IMPACT OF SELECTED SOCIO-DEMOGRAPHIC FACTORS ON THE DEVELOPMENT OF MORTALITY DUE TO CIRCULATORY SYSTEM DISEASES IN THE SLOVAK REPUBLIC

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SUMMARY

Aim: We mapped the situation within a group of diseases of the circulatory system (I00-I99) in the Slovak Republic during 1996–2014. We focused mainly on spatiotemporal differences in mortality while controlling for age and sex.

Methods: We performed binary logistic regression aiming to reveal socio-demographic factors that influence the odds of dying due to diseases of the circulatory system (I00-I99). In our analysis, the dependent variable was death diagnosis and the independent variables were age, region, gender, and marital status.

Results: Our findings suggest that odds of dying due to diseases of the circulatory system (I00-I99) increased for every year of age by 5.4%. Within the period from 1996 to 2014, the risk of dying from diseases of the circulatory system decreased by 2% every year. We also documented the fact that being female raised the odds of dying due to diseases of the circulatory system (I00-I99) by 12.9% compared to males. Furthermore, it could be argued that serious differences in terms of regional distribution of deaths caused by diseases of the circulatory system (I00-I99) exist in the Slovak Republic.

Conclusions: We present the development of diseases of the circulatory system (I00-I99) in the Slovak Republic. Differences in spatial distribution of deaths are documented as well as related gender differences. Our study can serve as a tool for policy makers and benchmark for professionals.

Key words: diseases of the circulatory system, Slovak Republic, binary logistic regression

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INTRODUCTION

Circulatory system diseases are the leading cause of death in Slovakia and the leading cause for hospitalization. They represent a significant medical, social and economic problem. These diseases result in standing mortality worldwide. The only way to eliminate them is a quality prevention and early diagnosis (1). The development of morbidity and mortality of these diseases are affected by numerous factors, some of which can be affected by an individual himself, for example changing lifestyle. Lifestyle and health behaviours can reach up to 60–70% of influence on the overall health of humans; socio-economic environment 15–20%; age, genetic and constitutional factors 10–15%; with the same proportion accounted for by health care. In addition to uncontrollable risk factors (age, gender, family history), morbidity of circulatory system diseases is affected by the so-called controllable factors, such as blood pressure, obesity, diabetes, high cholesterol, smoking, stress, a sedentary lifestyle, etc. The incidence of serious risk factors for circulatory system diseases in Slovak population aged under 65 is in the recent years disappointingly high. Concerning negative results, we can mention the observed elevated levels of total cholesterol in 54% of subjects, elevated blood pressure in 45% of subjects in the general population, with about half of them had blood pressure above 160/90 mmHg. Moreover, increase in the incidence of hypertension by 6% was documented, with approximately 62% being overweight or obese according to the BMI (body mass index) and 49% have risk values in waist circumference. Additionally, steady rise of smoking among younger age groups or lack of physical activity (no or almost no physical activity in 37% of men and 50% women) could be mentioned as well. Expert studies associate these risk factors with age, sex, level of education and the regions of Slovakia, with the worst records among the inhabitants of large cities and in terms of territorial deployment among residents of southern and eastern districts of Slovakia, including negative eating habits. In international comparison, the aggregate population of 0–64 years, Slovakia has the death rate of circulatory system diseases 2.5 times higher than Austria and the EU 15, 1.7 times higher than Finland, 1.2 times higher than Czech Republic, 1.3 times less than Hungary and 2.4 times less than in Ukraine (2, 3).

Many research studies focused on public health (4, 5) examine the long-term risk factors of the determinants of health to detect possible causes of health inequalities. Its elimination is a priority of the European Commission, which calls for the introduction of measures to eliminate health inequalities in the European Union (6), which are costly, both economically and socially.

The most typical group of health determinants includes demographic and biological determinants (e.g. age, sex, ethnicity, etc.), socio-economic determinants (lifestyle, education, employment, social contacts, etc.), environmental determinants (life and work) and health system. Estimation of the impact of various determinants on the health of humans differs among domestic and foreign authors. According to several sources, lifestyle and behaviours have the most decisive impact, followed by the environmental, genetic and biological factors as well as health services. The estimated share of health care on health is 10–20% (7). Health care is very important, although not the largest contributor to health. At least four fifths of efforts to improve the health status should be directed to preventing diseases, using "non-health" factors. The quality of prevention programs will require the implementation of multidimensional analyses with the conceptual medical, social, economic and regional framework, which are still absent in our public health system. The main reason is a lack of high-quality databases, epidemiological and socio-demographic data, research teams and seclusion of results of research activities. This prevents the development of national and international platforms as well as deeper comparative examination of determinants of health risk factors and their causal dimensions. Regular monitoring and evaluation of the social determinants of health in working and living conditions will lead to knowing and elimination of the influence of factors decreasing life expectancy with a negative impact on people's lives, productivity levels and health care spending. These facts determined the logical target of our research study to the effects of selected socio-demographic factors on the development of mortality due to circulatory system diseases in Slovakia.

Literature Review

Many researchers (8–30) have been examining the impact of age, gender, socioeconomic status, economic characteristics, demographic and sociological factors on mortality of circulatory system diseases for a long time. Their research studies are markedly heterogeneous by nature, since they examine a selected determinant or a group of determinants in relation to circulatory system diseases mortality in different populations only, at different times and through different methodologies. Despite the unification of their conclusions, they provide a valuable platform when considering the significance of selected determinants for further scientific researches. As suggested by some of the tabulated results (Table 1), marital status and socioeconomic status are often the subjects of analysis of causal relations in relation to morbidity and mortality from circulatory system diseases. These determinants are being examined by authors in various research processes and they conclude that single men have a higher risk of mortality due to circulatory system diseases than women. Women who were married or living with a partner had a similar risk of coronary heart disease, but significantly lower mortality, compared with women who were not. Divorce and widowhood was associated with an increased risk of mortality only for men but not women. Low socioeconomic status (SES) increases the risk of circulatory system diseases and deaths from type 1 diabetes. Being married provides up to 50% lower risk of death from circulatory system diseases with diabetes, as compared to being single. This suggests that single status, divorce and widowhood represent a potential adverse effect on health. Low SES, based on the results of some studies (Table 1), is associated with an increased risk of contracting coronary heart disease. The link between socioeconomic status and cardiovascular risk factors was more consistent among women than men. Several studies in its conclusions appeal to the increasing importance of prevention and treatment of coronary heart disease amongst a part of the population with a distinctive lower SES. The level of education is in some studies considered to be the most important factor among the socioeconomic elements in conjunction with the risk factors of circulatory system diseases. Similar, interesting findings exist; these are reviewed in Table 1. In addition to these factors, regional disparities in deaths due to circulatory system diseases in some countries are a subject of numerous research studies as well. Their creation and reinforcement are the result of the global crisis, the continued deepening of inequalities in health among countries and within some of them, the setting of health systems and many other exogenous and endogenous causes.

MATERIALS AND METHODS

Analysis was done on dataset containing all deaths in the Slovak republic within period of 1996–2014. In the descriptive part of the paper we offered description of evolution of diseases comprised in the chapter Diseases of the circulatory system (I00-I99) of the 10th revision of International Classification of Diseases in the Slovak Republic during mentioned period. In the quantitative analysis, we used binary logistic regression where we were interested in model comprising dichotomous outcome variables. In the presented logit model the log odds of dying due to the Diseases of the circulatory system (I00-I99) against dying from all the other possible diseases was modelled as a linear combination of the predictor variables. Predictor variables were year of death, age, gender, region and marital status.

RESULTS

Our dataset contained all deceased persons in Slovak Republic within the period from 1996 to 2014. In total, there were 997,165 observations (deceased individuals). With an enormous predominance, Diseases of the circulatory system were responsible for 53.8% of deaths. In total, 536,393 individuals died due to Diseases of the circulatory system in Slovak Republic during the previously mentioned 19-year period. Our dataset contained information about deceased individuals via death certificates in the previously outlined time period. The data were provided by the National Health Information Centre of the Slovak Republic.

Figure 1 proposed an overview of evolution of five most frequent causes of death within the Chapter IX – Diseases of the circulatory system. One can see that Ischemic heart diseases (I20-I25) which caused 54.8% of all deaths within the Diseases

Table 1. *Literature review*

Source	Variables	Methods	Results
Davletov et al. (2015)	Age	Age-standardized mortality rates by gender and region in Kazakhstan	Substantial differences in mortality from cardiovascular disease across regions equally between men and women have been found. Hazardous alcohol use appears to be highest in the north-eastern region of Kazakhstan, which could be associated with different patterns of alcohol consumption across different ethnic groups (ethnic Russians).
Naghavi et al. (2015)	Age, sex	Global Burden of Disease Study 2013; 188 countries between 1990 and 2013	Evaluation of the epidemiological convergence of the country depends on whether absolute or relative measure of inequality is being used. However, the age-standardized mortality rate for the seven principal causes of mortality is increasing, suggesting a reversal in some countries.
Rawshani et al. (2015)	Income, education, marital status, birthplace (region), comorbidity	Cox regression, rigorous covariate adjustment	Low SES (socioeconomic status) increases the risk of CVD and death in type 1 diabetes. Being married brings about 50% lower risks for death from CVD and diabetes compared to be single.
Roth et al. (2015)	Regions, age, sex	Regional comparison of cardiovascular mortality from 1990 to 2013	Over the past two decades there has been a reduction in mortality from CVD but also a growing number of people who are diagnosed with cardiovascular disease at a young age. There is wide variation between and within regions, CVD remain a dominant cause of death also in individuals younger than 40 years. Policies and health interventions must be adapted to a wide variety of local conditions in order to achieve the objectives set by the UN for the 2025th
Yang et al. (2015)	Regions, socio-economic and demographic indicators	26 studied regions in the south and west of China in the years 2008 to 2011 to identify the socio-economic and demographic factors, combined with differences in temperature; Poisson generalized additive model (GAM)	In most areas it has been an increasing trend in high or low temperature associated with increased cardiovascular mortality. Cardiovascular mortality in combination with a low temperature is affected by factors: years of education, the percentage of the population over 65 and the percentage of women. Cardiovascular mortality in association with high temperature is affected by factors: the number of beds, the percentage of the population working in industry and the percentage of women.
Floud et al. (2014)	Marital status of women	734,626 women (average age 60), Cox regression	Women who were married or living with a partner had a similar risk of coronary heart disease but significantly lower death rates from coronary heart disease compared with women who were not married or did not live with a partner.
Moran et al. (2014)	Region, age	21 world regions	In most regions of the world, particularly in high-income age-standardized death rate from ischemic heart disease has been declining since 1980. The high age-standardized death rate from ischemic heart disease in Eastern Europe, Central Asia and South Asia highlights the need for prevention and control of risk factors in these areas and research of unique behavioural and environmental determinants of increased mortality from ischemic heart disease.
Quinones et al. (2014)	Marital status, sex, age	3,766 men and women aged 28–74 years who survived 28 days after overcoming the first heart attack; Hazard ratios	Marital status has a strong protective effect on survival of first myocardial infarct with a diagnosed hyperlimidemy that decreases with increasing age. Treatment recommending lifestyle changes or other attributes specific to hyperlimidemy may be essential factors mediated through social support of the spouses.
Mikkola et al. (2013)	Sex, age	Annual mortality rates were calculated on the 100,000 inhabitants of middle-aged separately for men and women separately for the 5-year categories.	The mortality rate from heart disease in men increases at a relatively young age, but the risk among women increases sharply after 60 years of age. Identified data highlight the need to identify and avoid risk factor for CVD, especially in middle-aged women.
Roche et al. (2013)	Sex	73,783 people aged 25 years and over in Newfoundland and Labrador, Canada (15,152 diabetes; 9,517 of late diagnosis)	Men and women with diabetes had an increased risk of death in all cases also CVD than people who did not have diabetes, and the risk is greater in women than in men. Women with late onset diabetes had a higher risk compared to women without diabetes, but the two groups have a significantly higher risk than men.

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Source	Variables	Methods	Results
Tanno et al. (2013)	Marital status, duration of dialysis, BMI, systolic blood pressure, cholesterol, high density of lipoprotein-cholesterol, albumin, C-reactive protein, comorbidity, smoking, alcohol, education, employment	5-year study, 1,064 hemodialyc patients aged 30 years and older; Cox regression – hazard ratios	The results show that single status is a significant predictor of mortality for all CVD and mortality, and the distribution / survivorship is a significant predictor of CVD mortality in dialysis patients
Gupta et al. (2012)	Region, age, gender (smoking, tobacco use, low physical activity, obesity, hypertension, diabetes)		The study indicates that there are significant regional differences in risk factors in India. Regional differences in risk factors on macro level explain some of the regional differences in mortality due to cardiovascular disease. Further study where there is a comparison of different risk factors for cardiovascular disease in different regions needed and correlate them with differences in mortality from cardiovascular disease by using a single system.
Franks et al. (2011)	Socio-economic status (SES) – income, education	10-year study of 15,495 people aged 45–64 years; Cox analysis, Farmingham Risk Score	Low SES is associated with increased risk of coronary heart disease. After adjustment for variable time-dependent, the effect of SES remained significant.
Franks et al. (2010)	Socioeconomic status (SES) – income, education	10-year study, 15,495 adults aged 45–64 years, Cox method, Framingham risk score	The use of the income of patients on the basis of the blocking group and individual education minimizes distortion of SES and Framingham risk score suggests a more aggressive treatment of cholesterol in those with low SES.
Stringhini et al. (2010)	Social status, income, level of responsibility at work	9,590 men and women deceased till 2009	Low socio-economic position brought about 1.6 times higher risk of death in all cases of death in the population working in the civil service in London as reflected in health behaviour.
Loucks et al. (2009)	Sex, age (systolic blood pressure, the level of HDL cholesterol, BMI, smoking, "Fasting Glucose", use of antihypertensive drugs)	1,835 subjects of the Framingham Heart Study Offspring Cohort between years 1971 and 2003; Cox proportional hazards analyzes	The findings highlight the potential importance of prevention and treatment of ischemic heart disease for those who have recorded low socio-economic position.
Molloy et al. (2009)	Marital status, sex	13,889 Scottish men and women without a history of clinically diagnosed cardiovascular disease	Risk of cardiovascular mortality was the largest ever among the single and never married males and among the separated / divorced women compared with those who were married, modifying data on age and socio-economic factors.
Ikeda et al. (2007)	Marital status, sex	94,062 Japanese men and women aged 40–79; questionnaire	Single marital status was associated with a higher risk of mortality than married, same for women and men. Divorce and widowhood was associated with an increased risk only for men but not for women. This suggests that single status, divorce and widowhood represent a potential adverse effect on health.
Woodward et al. (2007)	Sex, age, marital history	6,540 men and 6,757 women aged 30–74 years, ASSIGN score (cardiovascular risk score)	Conventional cardiovascular score failed in the focus of social disparities in the course of the disease. Family history is a valuable indicator not only of ethnic sensitivity. ASSIGN score classified more people with the social deprivation and a positive family history of high risk.
Zhang (2006)	Marital status – history	Logistic regression models and mortality data on CVD from 1992 (Health and Retirement Study)	Middle-aged married and those who have never been married are the CVD healthiest. People who repeatedly changed their marital status have a higher chance of developing CVD and require care primarily in old age.
Malyutina et al. (2004)	Marital status, gender, education	485 men and 4 919 women aged 25–64 years in years (1984, 1985/86, 1988/89, 1994/95). Method: questionnaire	Educational differences in cardiovascular mortality in Russia has a similar direction as in Western countries. Educational differences in cardiovascular mortality in women and increased mortality among divorced men could not be explained by traditional risk factors.

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Source	Variables	Methods	Results
Cheung (2000)	Marital status, age of the woman	Women aged 35 and over; Cox regression	Being single has been associated with higher mortality. Causal interpretation is unlikely. Increased mortality was detected as a result of divorce or widowhood.
Yu et al. (2000)	SES (education, occupation, income, marital status), blood pressure, BMI, smoking	4000 people aged 15-69 years	The level of education seems to be the most important factor from the remaining socio-economic factors in conjunction with the risk factors of cardiovascular disease. People with lower socio-economic status have higher levels of cardiovascular risk factors. The link between socio-economic status and cardiovascular risk factors was more consistent in women than in men.

of the circulatory system displayed serious increment during a period of 2006–2008. After this period, the evolution of deaths started to decline again. Cerebrovascular diseases (I60-I69) that caused 17.8% of deaths within Diseases of the circulatory system had also shown significant rise within the period of 2006–2008. Afterwards, the number of deaths started to decrease. The number of deaths caused by Diseases of arteries, arterioles and capillaries (I70-I79) that caused 9.2% of deaths in the chapter Diseases of the circulatory system had been decreasing within the period between 1996–2004. From 2004–2006 we observed serious rise in the number of deaths. From 2006–2014, number of deaths within this group of diseases displayed considerable decrease. Situation within the group of Other forms of heart disease (I30-I52) that caused 7% of all deaths within the chapter Diseases of the circulatory system got worse over time. The situation within the group of Hypertensive diseases (I10-I15) that caused 7% of all deaths within Chapter IX worsened seriously from 1998–2001 and then remained stable. Situation in this group ameliorated from 2006.

In Table 2, information about the spatial and gender distribution of deaths was provided. Table 2 suggests that among Diseases of the circulatory system, the most dangerous were Ischemic heart diseases (I20-I25), Cerebrovascular diseases (I60-I69), Diseases of arteries, arterioles and capillaries (I70-I79), Hypertensive diseases (I10-I15) and Other forms of heart disease (I30-I52). One could say that the most frequent occurrence of Diseases of the circulatory system per capita was in Nitra region, followed by Banská Bystrica region and Trenčín region. Concerning differences between genders, 53.7% of all deceased persons due to Diseases of the circulatory system were females. Females are more likely to die due to Diseases of the circulatory in every block of diagnosis, except Other forms of heart disease (I30-I52), where a count of deaths was equal for both genders.

Table 3 depicted the situation from the perspective of age. One can see that the percentage of died from Diseases of the circulatory system increased consistently. In the age under 40 years, Diseases of the circulatory system were not a serious problem. In the age interval 41–50, every fourth person died due to Diseases of the circulatory system, in the age interval 51–60, every third person died due to Diseases of the circulatory system. At the age over 61 years, every second person died due to Diseases of the circulatory system and ratio did worsen as people got older.

Figure 2 revealed some interesting facts. We used boxplots for our analysis. The bottom of the box indicates the 25th percentile. It means that 25% of observations were situated below; while the top of the box represents the 75th percentile, thus 25% of observations have values above the 75th percentile. Therefore, 50% of the observations should lie within the box. Firstly, it can be concluded that in all groups of diagnosis the median age of death (dark line in the boxes) was lower for males than for females. Furthermore, whiskers (T-bars that extend from the boxes) extend less for females compared to males in all diagnoses groups, which indicate that death age varied less for females than for males. Additionally, whiskers in cases of males were always lower compared to females, which suggested that the minimal age of death was lower for males. If the data were normally distributed, we should expect 95% of the data to lie between the whiskers. On the other hand, we should look upon outliers in bottom side of whiskers. Outliers are represented by points – extreme values and stars

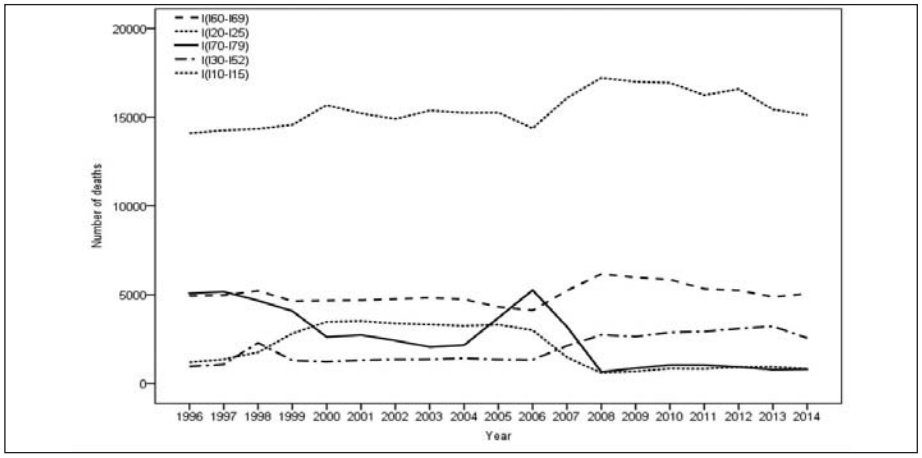

Fig. 1. *Evolution of deaths in time.*

Table 2. *Number of deaths caused by diseases of the circulatory system, 1996–2014 (cross tabulation – block of diagnosis, region, and gender)*

Type of diagnosis		Region								
		Bratislava	Trnava	**Trenčín**	Nitra	**Žilina**	Banská Bystrica	Prešov	Košice	Total
I00-I02	Male	10	4	2	4	1	4	1	5	31
	Female	8	5	5	6	6	1	2	3	36
	Total	18	9	7	10	7	5	3	8	67
I05-I09	Male	55	61	66	51	121	128	79	115	676
	Female	110	101	90	98	136	192	167	153	1,047
	Total	165	162	156	149	257	320	246	268	1,723
I10-I15	Male	1,338	1,455	2,000	2,557	1,794	2,304	2,244	2,374	16,068
	Female	1,626	2,020	2,632	3,533	2,280	3,118	3,068	3,274	21,551
	Total	2,964	3,475	4,632	6,090	4,074	5,422	5,312	5,648	37,619
I20-I25	Male	15,119	13,552	15,975	17,030	16,833	19,383	18,971	21,284	138,179
	Female	17,532	15,583	17,445	19,547	18,606	22,076	21,087	24,066	155,955
	Total	32,651	29,135	33,420	36,577	35,439	41,459	40,058	45,350	294,134
I26-I28	Male	545	655	1,255	1,163	902	858	675	972	7,026
	Female	699	725	1,442	1,369	919	955	834	1,217	8,161
	Total	1,244	1,380	2,697	2,532	1,821	1,813	1,509	2,189	15187
I30-I52	Male	1,587	1,645	2,419	2,068	3,428	2,307	2,749	2,503	18,713
	Female	1,852	1,670	2,470	2,146	3,315	2,373	2,333	2,438	18,601
	Total	3,439	3,315	4,889	4,214	6,743	4,680	5,082	4,941	37,314
I60-I69	Male	3,373	4,872	5,153	7,336	5,023	6,477	5,030	5,924	43,194
	Female	4,179	5,889	6,028	9,285	5,938	8,431	5,829	6,984	52,564
	Total	7,552	10,761	11,181	16,621	10,961	14,908	10,859	12,908	95,758
I70-I79	Male	3,153	2,790	1,624	5,205	1,990	2,005	3,791	1,793	22,354
	Female	3,562	3,368	1,776	7,270	2,488	2,589	3,962	1,998	27,013
	Total	6,715	6,158	3,400	12,475	4,478	4,594	7,753	3,791	49,367
I80-I89	Male	293	231	460	233	196	293	226	227	2,159
	Female	387	346	514	330	217	354	259	275	2,683
	Total	680	577	974	563	413	647	485	502	4,842
I95-I99	Male	23	10	25	58	29	22	10	30	208
	Female	32	12	23	56	25	31	20	47	246
	Total	55	22	48	114	54	53	30	77	454
Total	Male	25,496	25,275	28,979	35,705	30,317	33,781	33,776	35,227	248,608
	Female	29,987	29,719	32,425	43,640	33,930	40,120	37,561	40,455	287,857
	Total	55,483	54,994	61,404	79,345	64,247	73,901	71,337	75,682	536,465
% of deaths on total population of the region		8.8%	9.8%	10.4%	11.6%	9.3%	11.3%	8.7%	9.5%	9.9%

– extreme outliers. In case of Hypertensive diseases (I10-I15) both genders did reach extreme outliers, but the minimal age of death was resolutely higher in case of females. Moreover, the median age of deaths was higher in case of females. Concerning Ischemic heart diseases (I20-I25), the most dangerous diagnosis within the Chapter IX, it could be argued that the minimal age of death is much lower in the case of males. On the other hand, maximal age of death is higher. Moreover, the males' box was wider, which suggested that deaths age varies more for males compared to females. In terms of Other forms of heart disease (I30-I52), the gender difference was obvious. Median age of death was much lower for males compared to females. The males' box was nearly twice as wide as females', which suggested that age of death varied less for females compared to males. Moreover, the lowest age of death was much lower for males compared to females. In the case of Cerebrovascular diseases (I60-I69) a similar pattern, comparable to other diagnostic groups could be observed for both genders. In terms of Diseases of arteries, arterioles and capillaries (I70-I79) we saw similar pattern as in the case of other diseases.

Table 3. *Diseases of the circulatory system and age*

Age interval	Deaths caused by other diseases	Deaths caused by diseases of the circulatory system	Total number of deaths	Percentage of deaths caused by diseases of the circulatory system
0–10	10,161	240	10,401	2.3
11–20	5,071	297	5,368	5.5
21–30	10,435	868	11,303	7.7
31–40	17,424	3,280	20,704	15.8
41–50	43,449	14,844	58,293	25.5
51–60	78,885	40,352	119,237	33.8
61–70	99,664	84,559	184,223	45.9
71–80	114,584	170,851	285,435	59.9
81–90	70,861	179,773	250,634	71.7
91–100	10,134	40,677	50,811	80.1
101–110	104	652	756	86.2

Binary Logistic Regression

In line with the objective, binary logistic regression was used, which is a specific case of the generalized linear model. Our aim is to reveal socio-demographic factors that influence the odds of dying, or not dying due to Diseases of the circulatory system. Binary logistic regression is analogous to linear regression. In binary logistic regression the dependent variable is binary, thus has a dichotomous nature. Binary logistic regression overcomes many of the restrictive assumptions of linear regressions. While using binary logistic regression, dependent variable does not need to be normally distributed. Furthermore, this method does not require a linear relationship between the dependent variable and regressors. In binary logistic regression residuals need to be independent, but need not be normally distributed. The only assumption to be satisfied is an assumption of non-multicollinearity of explanatory variables which is fulfilled in our case.

In our analysis, the dependent variable was death diagnosis and the explanatory variables were year, age, region, gender and marital status. Dependent variable took the value 0, when one died of diagnosis other than diagnoses listed in the chapter Diseases of the circulatory system; and value 1 in cases, when one died due to some diagnosis listed in chapter Diseases of the circulatory system. There were five independent, explanatory variables which were coded as follows. Year of death is continuous variable which indicate a time of death. Age is a scalar variable which reaches values from 0 to 108, thus the youngest deceased individual was 0 years old and the oldest one was 108 years old. The region was nominal variable with 8 levels: Bratislava region, Trnava region, Trenčín region, Nitra region, Žilina region, Banská Bystrica region, Prešov region and Košice region. The variable region represented the place where one died. It did not represent the place of birth, or place of residence, but place of death. Bratislava region was set as the reference category, because this region was medially populated compared to other regions. Gender was a binary categorical variable which was coded 0 for males and 1 for females. Males were set as the reference category in our regression. Marital status was a categorical variable which achieved four levels: single, married, divorced and widowed. In our analysis, marital status-single was set as the reference category. Results of binary logistic regression can be found in Table 4. All obtained regression coefficients were statistically significant; moreover, the model as a whole was statistically significant. It could be said, that the evident statistical significance was reached by the mere fact that our dataset was huge.

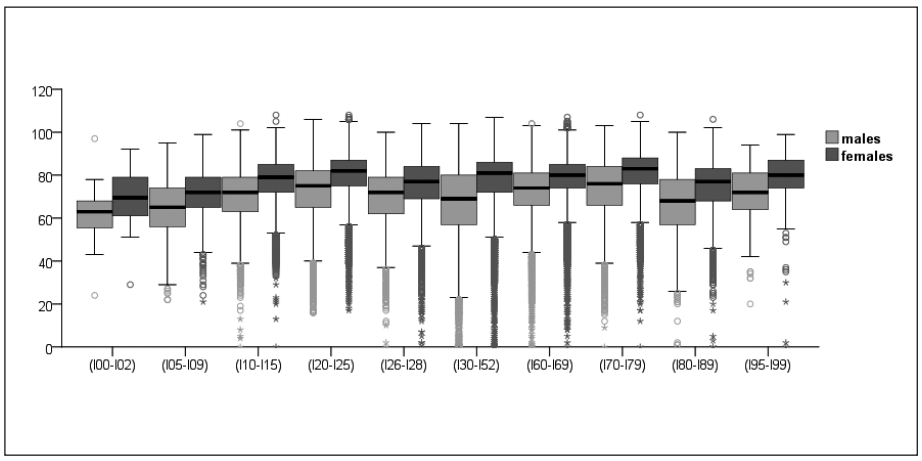

Fig. 2. *Boxplot: Age, Gender, Diagnosis.*

Table 4. *Odds of dying from cardiovascular diseases according to Year, Age, Gender, region and Marital status*

	B coefficient	Standard error	Degrees of freedom	p-value	Odds ratio
Year	−0.020	0.010	1	<0.001	0.980
Age	0.052	0.150	1	<0.001	1.054
Gender – females	0.122	0.005	1	<0.001	1.129
Region			7	<0.001	
Trnava	0.135	0.009	1	<0.001	1.145
Trenčín	0.245	0.009	1	<0.001	1.277
Nitra	0.128	0.009	1	<0.001	1.133
Žilina	0.171	0.009	1	<0.001	1.189
Banská Bystrica	0.232	0.009	1	<0.001	1.258
Prešov	0.344	0.009	1	<0.001	1.415
Košice	0.282	0.009	1	<0.001	1.328
Marital status			3	<0.001	
Married	−0.172	0.008	1	<0.001	0.830
Divorced	−0.093	0.011	1	<0.001	0.914
Widowed	−0.001	0.009	1	<0.001	0.985
Constant	−3.717	0.015	1	<0.001	0.024

Bratislava region is the reference category for region.
Single people are the reference category for marital status.

Table 4 indicated following findings. Year by year the number of deaths caused by Diseases of the circulatory system has been decreasing by 2%. Age had a positive influence on odds of dying due to Diseases of the circulatory system. Therefore, one unit increase in age increased the chance of dying due to Diseases of the circulatory system, while controlling for other explanatory variables. This chance increased every additional year of living by 5.4%. This conclusion suggested that the older the individual, the odds of dying due to Diseases of the circulatory system increased, with respect to other diagnoses. Concerning gender, our findings suggested that being female raised the odds of dying due to Diseases of the circulatory system by 12.9% compared to males. Regarding the variable region (i.e. place of death), Bratislava region was set as reference category. It could be concluded, that in every region compared to reference region of Bratislava, the odds of dying due to Diseases of the circulatory system was higher, in context of the fact that there were other explanatory variables in the model as well. The odds of dying due to Diseases of the circulatory system were higher by 14.5% in the Trnava region, by 27.7% higher in the Trenčín region, by 13.3% higher in the Nitra region, by 18.9% higher in the Žilina region, by 25.8% higher in the Banská Bystrica region, by 41.5% higher in the Prešov region and by 32.8% higher in the Košice region when compared to Bratislava region. Apropos of the marital status, where single people were set as the reference category, the findings suggested that married individuals have lower chance of dying due to Diseases of the circulatory system (by 17%) compared to single individuals, followed by divorced individuals (8.6%). Additionally, widowed individuals had approximately the same chance of dying due to Diseases of the circulatory system as single people had. However, one should keep in mind that our findings might be skewed by suppression effect which usually occurs in the binary logistic regression.

DISCUSSION

These alarming results about the number of deaths from circulatory system diseases raise discussion not only about the possible causes of death, but also about possible bad marking of individual diseases in health statistics in Slovakia. According to the Slovak Society of Cardiology, some diagnoses are overvalued and others undervalued in favour of other diagnoses. When a sudden death occurs, heart attack is often marked as the cause of death. However, it often does not reflect reality. High number of patients die due to the complications developed after the myocardial infarction. Therefore, it should be desirable to identify the exact cause of death. Additionally, the death rate of circulatory system diseases has substantially increased, even if the patient suffers from diabetes and kidney disease.

Slovakia has one of the highest rates of mortality due to circulatory system diseases which might be caused by a large number of myocardial infarction cases. This might be avoidable through effective prevention. Furthermore, if the myocardial infarction occurred while the patient is in relatively good health and being provided with quality healthcare the odds of dying would be significantly smaller. Therefore, it should be imperative to create a working platform, which will be the basis for long-term cooperation of the key organizations, particularly the Ministry of Health, Slovak Society of Cardiology as well as representatives of insurance companies and patient organizations. Also, it is necessary to implement all general practitioners and health insurance companies to a preventive screening programme of risk factors for premature and preventable mortality.

Unfortunately, no active prevention program for circulatory system diseases currently exists in Slovakia. The last one – "The national program for the prevention of diseases of the heart and blood vessels" was realised in 2011 (31). This included a variety

of educational activities, such as TV spots, leaflets, banners, as well as measuring cholesterol and blood pressure. The project was accompanied by the campaign "Know the symptoms of heart attack and stroke", where health professionals answered questions and explained symptoms to people in shopping malls. In our opinion, this type of prevention programs provides only the short-time effect. We should build awareness and educate the public about heart diseases regularly. Prevention programme should implement also a group of conditions and diseases including metabolic syndrome (obesity, diabetes mellitus, non-alcoholic steatohepatitis), which are part of the cardiovascular comorbidity and increased mortality and not to be confined only to the cardiovascular system. Accordingly, excessive alcohol consumption can cause mortality for cardiovascular outcomes (bleeding in the brain, malignant arrhythmias, alcoholic cardiomyopathy, etc.). With respect to the Slovak national particularities and a high level of spirits consumption, a campaign to reduce alcohol consumption should be part of the prevention programme mentioned. In this aspect, it is necessary to put pressure on the policy makers and to emphasize the effectiveness of national policies in terms of the limited alcohol advertising in all media, including advertisements and the internet and efficiency of increasing taxes on alcohol.

It is necessary to use innovative technology and advanced treatment for patients, and optimise their system of management and early detection of disease. If we want to reduce the number of premature deaths in Slovakia, without increased interest in the issue of circulatory system diseases will not do.

CONCLUSIONS

Prevention of heart failure is largely intertwined with the issues of prevention of the circulatory system diseases. The aim of primary prevention is to reduce the incidence of ischemic heart disease which is the most common cause of heart failure. This can only be achieved through systematic and purposeful education of the public about the risk factors of cardiovascular diseases and the need for a healthy lifestyle. These objectives are in the interest of the whole society and an urgent cooperation of numerous public sector institutions is needed for their successful achievement. In terms of health care system, making obligatory, regular preventive examinations should be one of the first steps, especially for at-risk population, aimed to detect and lower related risk factors.

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Conflict of Interests

None declared

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