



# Mortality Rate from Circulatory Diseases, Ischemic Heart Disease and Cerebrovascular Diseases in Serbia, 1998-2021

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## Abstract

**Background:** According to World Health Organisation data, on the top ten causes of death in the world in 2019, ischemic heart diseases ranked first, followed by stroke and chronic respiratory diseases. This study aimed to make cross-section of the current mortality rates of indicators of circulatory diseases, ischemic heart diseases and cerebrovascular diseases, access the trends of indicators in Serbia more than two decades and to find the correlation of these observed indicators between males and females.

**Methods:** Medical indicators were taken from the publicly available Health for all databases that deals with long-term evaluation and monitoring of indicators obtained from national authorities. In this epidemiological study, following indicators were analysed: indicator of standardized circulatory diseases, ischemic heart disease, and cerebrovascular diseases. SPSS was used for statistical analysis.

**Results:** Between 1998 and 2021 all of the mortality indicators were decreasing in Serbia. Between 2002 and 2005 observed indicators had almost constant decreasing trend. The standardized mortality for circulatory disease along with indicators for mortality from ischemic diseases and cerebrovascular disease was more prevalent among males than females,

**Conclusion:** Continuing the follow of indicators is of the great importance for public health and macroeconomic of countries. This decreasing trend in Serbia must remain constant and that can be effectively done through continuous improvement of health systems, focusing on the primary health care and conducting pharmaco-economic studies and epidemiological studies.

**Keywords:** Cardiovascular diseases; Mortality; Epidemiology; Medical indicators; Serbia



## Introduction

Non-communicable diseases (NCDs) are responsible for 41 million deaths each year, which is 71% of all deaths globally and affects all age groups, gender and all countries of the world (1, 2). According to the Lancet Global Burden of Disease Study in 2016, they contributed to 61.8% of all deaths (3). NCDs are mostly known as diseases of developed and high-income countries, but many studies provide new information about the current situation in low- and middle-income countries (4). According to the WHO data on the top ten causes of death in the world in 2019, ischemic heart diseases ranked first, followed by stroke and chronic respiratory diseases, which are all non-communicable diseases, and lower respiratory tract infections as infectious diseases are in fourth place, followed by neonatal conditions, cancer, mental illness, diarrheal disease, diabetes, and kidney diseases (5-7). There is also the implication that individuals with non-communicable diseases have a higher risk of having the communicable diseases.

The main, leading cause of mortality in the world are cardiovascular diseases, with proven significant increase from 90s to present time, accounting for almost 18 million deaths per year. This represents one third of all global deaths and more than 80% of these deaths are due to ischemic heart disease and cerebrovascular disease. Looking at the Europe, these non-communicable diseases take almost 4 million lives annually, and it differs between countries with different development level (8).

The mortality from cardiovascular diseases is decreasing in the developed countries with higher income levels, where these diseases are, historically, predominantly noticed. Although, globally, trend of mortality deaths keeps rising due to increased cardiovascular disease in the lower income countries (9). Serbia is classified as the country with lower-middle-income economy by the World Bank in 2024. In 2019 Serbia had an incidence rate of 920 per 100.000 population and was in 18th place among 54 countries regarding

the cardiovascular incidence rate, and 15th among the mortality rate (10).

Preventive measures to the risk factors for patients with cardiovascular diseases can reduce complications and the costs associated with the treatment. Cardiovascular diseases remain the leading cause of disease burden in the world and leading cause of disabilities and premature deaths (11). It is necessary to focus on implementing existing cost-effective policies and interventions.

A health indicator is a measure intended to collect information on a certain priority topic in the health of the population or in the work of the health system. Health indicators provide comparable information across different geographical, organizational or administrative boundaries and/or can track progress over time (12). Utilizing the standardized indicators developed by the WHO, which are tracked through wide range of decades, can tell us about the patterns of development of our countries. Indicators are great for suggesting the certain changes in the national guides of current diseases and help refocus to the new challenges of specific diseases because like everything, due to industrialization, the lifestyles, new technologies, these diseases and their patterns evolve and change along (13). Moreover, indicators can be used to check the effectiveness of health organization systems and suggest the change to the creators of health politics (14).

We aimed to make cross-section of the current mortality rates of indicators of circulatory diseases, ischemic heart diseases and cerebrovascular diseases, access the trends of indicators in Serbia in the period of more than two decades and to find the correlation of these observed indicators between males and females.

## Materials and Methods

Medical indicators were taken from the publicly available WHO, Health for all databases that deals with long-term evaluation and monitoring of indicators obtained from national authorities

(<https://gateway.euro.who.int/en/datasets/european-health-for-all-database/>). The research was an observational epidemiological study based on the macro-aggregation data of national populations of entire countries, conducted in Serbia in 2023. The data were anonymous and did not belong to individual citizens, so there was no question of data privacy protection.

Given that it was not an interventional study of a clinical/experimental type on humans or animals, according to the International Ethical Guidelines for Biomedical Research Involving Humans and the Guidelines of Good Clinical Practice, the research did not require consideration by the Ethics Committee.

Indicators that were analyzed in this research are standardized circulatory diseases, all ages, per 100,000, standardized; ischemic heart disease, all ages, per 100,000; and standardized cerebrovascular diseases, all ages, per 100,000; for both (males and females) and separately for males and females.

We used IBM SPSS ver. 23 (IBM Corp., Armonk, NY, USA) for performing the tests. Descriptive statistics that include display of interquartile range, and median value was done. We analyzed

indicators from 1998 to 2021 (the last available years after database update, dated 2023.10.04.). First, an assessment of the normality of the variables was made, and after it was determined that data were normally distributed, independent t-test was performed with the aim of determining the existence of a statistically significant difference in the representation of the difference in mortality according to gender. A statistically significant difference is one with a value below 0.01. A linear trend analysis was performed with the aim of assessing the current progress status of the indicators over the years.

## Results

If we look at the indicator age-standardized death rate for diseases of the circulatory system, the median value for both gender for the observed period (1998-2021) was 500/100,000, while median value in males was 1.25 times higher than in females (561 vs. 448). There was a statistically significant difference between the indicators of the mortality rate from circulatory diseases between males and females ( $P < 0.01$ ) (Table 1).

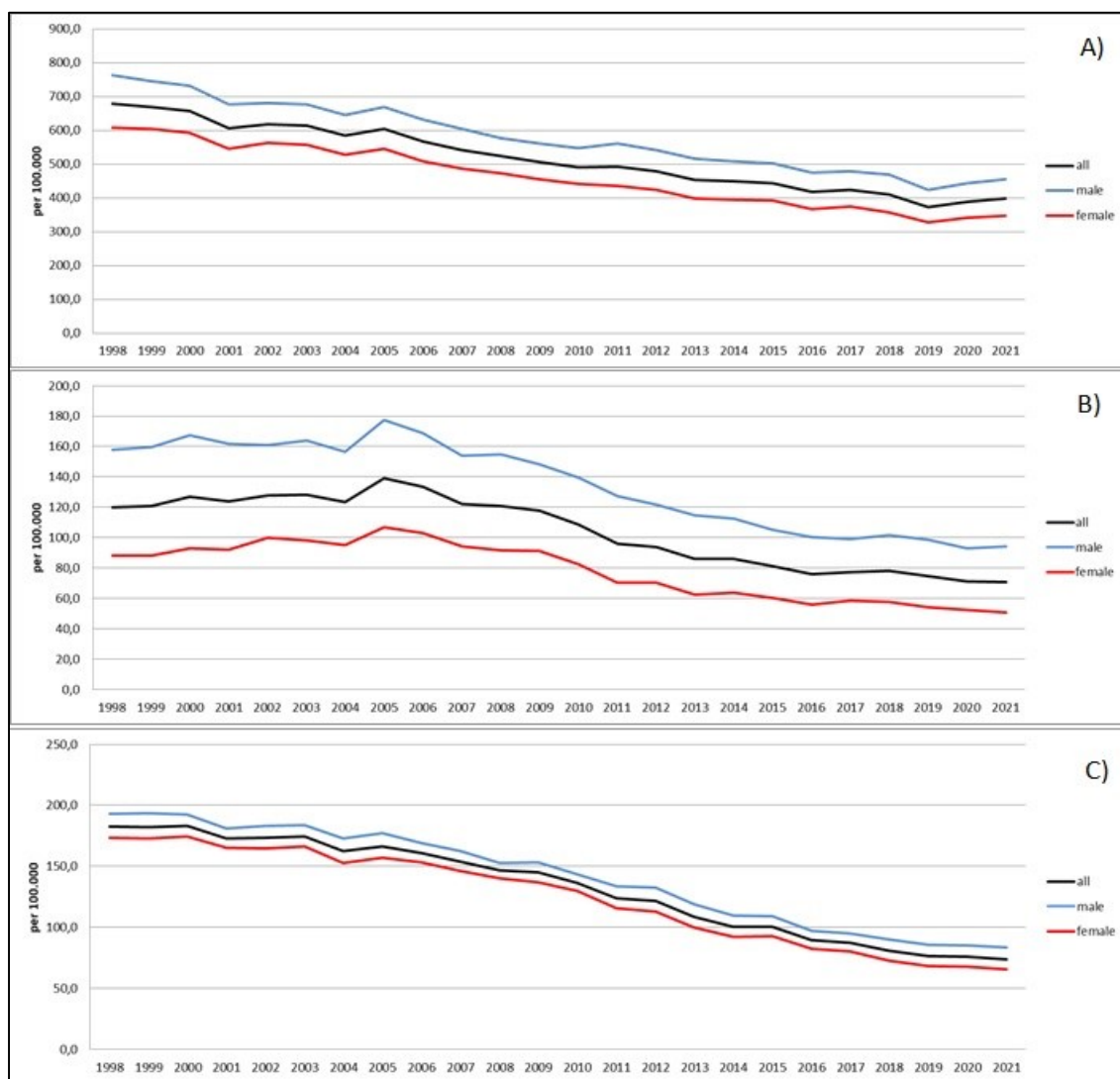
**Table 1:** First and last year of followed period, interquartile range, median value, and linear trend for indicators of mortality rates from all circulatory disease, ischemic heart disease and cerebrovascular diseases per 100,000 and  $P$ -value of T-paired test between gender in Serbia (1998-2021)

Variable	All Circulatory diseases			Ischemic heart disease			Cerebrovascular diseases		
	Both	Male	Female	Both	Male	Female	Both	Male	Female
1998	678	762	609	120	158	88	182	193	173
2021	398	456	347	71	93	52	74	83	65
IQ range	176	189	167	50	58	35	79	80	78
Median	500	561	448	113	144	85	141	148	133
Linear trend	negative	negative	negative	negative	negative	negative	negative	negative	negative
P value	< 0.001			< 0.001			< 0.001		

\*IQ range – interquartile range

When observing the linear trend for the period from 1998 to 2021, a negative trend was observed in the mortality rate when both genders were observed ( $y = -13.305x + 682.5$ ;  $R^2 = 0.9761$ ), but also when they were observed separately,

with the fact that the decline was more pronounced in females ( $y = -12.658x + 619.31$ ;  $R^2 = 0.9776$ ), than in males ( $y = -14.18x + 755.76$ ;  $R^2 = 0.9704$ ) (Fig. 1).



**Fig. 1:** A) Age-standardized mortality rates for circulatory diseases per 100,000 in Serbia; B) Age-standardized mortality rates for ischemic heart disease per 100,000 in Serbia; C) Age-standardized mortality rates for cerebrovascular diseases per 100,000 in Serbia

For the indicator age-standardized death rate for ischemic heart disease, the median value was 113/100,000, and in males was 1.34 times higher than in females (114 vs. 85). There was a statistically significant difference between the indicators of the mortality rate from ischemic heart disease between gender ( $P < 0.01$ ) (Table 1). In the period from 1998 to 2021, a negative trend was observed in the mortality rate when both genders were observed ( $y = -2.9914x + 141.65$ ;  $R^2 = 0.826$ ), but also when they were observed separately, and it was more pronounced in males ( $y = -3.7934x +$

$182.34$ ;  $R^2 = 0.8634$ ), than in females ( $y = -2.3279x + 107.37$ ;  $R^2 = 0.7757$ ) (Fig. 1).

Finally, the indicator age-standardized death rate for cerebrovascular diseases had the median value, for both genders, of 141/100,000, and as previous, it was 1.11 times higher for males (148 vs. 133). Correlation was also found for this indicator, in relation to the gender ( $P < 0.01$ ) (Table 1). When observing the linear trend for period between 1998 and 2021, it was noticed a negative trend for both genders collectively ( $y = -$

$5.4762x+200.83$ ;  $R^2=0.9736$ ), but when they were observed separately, decline was slightly more pronounced in males ( $y= -5.5172x + 210.5$ ;  $R^2 =0.9757$ ) than in females ( $y= -5.4311x + 192.11$ ;  $R^2 = 0.9717$ ) (Fig. 1).

## Discussion

Well organized health system of the country lies on the good organization of different health sectors, but especially the primary health organization (15). In the past, the primary sector was not recognized as crucial in the formation of a good health system which was the main problem of non-decreasing trends in various non-communicable diseases, incidence, prevalence and eventually mortality. The focus was more on the curing diseases and consequences that diseases always bring along, that eventually hurt the government budget by spending way more than it would by preventing it (16). Earlier, non-communicable diseases were hidden by the communicable diseases, and they silently rose. However, their present was unmasked once the communicable diseases were more or less, put under the control. Now those problems are more recognized and health sectors are turning their heads towards the more efficient models – recognition of the factors of the risk for non-communicable diseases and their prevention (17). On this way, the well-being of more country citizens is reached and the main goal is reducing the increasing trends of non-communicable diseases. Cardiovascular diseases (CVDs) occur in all countries worldwide, but the death from these diseases is the highest in the low- and middle-income countries, mainly as the result of poorer organization primary health care programs which does not responds adequately to their needs. This leads to death of the people at the younger age, when they are the most productive, and the most endangered are the people with lowest income. And at the macro-economic level, CVDs place a heavy burden on the economies (18, 19). The Global Burden of Diseases, Injuries, and Risk Factors Study 2019 showed that number of

cardiovascular disease deaths steadily increased from 12.1 million in 1990 to 18.6 million in 2019 and the majority of cardiovascular disease deaths globally were from ischemic heart disease and stroke. The death from cardiovascular diseases were more present among males than among females, globally, and between age 30 and 70 with highest number of deaths in China, India, USA, Russia and Indonesia, and age standardized mortality rates was the lowest in France, Japan and Peru (20). When comparing those results, we can note that in late 90s (1998) mortality rates for Serbia were the highest for each observed indicator.

Stroke and ischemic heart diseases are contributing to the greatest number of death and disability in the world, and like that they are also diseases that influence the huge part of global burden of disease that reflects the health care of each country (21). Although, the numbers are still high, our findings showed that mortality trends for ischemic heart diseases and cerebrovascular disease are decreasing from 2005.

Almost half of all death in Europe is caused by cardiovascular disease with rates being the highest in Lithuania (5706 per million) and lowest in France (466 per million) with prevalence predominantly being higher among males than females (22). Our finding shows that the mortality from circulatory disease in Serbia was 1.25 times higher for males than for the females. Among the EU Member States, Latvia recorded the highest gender gap.

In 2017, approximately 17.8 million deaths were attributed to CVD globally. The age-adjusted death rate per 100,000 populations was 233. The highest mortality rates attributable to CVD in 2017 were in Eastern Europe and Central Asia (23). The median value of standardized mortality rates for circulatory diseases for Serbia, between 1998 and 2021, was roughly 500 per 100,000 among both genders.

Ischemic heart disease was more prevalent among males in 2017, and it accounted in more than 100 million people (24). Mortality rates from ischemic heart disease weren't higher than 150 per 100,000 in the world but according to the

data from 2017 from American Heart Association they were above 280 per 100,000 in Eastern (23). Our findings agree with these results where median value for the observed period was 113 per 100,000 and it was more prevalent among males (1.34 times more than in the females).

From 6.2 millions of deaths caused by cerebrovascular diseases in 2017, the 2.7 were cause by ischemic stroke and mortality rates from ischemic stroke was highest in Easter European countries (24, 25). Our findings showed that median value for the observed period was 141 per 100,000 and it was more prevalent among males.

All this data from world and results for the Serbia reflects a need for countries to establish cost-effective public health programs aimed at reducing cardiovascular risk through modifiable risk behaviors like unhealthy diet, lack of exercise, psychosocial stress, and insufficient sleep (26). Those risk factors are also the risk factors for many non-communicable diseases (27). Monitoring of risk factors and implementing and updating the national guides for cardiovascular diseases will positively affects the rates of morbidity and mortality (28, 29). Monitoring the hypertension, as the major risk factor, and proper use of medications prescribed by the doctors can lead to reducing this major risk factor for circulatory diseases and mortality (30). Evidence from 18 countries has shown that hypertension programs can be implemented efficiently and cost-effectively at the primary care level which will ultimately result in reduced coronary heart disease and stroke (31). Cost effective analysis and monitoring of indicators related to cardiovascular mortality and morbidity can potentially guide government for gross domestic product spending on healthcare and assess the effectiveness of national health programs for these diseases (32).

This study strength is long term data that provide bigger picture of indicators of mortality and their trends in observed years. Indicator are valuable tools for keeping data available and relevant to the country with an aim of focusing to the public health improvement in the domain of prevention of cardiovascular diseases that are leading cause of death in the world. Limitation of study is that

it gives the data only about the awareness and implications, but it does not focus on the risk factor which can be potential ideas for further research.

## **Conclusion**

In the observed period (1998-2021) all of the mortality indicators (circulatory diseases, ischemic heart disease, and cerebrovascular diseases per 100.000) are decreasing in Serbia. Between 2002 and 2005 observed indicators have almost constant decreasing trend. The standardized mortality for circulatory disease was more prevalent among males than females, along with indicators for mortality from ischemic diseases and cerebrovascular disease. Serbia, as the middle-income country, has recognized the importance of the prevention of CVD and implemented adequate strategies. Continuing the follow of indicators is of the great importance for public health and macroeconomic of countries. This decreasing trend in Serbia must remain constant and that can be effectively done through continuous improvement of health systems, focusing on the primary health care, comparing the health system with neighbor countries, conducting pharmacoeconomic and epidemiological studies.

## **Journalism Ethics considerations**

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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## **Conflict of interest**

The authors declare that there is no conflict of interests.

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