced but still statistically significant (*Fig. 1*). Specifically, the highest RR was noted 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 was most prominent 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, $p<0.05$).

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 pronounced, varying between 2.1 (neoplasms) and 3.4 (circulatory system diseases). Notably, the excess of deaths from neoplasms was most prominent among divorced females (RR=2.9, $p<0.05$).

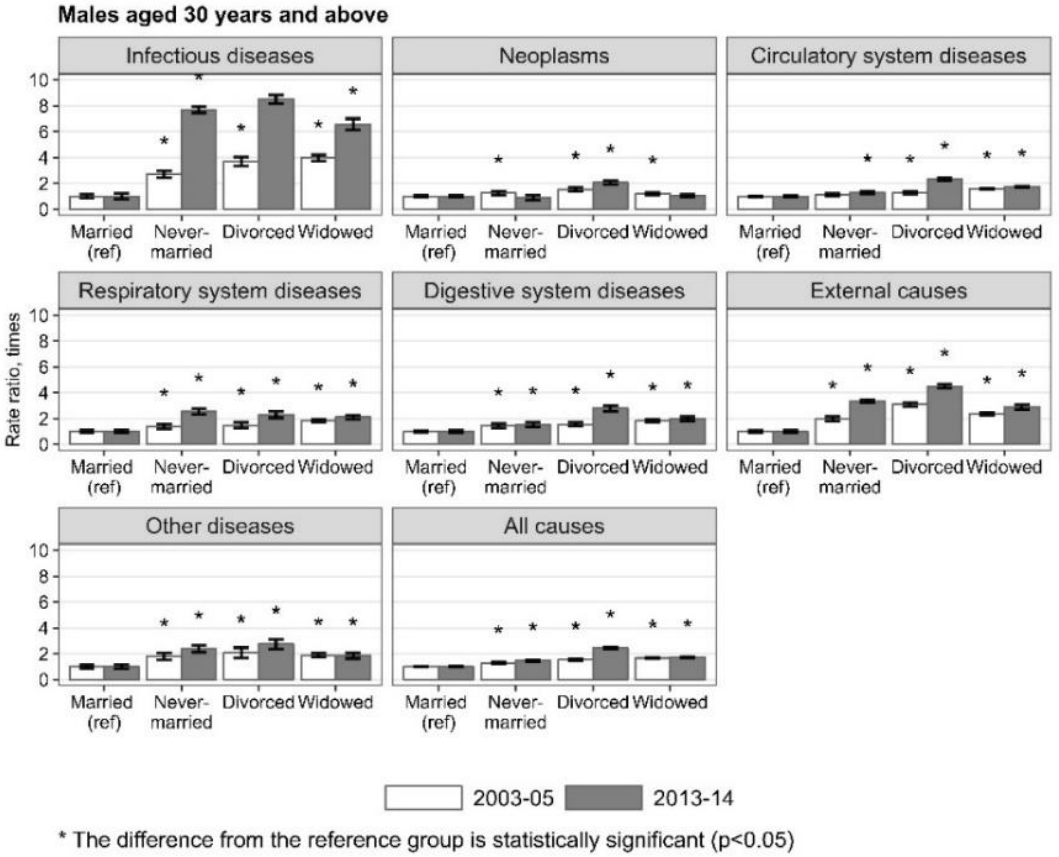

Figure 1. **Mortality rate ratio by main cause of death and marital status in 2003-2005 and 2013-2014, Moldova, males aged 30 years and over (times)**
Note: reference group (ref.) – married males.
Source: author's calculations based on NBS and NAPH data.

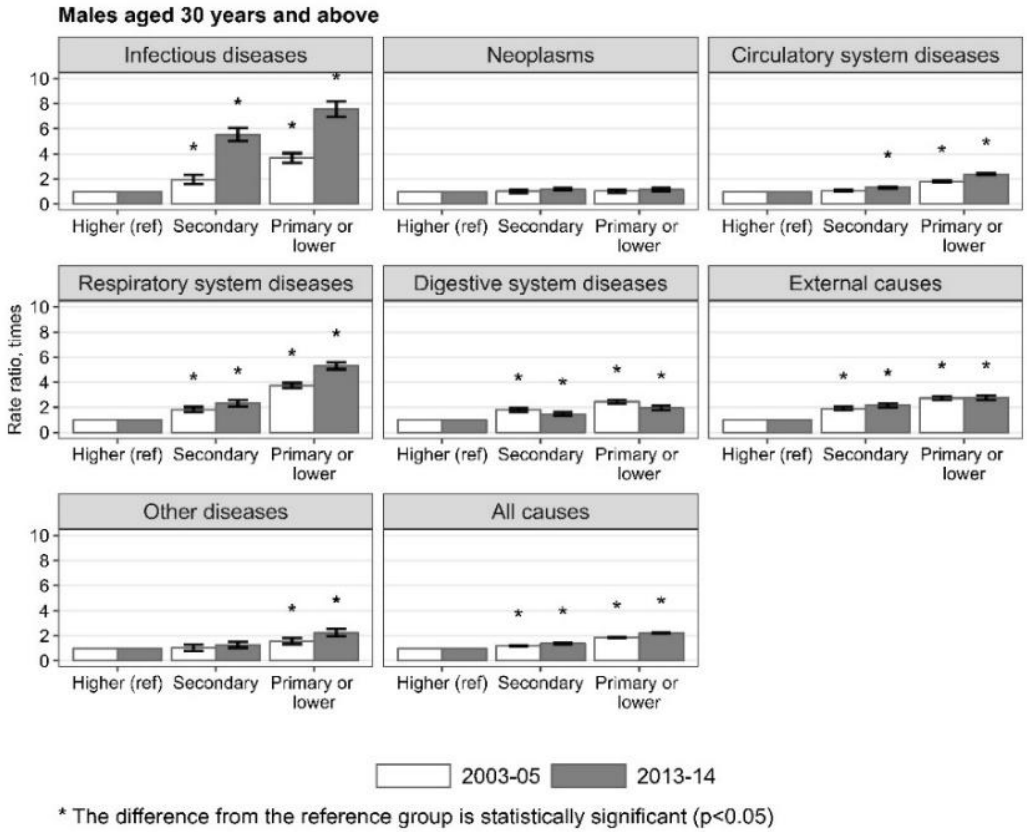

***Figure 2*. Mortality rate ratio by main cause of death and the level of education in 2003-2005 and 2013-2014, Moldova, males aged 30 years and over (times)**
Note: reference group (ref.) – males with higher education.
Source: author's calculations based on NBS and NAPH data.

In the second study period, relative mortality differences 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 significant 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. Notably, differences in neoplasm mortality by education level were not statistically significant (*Fig. 2*).

Discussion and conclusions. The study aimed to investigate disparities in all-cause and cause-specific mortality in Moldova, focusing on marital status and educational attainment. The availability of data *limited* our research to two specific periods, closely aligned with the population censuses conducted in 2004 and 2014, which provided a unique source of population data categorised by the analysed attributes.

We examined both absolute and relative differences in all-cause and cause-specific mortality for the years 2003-2005 and 2013-2014, using the married population and individuals with higher education as reference groups. In the latter

period, life expectancy differences by marital status were equally pronounced for both men and women. Married men and women exhibited the highest life expectancy at age 30, while never-married women and divorced men had the lowest values. The maximum disparity between these groups amounted to around 13 years for both genders. In the second period, the difference in life expectancy at age 30 between the population with higher education and those with primary education or lower was approximately ten years for both men and women. The most significant disparities in death probabilities based on the analysed socio-demographic characteristics were found within the age groups 30-39 and 40-49, with a less pronounced impact on older adults. Over the period between the two censuses, the increase in mortality differences associated with marital status was more pronounced among women than men. Meanwhile, differentiation in life expectancy by educational level remained relatively stable over time for males and showed a slight decline among females.

Our findings align with a census-linked study on socio-demographic disparities in Lithuania, where the lowest life expectancy at age 30 in 2001-04 was observed among divorced males, never-married females, and individuals with less than a secondary education. The maximum difference in male life expectancy at age 30 by marital status and educational level in Lithuania (11 years) closely resembled the observations in our study. However, female life expectancy differentiation was less marked in Lithuania compared to Moldova, with the largest difference among Lithuanian women not exceeding seven years by educational level and five years by marital status (Jasilionis et al., 2006). This fact suggests that the health situation of Moldovan women is not only less favourable compared to other FSU countries (Penina et al., 2022) but also exhibits more pronounced socio-demographic inequalities.

In most instances, the identified advantaged and disadvantaged population groups remained consistent when analysing mortality disparities by cause of death. The risk of mortality from leading causes of death consistently remained higher in the groups under investigation compared to the reference groups. Circulatory system diseases contributed the most to the absolute difference in all-cause mortality between the reference groups and the groups under examination. However, the most significant relative differences concerning marital status and educational level were observed for infectious and respiratory diseases. High relative disparities were also evident for two alcohol-related causes of death, external causes and digestive system diseases. Being never-married, divorced, or having primary or lower education was associated with an increased risk of mortality. At the same time, the level of education did not appear to influence the risk of mortality from neoplasms.

To address social disparities in Moldova based on marital status and educational level, efforts should focus on reducing mortality within the identified vulnerable social groups, namely divorced men, never-married women, and adults aged 30 and over with primary education or lower. In these social groups, particularly within the 30-49 age range, preventive measures should be implemented to address risk factors associated with infectious diseases, respiratory diseases, liver cirrhosis, and external causes of death.

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