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Evaluation of Health Insurance and Social Disease Burden of Cardiovascular Disease

Ph.D. Thesis

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1. INTRODUCTION

Epidemiological changes in the 20th century have resulted in a decline in the number of deaths from communicable diseases and an increase in the incidence of non-communicable chronic diseases. Among non-communicable diseases, cardiovascular diseases have become the leading causes of morbidity and mortality globally, despite a decline in disease incidence. This increase is now localised in middle and low income countries.

The number of age-standardised deaths from cardiovascular diseases has also been declining in many regions of the world, while the absolute number of deaths has been rising. This increase is mainly characterising middle- and low-income countries.

In developed countries, including Hungary, cardiovascular disease has become the leading cause of mortality, ahead of malignant tumours. Diseases of the circulatory system were responsible for 55% of deaths in women and 45% in men, in Hungary, in 2015.

Cardiovascular disease typically causes damage to the heart, brain, peripheral vascular system and kidneys. The World Health Organisation (WHO) categorises cardiovascular diseases into the following main groups: ischaemic heart disease (coronary heart disease), cerebrovascular disease, hypertension, peripheral vascular disease, heart failure, rheumatic heart disease, congenital heart disease, cardiomyopathies. According to WHO data, coronary heart disease is the most common cause of death worldwide, accounting for 15.5% of all deaths, i.e. around 8.76 million deaths in 2015. The incidence and age-standardised mortality of ischaemic heart disease have declined globally over the past 25 years, with the largest decrease in high-income countries. At the same time, the disease burden of coronary heart disease is particularly high in Eastern Europe and Central Asia, but unfavourable mortality rates have been detected in South Asia, North Africa and the Middle East. The number of years of life lost (YLL) due to ischaemic heart disease is highest in South Asia, reflecting both the size of the population and the early onset of the disease.

According to WHO data, stroke was the second most common cause of death, accounting for 11.1% of all cause mortality, with 6.24 million deaths. The prevalence of stroke increases with age, peaking in the 74 to 79 age group. People in low- and middle-income countries are diagnosed on average 6 years younger than people in high-income countries. The prevalence of stroke is highest in Oceania, Eastern Europe, Central Asia and South-East Asia, while mortality rates are worst in Oceania and Sub-Saharan Africa.

According to a previous study, Peripheral Arterial Disease (PAD) is the third leading cause of atherosclerotic cardiovascular deaths after coronary artery disease and stroke. Patients with

PAD are twice as likely to have a myocardial infarction or a stroke. Our recently published literature review revealed that the prevalence of PAD is increasing, which represents a significant health burden for both the society and healthcare systems.

Cardiovascular diseases are among the first causes with regard to Disability-Adjusted Life Years (DALYs) as well. Coronary heart disease accounted for more than half of the disability-adjusted life years due to cardiovascular disease, while cerebrovascular disease accounted for a quarter of DALYs. According to data from the Global Burden of Disease Study (GBD) 2016 study ischaemic heart disease and stroke are among the leading causes of premature death in our country. The WHO's global health policy goals formulated within the framework of the Global Action Plan include a 25% reduction in premature deaths from non-communicable diseases by 2025. Health programmes of the EU have also targeted the reduction of non-communicable diseases. In Hungary, cancer was the leading cause of premature death in both sexes, followed by diseases of the circulatory system in 2015. There was a significant difference between the sexes in the distribution of premature mortality in terms of relative prevalence. Circulatory system diseases accounted for 32% of premature deaths in men and 24% in women. The treatment of cardiovascular diseases is a major burden for health care systems. As a result of prevention, advancement of pharmaceutical therapy and technological development, the number of deaths from cardiovascular disease has fallen in several Western countries. However, the disease burden of cardiovascular diseases has remained extremely high due to a number of factors, including the increase in life expectancy, population growth, ageing, inadequate adherence to evidence-based health professional guidelines, and difficulties in advocating preventive measures. Specific cardiovascular risk factors are increasing. Several factors contribute to the development of cardiovascular diseases. Well-known risk factors are: male gender, high blood lipids, smoking, advanced age, hypertension, diabetes, obesity, sedentary lifestyle, psychosocial stress, living and working conditions and family history (genetics). Additional risk factors include certain genetic defects, increased blood viscosity, elevated fibrinogen concentrations, increased homocysteine in the blood, high levels of C-reactive protein (CRP), kidney disease, high uric acid levels, increased oxidative stress, and sudden changes in air pollution and weather conditions. According to GBD 2015 data, the leading cause of health loss in Hungary are high blood pressure, followed by high body mass index. The most important tool for the prevention of cardiovascular disease is the facilitation of adoption of a healthy lifestyle, with particular focus on promoting smoking cessation. Regular screenings for cardiometabolic diseases have been proven to contribute to reducing the mortality rate associated with cardiovascular diseases. Hungary has shown suboptimal numbers in this regard

with more than 2 million blood pressure screenings, 1.6 million diabetes screenings, and 2.7 million lipid metabolism screenings cancelled per year. It is a known fact that early diagnosis of myocardial infarction, prehospital care, and the time elapsed between revascularization treatment significantly affect mortality. The recommendation of the European Society of Cardiology (ESC), according to which a cardiac catheterization laboratory accessible within 60 minutes from anywhere in the country must be available, has been implemented in Hungary since 2014. The establishment of a sufficient number of haemodynamic laboratories meeting professional standards has contributed significantly to the reduction of mortality statistics. The 2021 ESC guideline, published under the title Cardiovascular disease (CVD: Cardiovascular disease) Prevention Guidelines on the prevention of cardiovascular diseases in clinical practice, mentions, among other things, the use of new cardiovascular risk calculators as a novelty compared to the 2016 version, adaptation of the risk assessment for the young, the elderly, and people living with cardiovascular disease. The recommendation also discusses to the use of new drugs, which can have a significant impact on healthcare costs.

Individual and social risk factors differ significantly in different regions of the world. However, many areas of the world lack reliable data to estimate cardiovascular disease, which hinders the development and implementation of national prevention and treatment strategies.

2. AIMS

The aim of the thesis is to review the epidemiological indicators of ischaemic heart disease and cerebrovascular diseases among cardiovascular diseases at the national and international levels. Within coronary artery disease, our research also covers the analysis of the annual epidemiological and health insurance disease burden of acute myocardial infarction.

Main aims of our research are summarised as follows:

1. To evaluate the epidemiological situation of ischaemic heart disease (incidence, prevalence, mortality) from a national and international perspective.
2. To present national and international data on premature mortality associated with ischaemic heart disease and the regional comparison of these data for the age group 45-59 years.
3. To present national and international data on premature mortality associated with cerebrovascular disease and the regional comparison of these data for the age group 45-59 years.
4. To determine the epidemiological disease burden of acute myocardial infarction based on routinely collected, annual, real-world data retrieved from the financial database of the National Health Insurance Fund of Hungary.
5. To assess the annual health insurance treatment cost of acute myocardial infarction based data retrieved from the financial database of the National Health Insurance Fund of Hungary.

3. IN-DEPTH EVALUATIONS

3.1. EPIDEMIOLOGICAL ASPECTS OF ISCHAEMIC HEART DISEASE

Introduction and objectives: Ischaemic heart disease is one of the leading causes of mortality worldwide. Our aim was to outline epidemiological aspects of ischaemic heart disease.

Methods: The paper discusses the incidence, prevalence and mortality related to ischaemic heart disease per 100.000 population through a literature review. Data were retrieved from the Global Burden of Disease (GBD), the World Health Organization (WHO), the European Mortality Database (MDB) and the database of the Information System of Public Health Analysis Centre. (*NEKIR*). Periods analysed include 1990-2017, 2014-2018, and the year 2019. Ischaemic heart disease was identified with codes I20-I25 of the International Classification of Diseases 10th revision.

Results: Globally, the Eastern Mediterranean region shows the most unfavourable data. High mortality is paralleled with high incidence in all regions. The mortality was more favourable in the European Union (females: 58,77/100.000, males: 101,55/100.000) than in Hungary (females: 141,31/100.000 ; males: 221,55/100.000) in 2019. In Hungary, mortality due to ischaemic heart disease shows the most unfavourable rates in regions of the Great Plain and Northern Hungary in the whole population and among people aged 25-65 years. Mortality rates were the highest in the Ózd district both in men and women. Lower mortality rates were detected in Mid-Hungary and the Trans-Danubian regions.

Conclusion: Compared to averages of EU member states, Hungary has higher ischaemic heart disease incidence, prevalence and mortality for the whole population. Awareness of epidemiological indicators is inevitable for informed, adequate decision-making in health care.

3.2 INEQUALITIES IN PREMATURE MORTALITY FROM ISCHAEMIC HEART DISEASE IN THE EUROPEAN REGION OF THE WHO

Objectives: Ischaemic heart disease (IHD) is one of the leading causes of premature mortality. Our aim was to analyse standardised premature mortality rates from IHD by region in the age group 45 to 59 years.

Methods: We performed a retrospective, quantitative analysis of age-specific mortality rates from IHD between 1990-2014 per 100,000 population in Western European (WE: N=17), Eastern European countries (EE: N=10) and countries of the former Soviet Union (fSU: N=15) within the European Region of the World Health Organisation (WHO) based on data retrieved from the WHO European Mortality Database. Descriptive statistics, time series analysis and mathematical statistical tests were used for the analyses (ANOVA, Kruskal-Wallis test, Mann-Whitney test, paired t-test).

Results: On average, age-specific death rates (ASDR) from IHD per 100,000 population were the lowest in WE (men: 1990: 143.67, 2014: 50.29; women: 1990: 29.06, 2014: 9.89), and the highest in fSU (men: 1990: 358.69, 2014: 253.25; women: 1990: 99.78, 2014: 57.85). Between 1990 and 2014, all three regions experienced significant decrease in ASDR both in men and women (fSU: -29.39%; -42.02%; EE:-49.41%;-50.57%; WE: -64.99%;-65.97%) ($p < 0.05$). Between 1990 and 2004, ASDR decreased in WE in both sexes ($p < 0.001$), in EE among males ($p = 0.032$). Between 2004 and 2014, ASDR from IHD decreased significantly in both sexes in fSU and WE, in EE only among women ($p < 0.05$).

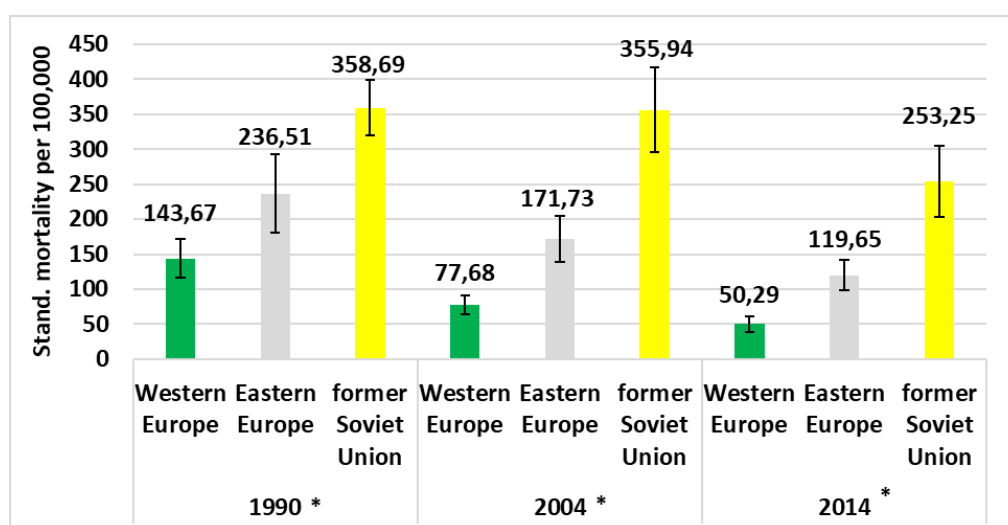


Figure 1.: IHD mortality trend in WE, in EE and in fSU, 45-59 males, 1990 to 2014.

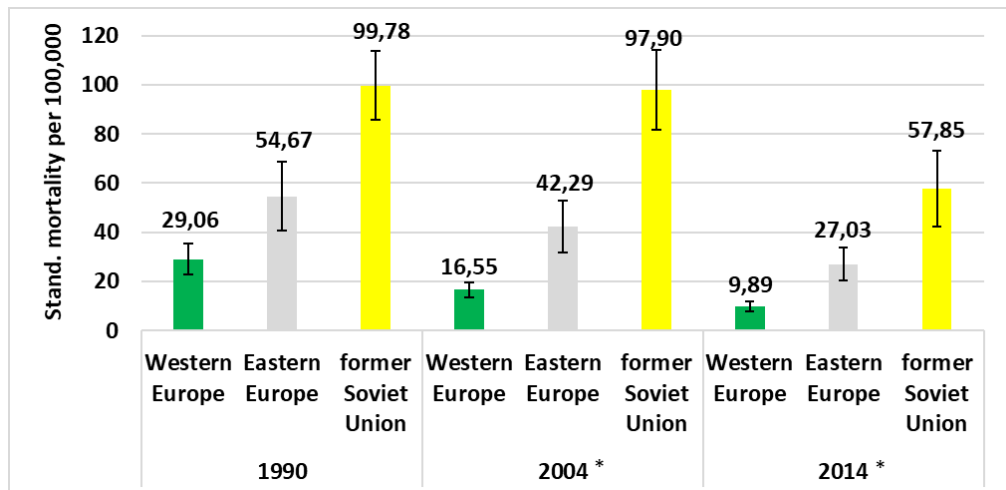


Figure 2.: IHD mortality trend in WE, in EE and in fSU, 45-59 females, 1990 to 2014.

Conclusions: During the whole period analysed, ischaemic heart disease mortality significantly decreased in both sexes in all the regions. Social-political-economic stress have an impact on IHD mortality.

3.3 INEQUALITIES IN PREMATURE MORTALITY DUE TO CEREBROVASCULAR DISEASE IN EUROPE

Introduction: Cerebrovascular diseases are a significant public health concern, they are among the leading causes of death worldwide and one of the major causes of disability.

Objective: Our aim was to analyse national and international data regarding premature, cerebrovascular disease mortality per region in the 45–59 age group.

Methods: We performed a retrospective, quantitative analysis on age-specific, premature cerebrovascular disease mortality between 1990 and 2018 per 100 000 population on data derived from the World Health Organisation, European Mortality Database on Western European (n = 17), Eastern European (n = 10) countries, and countries of the former Soviet Union (n = 15). Descriptive statistics, time series analysis and Kruskal–Wallis test were performed.

Results: Age-related, cerebrovascular disease mortality per 100 000 population was the lowest in Western European countries (males: 1990: 35.14, 2018: 12.38; females: 1990: 21.11, 2018: 8.75), and the highest in former Soviet Union countries (males: 1990: 134.19; 2018: 84.16; females: 1990: 83.62, 2014: 32.88). Significant differences were found in age-specific, cerebrovascular disease mortality in both sexes between Eastern and Western European

countries and former Soviet Union countries (1990, 2004, 2014: $p < 0.05$). Between 1990 and 2018, agespecific, standardized cerebrovascular disease mortality showed the biggest decrease in Western European countries among males (-64-78%). Between 1990 and 2018, agespecific, standardized cerebrovascular disease mortality showed the biggest decrease in Eastern European countries among females (-65.08%).

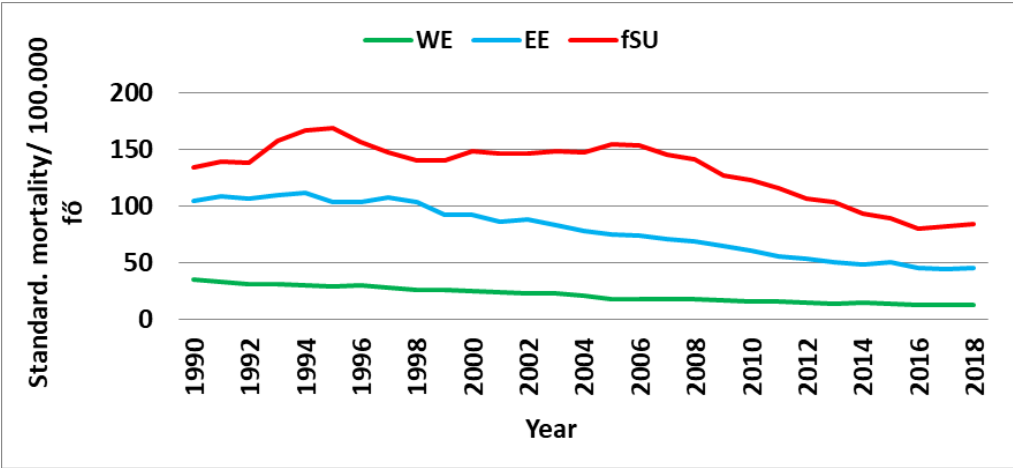


Figure 3.: Cerebrovascular disease mortality trend in WE, in EE and in fSU, 45-59 males, 1990 to 2018.

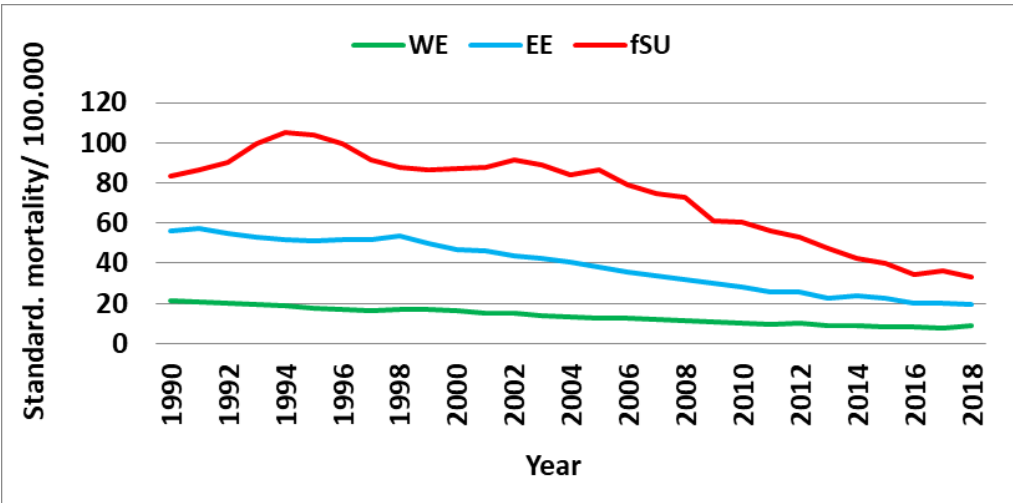


Figure 4.: Cerebrovascular disease mortality trend in WE, in EE and in fSU, 45-59 females, 1990 to 2018.

Conclusions: Age-specific, cerebrovascular disease mortality decreased in both sexes in all regions analysed. Hungary was found to have seen a decrease above the Western European average, premature cerebrovascular mortality decreased by 66.3% in males and 63,38% in females between 1990 and 2018.

3.4 EPIDEMIOLOGICAL DISEASE BURDEN AND ANNUAL HEALTH INSURANCE TREATMENT COST OF ACUTE MYOCARDIAL INFARCTION IN HUNGARY

Introduction: Cardiovascular diseases have been the leading causes of death worldwide accounting for one third of all-cause mortality, and nearly half of mortality in Europe.

Aims: The aim of our study was to determine the epidemiological disease burden of acute myocardial infarction.

Data and methods: Data were derived from the financial database of the Hungarian National Health Insurance Fund Administration for 2018. Data analysed included annual patient numbers, prevalence per 100,000 population in acute inpatient care, health insurance costs calculated for age groups and sex for all types of care. Patients with acute myocardial infarction were identified with the code: I21 of the International Classification of Diseases 10th revision.

Results: In 2018, the National Health Insurance Fund Administration spent 16.728 billion Hungarian Forints on treatment of acute myocardial infarction, 61.902 million American Dollars, 52.463 million Euros. Acute inpatient care accounted for 95.8% of costs (16.032 billion Hungarian Forints; 59.321 million American Dollars; 50.276 million Euros) with 16,361 persons (9,742 male; 6,619 females) hospitalised. Based on patient numbers in acute in-patient care, prevalence per 100,000 among men was 208.54, among women 129.61 patients. In all age groups, except for patients aged >75 years, the number of males was higher than that of females.

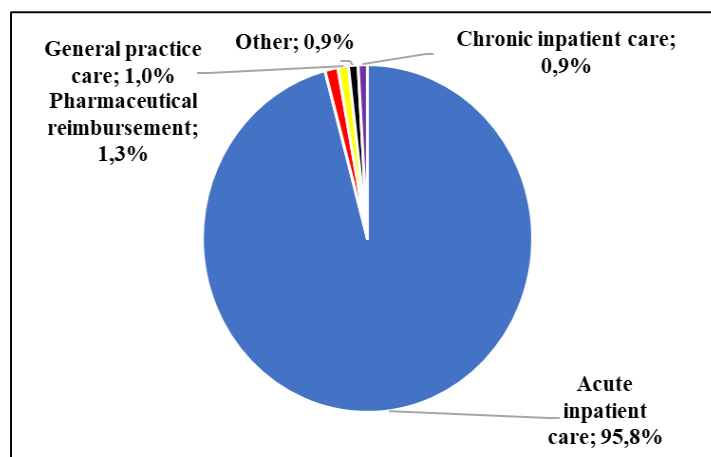


Figure 5.: Distribution of health insurance costs for the care of patients treated for acute myocardial infarction with regard to all types of care (Hungarian National Health Insurance Fund Administration, 2018)

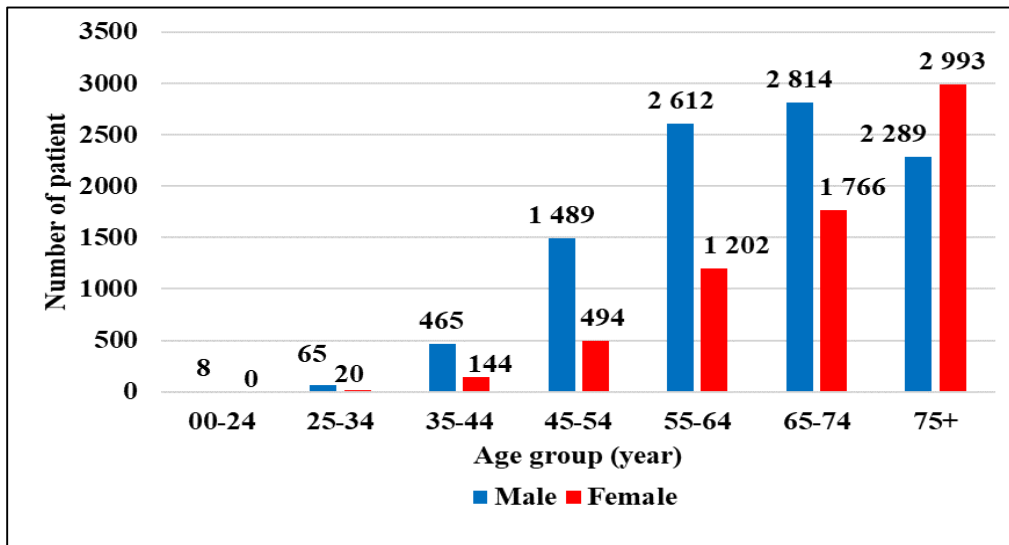


Figure 6. The number of patients treated with acute myocardial infarction in acute inpatient care, by gender and age group (Hungarian National Health Insurance Fund Administration, 2018)

Conclusions: Acute inpatient care was the major cost driver in the treatment of acute myocardial infarction.

4. DISCUSSION

Cardiovascular diseases are the leading causes of death worldwide, and their public health importance is undebatable. As the most common cause of death within the group of cardiovascular diseases, the disease burden of ischemic heart disease is the most significant globally.

An acute myocardial infarction is an acute form of ischaemic heart disease. Acute myocardial infarction significantly contributes to mortality indicators. After ischaemic heart disease, stroke is the second most common cause of death within the category of cardiovascular diseases. Due to their public health significance, we devoted previous chapters to discussing the epidemiological aspects of ischaemic heart disease within the group of cardiovascular diseases, and to analysing the inequalities in premature death caused by ischaemic heart disease and cerebrovascular disease in the WHO European Region.

Periods analysed were determined depending on the availability of data, as described in the methodological part of each chapter, as there were occasional, considerable limitations in this regard.

We examined the epidemiological and health insurance burden of disease caused by acute myocardial infarction in a Hungarian sample.

Standardized mortality caused by ischemic heart disease is decreasing, but at the same time, significant inequalities can be found in mortality indicators and the rate of improvement between individual countries and within specific areas. In North America, as well as in the countries of Northern Europe and Western Europe, we can see a favourable development regarding mortality indicators, but at the same time in Central Asia, South Asia, and Eastern Europe, mortality indicators are less favourable. In Eastern European countries and former states of the Soviet Union, premature death - in the 45-59 age - group also showed an increase in the early 1990s. Age-specific ischaemic mortality decreased on average between 1990 and 2014 in the selected Western European and Eastern European countries and former Soviet states. According to available data, the mortality among males in the latter group increased in four countries (Ukraine, Moldova, Belarus, Kyrgyzstan). In the case of women, an increase in standardized age-specific mortality was observable only in Ukraine. In Hungary, standardized mortality caused by ischaemic heart disease showed an improvement for the entire population between 1990 and 2017, however, the rate of improvement fell behind the average of the countries of the European Union. With regard to Hungary the least favourable indices were found in regions of the Great Plain and Northern Hungary. Mortality rates due to ischaemic heart

disease were the lowest in the Trans-Danubian region and Mid-Hungary except for Nagykáta, Szob and Vác regions. In these regions, unfavourable data were found for both sexes in premature mortality. The above regional differences can be due to national inequalities in access to percutaneous coronary intervention (PCI). Similar to Hungary, significant regional inequalities can be observed in other countries with regard to the epidemiological indicators of cardiovascular diseases. In Slovakia, significant regional disparities are described in mortality rates caused by ischaemic heart disease, with the mortality rate changing favorably in the part of the country extending from Eastern Slovakia to Western Slovakia. In the framework of a previous research carried out in Scotland, among other socio-demographic factors, inequalities regarding the mortality of ischaemic heart disease were examined based on place of residence. Authors found less favourable epidemiological indices among people living in country. Australian researchers also examined the place of residence (rural, urban) as an independent variable in relation to territorial inequalities. According to the results of their systematic review, cardiovascular mortality is higher among rural populations than among people living in the city. Similar results were found in a study conducted in the United States regarding the prevalence of ischaemic heart disease, according to which the incidence of ischaemic heart disease was higher in the rural population than in people living in cities.

Within the group of ischaemic heart diseases, acute myocardial infarction is of particular importance, the long-term mortality rates of people suffering from the disease in Hungary are lower than those of patients treated in other European countries. Socio-economic status, patient compliance and access to adequate therapy all play a crucial role in the development of regional inequalities. According to the results of a research conducted in Hungary, in the case of non-ST elevation myocardial infarction (NSTEMI), there were significantly more PCIs performed in regions of Central Hungary and West Hungary than in the region of Eastern Hungary. According to the results of the study, PCI performed in the acute phase of the disease reduced mortality. These research results correlate with the territorial distribution of the mortality indicators we described earlier.

From the point of view of mortality, 30 and 365 days after the onset of an acute myocardial infarction, medical instructions, the patient's lifestyle and socio-economic situation, as well as rehabilitation are important determining factors. Cardiac rehabilitation plays a significant role in the improvement of post-infarction quality of life. In the case of people of active age, it is important to restore the ability to work. Taking into consideration both the national and the international situation, it can be generally stated that the number of patients participating in rehabilitation care is low.

Regarding premature mortality due to cerebrovascular disease (in the age group 45-59 years) in Europe, similar to mortality data on ischaemic heart disease, the lowest rates were found in Based on our analyses, the age-specific cerebrovascular mortality of Eastern European countries did not differ significantly from that of the successor states of the Soviet Union in the examined years. In Eastern European countries and post-Soviet states, the economic and financing changes that occurred after 1990 had a significant impact on the functioning of the healthcare systems and at the same time on neurological care services. It should be emphasised, however, that the cerebrovascular mortality of men and women in the 45-59 age group decreased to a greater extent in Hungary between 1990 and 2018 than the Western European average.

As regards income levels, the majority of deaths from cardiovascular disease occur in low- and middle-income countries.

Mortality indicators are largely influenced by social, political and economic stress. In a given country, health care expenditure also markedly impacts mortality statistics. Research on economic disease burden is scarce; further research has highlighted that in Serbia 1.8% of the GDP was spent on covering CVD-related costs. Based on estimates of an earlier analysis, the cost of CVDs in Russia in 2009 was 24,400.4 million euros. An international systematic review estimated monthly treatment costs for stroke and coronary artery disease to be between 300 and 1000 USD. In the United States, health care costs related to ischaemic heart disease are projected to increase by 41% by 2040, from 126.2 billion USD to 177.5 billion USD, compared to the base year of 2010. In 2018, the National Health Insurance Fund of Hungary spent a total 16.728 billion HUF (61.902 milliárd USD; 52.463 milliárd EUR) on the treatment of acute myocardial infarction. Analysing the financing data for acute myocardial infarction, it can be established that the main cost driver in the treatment of the disease is active inpatient care in Hungary. According to the results of a research conducted in the United States, the total annual cost of acute myocardial infarction was estimated at 84.9 billion USD for the year 2016. Between 2003 and 2014, the loss of productivity caused by premature mortality was estimated at 40.5 billion USD. According to this study, people with acute myocardial infarction spent 5.9 days less at work than people not affected by the disease.

Regarding DALYs, at present, smoking is the main risk factor, consequently smoking cessation programmes are of great importance. In the development of cardiovascular diseases, obesity is also a major risk factor, given the resulting metabolic changes. In the prevention of obesity, population-level strategies, such as the introduction of the Public Health Product Tax and the reform of public catering, may also have considerable results.

In addition to the above-mentioned factors, the development of cardiovascular risk factors was also adversely affected by the COVID-19 pandemic. The pandemic also contributed to an increase in physical inactivity and unhealthy eating habits. During the pandemic, fears of getting infected also reduced the number of people attending healthcare, leading to an increase in out-of-hospital cardiac arrests and late presentation and admission of patients with acute myocardial infarction. Some studies on the subject have raised the possibility of a link between the pandemic and an increased risk of acute myocardial infarction. In addition to these findings, the suspension of elective interventions has been an important factor delaying the implementation of rehabilitation programmes.

The economic burden of acute myocardial infarction is significant, financing is often limited, and effective prevention and utilisation of available resources can lead to significant health and productivity cost savings while increasing patient safety.

The analyses presented in previous chapters of this thesis show that Hungary has witnessed a decrease in standardised mortality from ischaemic heart disease and cerebrovascular disease in recent years. Nonetheless, effective preventive strategies are needed to further improve mortality and morbidity rates, as the health status of the Hungarian population is worse than in many other European countries. One of the most important tasks is to eliminate cardiovascular risk factors through health promotion as part of primary prevention. International studies have highlighted the efficaciousness of prevention programmes aimed at cardiovascular disease reduction. Information, health education and the use of cardiovascular risk calculators are essential. Within the framework of secondary prevention, the organisation of screening programmes for the general public is of particular importance in order to ensure timely diagnosis and effective treatment. The voluntary nature of screening means that it is necessary to consider those who do not attend screenings. There may be many reasons for absenteeism, but generally speaking, people who regularly attend screening tests are more health-conscious and have better health determinants. In the light of the studies presented above and the association between place of residence and epidemiological indicators, it would be of crucial importance to reach individuals who do not attend screenings, particularly those living in disadvantaged small settlements. Further advancement of diagnostic methods and pharmacological therapies and the reduction of inequalities in access to modern healthcare all contribute toward improving morbidity and mortality rates. Improving morbidity rates would result in reduced healthcare costs and consequently, reduced burden on healthcare systems. The national data interpreted in the above chapters point to areas that would need to be improved in order to achieve better epidemiological indicators. Our overview and analysis can help inform policy decisions.

A further possible direction of our investigation is the epidemiological analysis of mortality from cerebrovascular disease in patients aged over 65 years, similar to the topic of our manuscript accepted after the present thesis was completed, which discusses spatial disparities in mortality from ischaemic heart disease in old age. Depending on the availability of data, we would also like to extend the period of analysis for several aspects of our research presented in this thesis. Our objectives include the analysis of patient pathways for the care of cerebrovascular disease and acute myocardial infarction based on the National Health Insurance Fund database.

5. NOVEL RESULTS

Novel results as discussed in previous chapters are summarised as follows:

1. We provided an overview of the regional disparities in morbidity and mortality from ischaemic heart disease in Hungary.
2. We presented and discussed regional disparities in premature mortality from ischaemic heart disease in the 45-59 age group, in Hungary.
3. We evaluated and discussed international, regional disparities in premature mortality from ischaemic heart disease in the 45-59 age group
4. We estimated the epidemiological burden of disease for acute myocardial infarction based on real-world, routinely collected data from the National Health Insurance Fund (NEAK) financing database.
5. We assessed the annual health insurance burden of acute myocardial infarction based on the NEAK health insurance financing database.

6. LIST OF PUBLICATIONS

PUBLIKÁCIÓK SZERELTVE A DOKTORI ÉRTEKZÉSHEZ

1. **Németh N**, Endrei D, Horváth L, Elmer D, Csákvári T, Pónusz R, Szapáry L, Boncz I. A cerebrovasculáris betegségekből eredő, idő előtti halálozás egyenlőtlenségei Európában 1990 és 2014 között. *Orv Hetil.* 2021; 162(4): 144–152. **(Impact Faktor: 0,707)**
2. **Németh N**, Endrei D, Elmer D, Csákvári T, Horváth L, Kajos LF, Cziráki A, Boncz I. A heveny szívinfarktus okozta országos epidemiológiai és egészségbiztosítási betegségteher Magyarországon. *Orv Hetil.* 2021; 162(Suppl 1): 6–13. **(Impact Faktor: 0,707)**
3. **Németh N**, Boncz I, Elmer D, Horváth L, Csákvári T, Endrei D. Az ischaemiás szívbetegség epidemiológiai aspektusai. *Egészség Akadémia.* 2022; 13(1-2): 28-39.
4. **Németh N**, Boncz I, Elmer D, Horváth L, Csákvári T, Endrei D. Az ischaemiás szívbetegség okozta halálozás egyenlőtlenségei 65 év felettek körében, 1990-2016. *Cardiologia Hungarica.* 2023; 53: 30–224.
5. Horváth L, **Németh N**, Fehér G, Kívés Zs, Endrei D, Boncz I. Epidemiology of Peripheral Artery Disease: Narrative Review. *Life.* 2022; 12(7): 1041. <https://doi.org/10.3390/life12071041> **(Impact Faktor: 3.251)**

Cumulative impact factor: 17.531. Impact factor of publications incorporated in the PhD Thesis: 4.665

PÁRTEVÉSELÉS AZ INTERNACIONÁLIS KONFERENCIÁKON KIADOTT ABSTRACTSOK SZERELTVE A DOKTORI ÉRTEKZÉSHEZ:

1. **Németh N**, Boncz I, Horváth L, Csákvári T, Pónusz R, Elmer D, Endrei D. Mortality from ischaemic heart disease among men in Hungary by county. *Value Health.* 2022, 25: 7 p. S436.
2. **Németh N**, Boncz I, Elmer D, Danku N, Horváth L, Csákvári T, Pónusz R, Kovács D, Kajos L, Endrei D. Epidemiological disease burden of heart failure, unspecified based on routinely collected health insurance claims data. *Value Health.* 2022, 25: S129-S129.
3. **Németh N**, Boncz I, Elmer D, Danku N, Horváth L, Csákvári T, Pónusz R, Kovács D, Kajos L, Endrei D. Epidemiological disease burden of left ventricular failure based on routinely collected health insurance claims data. *Value Health.* 2022, 25: S136-S136.
4. **Németh N**, Boncz I, Elmer D, Danku N, Horváth L, Csákvári T, Pónusz R, Kajos L, Endrei D. Epidemiological disease burden of hypertensive heart disease with heart failure based on routinely collected health insurance claims data. *Value Health.* 2022, 25: S123-S123.
5. **Németh N**, Endrei D, Elmer D, Danku N, Horváth L, Csákvári T, Pónusz R, Kajos L, Boncz I. Annual health insurance treatment cost of hypertensive heart disease with heart failure based on routinely collected financing data. *Value Health.* 2022, 25: S51-S51.
6. **Németh N**, Endrei D, Elmer D, Danku N, Horváth L, Csákvári T, Pónusz R, Kajos L, Boncz I. Annual health insurance treatment cost of left ventricular failure based on routinely collected financing data. *Value Health.* 2022, 25: S51-S51.
7. **Németh N**, Boncz I, Elmer D, Danku N, Horváth L, Csákvári T, Pónusz R, Kovács D, Kajos L, Endrei D. Epidemiological disease burden of hypertensive heart and chronic kidney disease with heart failure based on routinely collected health insurance claims data. *Value Health.* 2022, 25: S124-S124.
8. **Németh N**, Endrei D, Elmer D, Danku N, Horváth L, Csákvári T, Pónusz R, Kovács D, Kajos L, Boncz I. Annual health insurance treatment cost of hypertensive heart and chronic kidney disease with heart failure based on routinely collected financing data. *Value Health.* 2022, 25: S104-S104.
9. **Németh N**, Endrei D, Pónusz R, Elmer D, Sebestyén A, Horváth L, Csákvári T, Boncz I. Epidemiological disease burden of acute myocardial infarction based on routinely collected health insurance claims data. *Value Health.* 2020; 23: S101-S101.
10. **Németh N**, Elmer D, Horváth L, Csákvári T, Pónusz R, Endrei D, Boncz I. Age-specific examination of early cerebrovascular mortality: 1990-2014. *Value Health.* 2020; 23: S100-S100.

11. **Németh N**, Elmer D, Horváth L, Csákvári T, Pónusz R, Boncz I, Endrei D. Changes in the early mortality related to ischaemic heart disease among people aged 45-59 between 1990-2014. *Value Health*, 2020; 23: S99-S100.
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- 1. Németh N.** Elmer D, Horváth L, Pónusz R, Endrei D, Boncz I. Ischaemiás szívbetegségből eredő halálozás korszpecifikus felmérése. In: Magyar Egészség-gazdaságtani Társaság XIII. META Konferencia. Budapest, 2019; p.
- 2. Németh N.** Elmer D, Horváth L, Molnárné Csákvári T, Pónusz R, Endrei D, Boncz I. Demográfiai faktorok elemzése a heveny szívinfarktussal regisztráltak körében. In: Magyar Egészség-gazdaságtani Társaság XII. META Konferencia. Budapest, 2018; p.
- 3. Németh N.** Elmer D, Endrei D, Boncz I. A heveny szívinfartus előfordulásának elemzése a PULVITA Egészségügyi Adattárház adatai alapján: 2012-2016. In: XI. IME-META Országos Egészség-gazdaságtani Továbbképzés és Konferencia: A PTE 650 éves jubileuma jegyében. Pécs, Pécsi Tudományegyetem. 2017; p. 167-169.
- 4. Németh N.** Elmer D, Pónusz R, Boncz I, Endrei D. Egészségügyi intézményekben ellátott heveny szívinfartusok előfordulása Magyarországon In: Bódog F, Csiszár B, Hegyi D, Pónusz R. (Eds.) DKK17-Doktoranduszok a Klinikai Kutatásokban absztraktkötet. Pécs, Pécsi Tudományegyetem Doktorandusz Önkormányzat. 2017; p. 78.
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