TRENDS IN AGE-ADJUSTED CORONARY HEART DISEASE MORTALITY RATES IN SLOVAKIA BETWEEN 1993 AND 2009

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SUMMARY

Cardiovascular diseases (CVD) and especially coronary heart disease (CHD) are the main causes of death in the Slovak Republic (SR). The aim of this study is to explore trends in age-adjusted coronary heart disease mortality rates in the whole Slovak population and in the population of working age between the years 1993 and 2009. A related indicator – potential years of life lost (PYLL) due to CHD – was calculated in the same period for males and females. Crude CHD mortality rates were age-adjusted using European standard population. The joinpoint Poisson regression was performed in order to find out the annual percentage change in trends. The age-adjusted CHD mortality rates decreased in the Slovak population and also in the population of working age. The change was significant only within the working-age sub-group. We found that partial diagnoses (myocardial infarction and chronic ischaemic heart disease) developed in the mirror-like manner. PYLL per 100,000 decreased during the observed period and the decline was more prominent in males. For further research we recommend to focus on several other issues, namely, to examine the validity of cause of death codes, to examine the development of mortality rates in selected age groups, to find out the cause of differential development of mortality rates in the Slovak Republic in comparison with the Czech Republic and Poland, and to explain the causes of decrease of the age-adjusted CHD mortality rates in younger age groups in Slovakia.

Key words: coronary heart disease, age-adjusted mortality rates, joinpoint regression analysis of trends

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INTRODUCTION

Cardiovascular diseases (CVD) are the main causes of death in middle- and high-income countries in the world (1), in Europe, and specifically in the European Union (2). Since the 1950s, when this group of diseases surpassed the 50% mark of all deaths, it has become the main cause of death in the Slovak Republic (SR) (3). In Europe, the leading cause of death within the CVD group is coronary heart disease (CHD) followed by stroke (2–4). However, over the past decades, a number of countries in the world, including countries neighbouring the Slovak Republic such as the Czech Republic or Poland, have recorded a significant decline in CHD mortality rates (5–16). There are limited studies addressing the age-adjusted CHD mortality rates development in SR in detail. Given this fact, the aim of this study is to explore trends of age-adjusted coronary heart disease mortality rates in the Slovak population and within the working age sub-group between 1993 and 2009. A related indicator – potential years of life lost (PYLL) due to CHD – was calculated in the same period for males and females.

MATERIALS AND METHODS

This study provides an overview of the development of age-adjusted CHD mortality rates and PYLL per 100,000 due to CHD (ICD 9: 410–414; ICD 10: I 20–I 25), myocardial infarction (MI, ICD 9: 410; ICD 10: I 21, I 22) and chronic ischaemic heart disease (CHIHD, ICD 9: 414; ICD 10: I 25) between 1993 and 2009 in the Slovak population in general and in the population sub-group consisting of individuals aged from 25 to 64 years in particular (for the purpose of this study i.e. the population in working age). National deaths and population data were obtained from the Statistical Office of the Slovak Republic. Crude mortality rates were age-adjusted using direct standardisation and European Standard Population. For the age-adjusted mortality rates the corresponding 95% confidence intervals (95% CI) were calculated. A joinpoint Poisson regression provided the estimated annual percentage change and detected points-in-time at which significant changes in the trends occurred (Version 3.5– April 2011; Statistical Methodology and Applications Branch and Data Modelling Branch, Surveillance Research Program National Cancer Institute). The model that best fit the data was selected for the purpose of generating results. A maximum of three joinpoints was allowed for estimations. For each annual percentage change (APC) estimate the corresponding 95% CI was calculated. Also the average annual percentage change (AAPC) in the trends for the whole observed period between 1993 and 2009 was expressed. The burden of CHD on the population of productive age – premature deaths – is presented through PYLL per 100,000. PYLL due to CHD was calculated using the 5-years age groups method by gender (17, 18). For the purpose of this study, a premature death was defined as a death before the 65th year of life.

RESULTS

Mortality Rates in the Whole Population

Age-adjusted CHD mortality rates in Slovakia during the observed period decreased. However, a higher value of the age-adjusted CHD mortality rate was recorded in the final year compared to the initial year of observation, 256.81 per 100,000 in 1993 and 268.08 per 100,000 in 2009.This fact is a result of deceleration in declining trend that started in 1994 (302.74 per 100,000) and continued with slight fluctuations until 2006 (246.35 per 100,000) (Fig. 1 A). The results of the joinpoint regression show that AAPC in the observed period (for both sexes) represents the decrease of 0.4% (−0.8; 0.1) but this decrease was not significant (p>0.05) (Table 1)

On the other hand, a contrast in the development of trends of age-adjusted MI and CHIHD mortality rates was recorded in the observed period. In 1993, the age-adjusted MI and CHIHD mortality rates were at an approximately similar level (MI: 123.33 per 100,000, CHIHD: 125.17 per 100,000). Subsequently, the age-adjusted CHIHD mortality rate increased in 1994 (179.51 per 100,000) and in 1998 (192.90 per 100,000). The age-adjusted CHIHD mortality rate peak was recorded in 2003 (242.74 per 100,000) and subsequently it slightly decreased. AAPC in the age-adjusted CHIHD mortality rate trend represented a significant increase of 2.6% (0.9; 4.3) (Fig. 1A, Table 1). At the same time, the trend of the age-adjusted MI mortality rate developed in the opposite way. The age-adjusted MI mortality rate in the period 1993–1997 decreased slightly (123.33 per 100,000; 107.93 per 100,000; p>0.05). Subsequently, a steeper decrease in the trend was recorded in 1998 (75.23 per 100,000) that continued until 2006 (29.96 per 100,000). This decrease was interrupted by a slight increase in the mortality rate between years 2007–2009. AAPC in the age-adjusted MI mortality rate represented 3.4% decrease (−9.8; 3.4) in the observed period that was not significant. The significant APC was recorded in the period 2006–2009 when the APC represented an increase of 29.4% (8.2; 54.7) (Fig. 1A, Table 1). The gender specific age-adjusted mortality rates developed in the similar way in the observed period and the mortality rates were higher in males. In males, we recorded a significant AAPC of −0.7% (−1.2; −0.2) in CHD mortality rates (Fig. 1 B, C; Table 1).

Mortality Rates in the Working Age Population

The age-adjusted CHD mortality rate developed in the observed period as follows: between 1993–2006, there was a decrease recorded (1993: 123.20 per 100,000; 2006: 72.85 per 100,000). APC in mortality rate trend between 1993 and 2005 represented a decrease of 4.5% (−5.1; −4.0; p<0.05). This decrease was interrupted by an increase in 2007 (80.91 per 100,000), APC in this period represented an increase of 1.5% (−1.6; 4.8; p>0.05). AAPC in the age-adjusted CHD mortality rate represented a decrease of 3% (−3.8; −2.2; p<0.05) in the observed period (Fig. 1 D, Table 1). The development of the age-adjusted MI and CHIHD mortality rates was similar to the one in the whole population. Between 1993 and 1997, the age-adjusted MI mortality rate was higher than the age-adjusted CHIHD mortality rate. However, the trends changed in 1998. Until 2008, the trends developed in a mirror-like manner. Figure 1 (graph D) clearly illustrates this pattern. In 2008, the trends almost met (MI: 37.58 per 100,000; CHIHD: 40.08 per 100,000). AAPC in the MI mortality rate trend represented a significant decrease of 4.5% (−8.7; −0.1). AAPC in the CHIHD mortality rate trend represented an increase of 1.2% (−0.7; 3.1; p>0.05) (Table 1). The gender specific age-adjusted mortality rates developed during the observed period in the work-

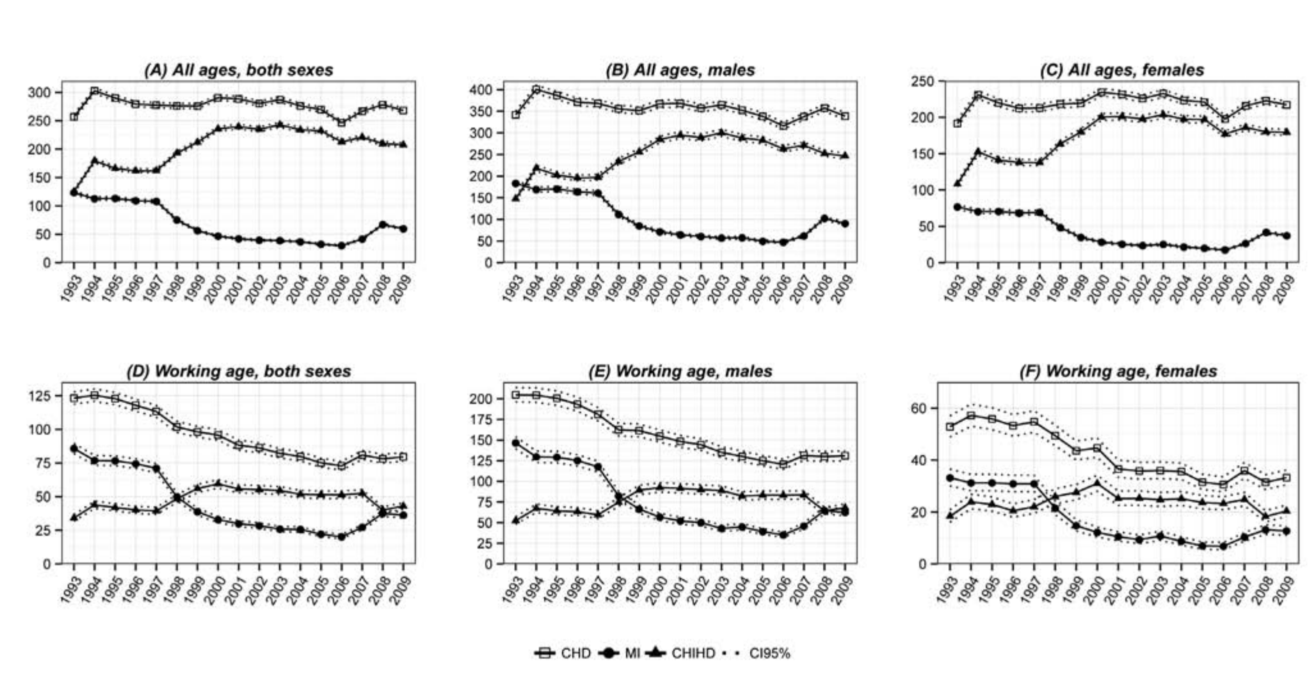

Fig. 1. Age-adjusted CHD, MI and CHIHD mortality rates in the Slovak population per 100,000 inhabitants between 1993–2009 (European standard population).

Table 1. *Annual percentage changes in age-adjusted coronary heart disease, myocardial infarction, and chronic ischaemic heart disease mortality rates trends in Slovakia between 1993–2009 in the whole population and in the working age population*

		Period 1 (0 joinpoints)			Period 2 (1 joinpoint)			Period 3 (2 joinpoints)			Period 4 (3 joinpoints)			AAPC		
		Years	APC	95% CI	Years	APC	95% CI	Years	APC	95% CI	Years	APC	95% CI	Years	APC	95% CI
Coronary heart disease																
Males	All ages	1993–2009	−0.7*	(−1.2;−0.2)	–	–	–	–	–	–	–	–	–	1993–2009	−0.7*	(−1.2;−0.2)
	25–64	1993–2005	−4.4*	(−4.9;−3.9)	2005–2009	1.5	(−1.1;4.3)	–	–	–	–	–	–	1993–2009	−3.0*	(−3.6;−2.3)
Females	All ages	1993–2009	0.1	(-0.4;0.7)	–			–	–	–	–	–	–	1993–2009	0.1	(−0.4;0.7)
	25–64	1993–2005	−5.0*	(−6.3;−3.8)	2005–2009	0.5	(−6.4;8)	–	–	–	–	–	–	1993–2009	−3.7*	(−5.4;−1.9)
Both sexes	All ages	1993–2009	−0.4	(−0.8;0.1)	–			–	–	–	–	–	–	1993–2009	−0.4	(−0.8;0.1)
	25–64	1993–2005	−4.5*	(−5.1;−4)	2005–2009	1.5	(−1.6;4.8)	–	–	–	–	–	–	1993–2009	−3.0*	(−3.8;−2.2)
Myocardial infarction																
Males	All ages	1993–1997	−3.9	(−14.7;8.4)	1997–2000	−24.1	(−48;10.8)	2000–2006	−5.2	(−12.9;3.2)	2006–2009	28.5*	(6.3;55.3)	1993–2009	−3.4	(−10.1;3.9)
	25–64	1993–1997	−5.9	(−13.4;2.2)	1997–2000	−21.4	(−39.4;2)	2000–2006	−6.2*	(−11.5;−0.6)	2006–2009	22.6*	(7.6;39.6)	1993–2009	−4.5	(−9.2;0.4)
Females	All ages	1993–1997	−3	(−13.6;9)	1997–2000	−25.7	(−48.6;7.4)	2000–2006	−5.6	(−13;2.5)	2006–2009	31.3*	(9.2;57.9)	1993–2009	−3.3	(−9.9;3.8)
	25–64	1993–1997	−2.2	(−12.1;8.8)	1997–2000	−27.2	(−48;2.1)	2000–2006	−7.3	(−14;0)	2006–2009	25.2*	(5.7;48.2)	1993–2009	−5	(−10.9;1.4)
Both sexes	All ages	1993–1997	−3.8	(−14.1;7.7)	1997–2000	−24.5	(−47.1;7.9)	2000–2006	−5.4	(−12.7;2.5)	2006–2009	29.4*	(8.2;54.7)	1993–2009	−3.4	(−9.8;3.4)
	25–64	1993–1997	−5.1	(−11.9;2.2)	1997–2000	−22.6*	(−38.8;−2)	2000–2006	−6.3*	(−11.1;−1.2)	2006–2009	23.2*	(9.5;38.5)	1993–2009	−4.5*	(−8.7;−0.1)
Chronic IHD																
Males	All ages	1993–2002	6.8*	(4.5;9.3)	2002–2009	−3	(−6.1;0.3)	–	–	–	–	–	–	1993–2009	2.4*	(0.7;4.2)
	25–64	1993–2001	7.1*	(3.9;10.5)	2001–2009	−3.8*	(−6.7;−0.8)	–	–	–	–	–	–	1993–2009	1.6	(−0.4;3.6)
Females	All ages	1993–2001	7.0*	(4.2;9.7)	2001–2009	−1.6	(−4.1;0.9)	–	–	–	–	–	–	1993–2009	2.6*	(0.9;4.3)
	25–64	1993–2000	5.3*	(1.5;9.2)	2000–2009	−3.6*	(−6;−1.2)	–	–	–	–	–	–	1993–2009	0.2	(−1.7;2.1)
Both sexes	All ages	1993–2001	7.3*	(4.5;10.1)	2001–2009	−1.9	(−4.4;0.7)	–	–	–	–	–	–	1993–2009	2.6*	(0.9;4.3)
	25–64	1993–2001	6.3*	(3.2;9.5)	2001–2009	−3.7*	(−6.5;−0.8)	–	–	–	–	–	–	1993–2009	1.2	(−0.7;3.1)

* significant change ($p<0.05$); APC – annual percentage change, AAPC – average annual percentage change

ing age group in the similar way and the mortality rates were higher in males (Fig. 1 E, F; Table 1).

Potential Years of Life Lost

The development of PYLL due to CHD was similar to the development of mortality rates. The decrease was steeper in males than in females. A decrease from 888 PYLL per 100,000 in 1993 to 665 PYLL per 100,000 in 2009 was recorded in males, and from 210 PYLL per 100,000 in 1993 to 167 PYLL per 100,000 in females (Fig. 2).

DISCUSSION

In this study, we described the development of age-adjusted CHD mortality trends in the Slovak Republic between 1993 and 2009. The significance of changes in trends was examined by joinpoint regression. Similar studies were also conducted elsewhere (19–22). Our analysis of trends indicates several interesting points that, in the broader context, can be understood as indirect indicators of efficiency of activities focused on the reduction of CVD burden in the Slovak population. In the observed period, age-adjusted CHD mortality decreased in the whole population and within the working age group (25–64 years). However, the decrease was significant only in the working age group. This may mean that CHD mortality is apparently influenced by adverse development in the higher age groups. Baráková states that the CVD mortality rate in Slovakia is negatively influenced by stagnant mortality rates in age groups of 65 years and higher (23). The Slovak Republic is not in the group of countries where the mortality rates have decreased significantly in the last decades as in the USA, England, Italy, Sweden, Iceland, and also in the Czech Republic and Poland (5–13, 15). In 2005, the Slovak Republic had 1.5 times higher CHD mortality rate compared to the Czech Republic, 2 times higher CHD mortality rate compared to Poland and 2.5 times higher CHD mortality rate compared to Austria. Also, in the same year, 3 times higher CHD mortality rate was recorded in the Slovak Republic compared to the EU 15. The Ukraine had 2 times higher CHD mortality rate than the Slovak Republic (24). Also the age-adjusted CHD mortality rates in Hungary are lower compared to Slovakia (25). One of the possible reasons for this situation is the prevalence of main risk factors in the Slovak population – smoking, high blood pressure, high cholesterol, diabetes, and obesity. The reduction of risk factors prevalence contributed to the decline in many other countries (5–12, 16, 26). Given the fact that the Slovak Republic was not a member of international studies such as MONICA, INTERHEART and others, the only possible representative source that could provide information about prevalence of the main risk factors in the Slovak population was the CINDI programme. This programme took place between the years 1993 and 2008. According to the results, in the last 10 years, only small decrease of risk factors prevalence was recorded. The biggest decrease was recorded in dyslipidaemia and a slight decrease was recorded in smoking prevalence. A decrease in blood pressure rates was not recorded in the last 10 years. At the same time, however, there was recorded an increase in BMI and diabetes prevalence in the Slovak population (27). The most recent survey, that measured the prevalence of the main CVD risk factors in Slovakia in 2011, is the European Health Examination Survey. The authors state that in comparison with the CINDI programme, results from 2011 suggest a significant decrease in total cholesterol mean values in both sexes, an increase in BMI especially in males, an increase in systolic blood pressure in males and stabilisation in females, and a significant decrease in smoking prevalence (28). Conversely, from the results of MONICA and post-MONICA programmes in the Czech Republic it is clear that in the period between 1985–2007, a significant decrease in systolic blood pressure, a decrease in prevalence of hypertension in females, a significant decrease in smoking prevalence in males, and a significant decline in total cholesterol in both males and females were recorded However, an increase in overweight, in males in particular, and diabetes prevalence were recorded (29). According to a modelling study in the Czech Republic, the reduction of main risk factors explained around 52% of the CHD mortality decline between the years 1985–2007 whereas the treatment methods used in this period explained some 43% of the mortality fall (26). We can presume that a decrease in age-adjusted CHD mortality rates in the working age group in Slovakia described in our study, may be a result of positive changes in the prevalence of main risk factors which are still highly prevalent in the older age groups.

When comparing the age-adjusted mortality rates in males and females in our study, in all cases males had higher mortality rates than females. However, interestingly, when we look at AAPC in CHD in the whole population, we can observe a significant decrease of 0.7% in males and conversely a non-significant increase (0.1%) in females. This suggests that the decrease in the total CHD mortality is decelerated by the development of mortality in females. In both males and females in the same period, a significant increase in AAPC was recorded in the age-adjusted CHIHD mortality rates that was higher in females (2.4%, 2.6% respectively) and a non-significant decrease in AAPC in the age-adjusted MI mortality rates (−3.4%, −3.3%, respectively). This observation of a steeper decrease in males appears not to be unique. In the Czech Republic between the years 1985–2009, the age-adjusted CHD mortality rates decreased in males and females. The change between the initial and final year was higher in males than in females (−49.9%, −40% respectively) (26). Also Cífková et al. state that the age-adjusted CHD mortality rates in the Czech Republic in 1985–2007 were higher in males than in females and the decrease was steeper in males (15).

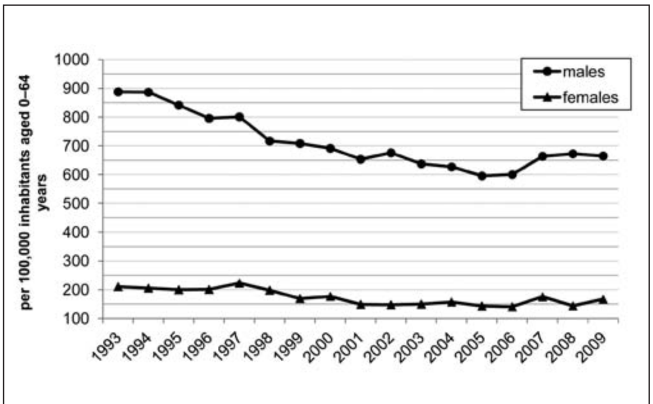

***Fig. 2.** Potential years of life lost due to CHD in Slovakia between1993–2009.*

Table 2. *Age-adjusted coronary heart disease, myocardial infarction and chronic ischaemic heart disease mortality rates per 100,000 inhabitants (all ages) in the Slovak Republic between 1993–2009*

	Coronary heart disease								
	Males	**95% CI**		**Females**	**95% CI**		**Both sexes**	**95% CI**	
1993	341.75	333.71	349.97	191.43	186.60	196.36	256.81	252.40	261.29
1994	400.59	391.34	410.02	230.93	225.47	236.51	302.74	297.76	307.78
1995	386.60	377.62	395.77	219.93	214.68	225.29	289.94	285.14	294.81
1996	371.16	362.49	380.01	212.30	207.22	217.50	279.17	274.53	283.89
1997	368.09	359.56	376.78	212.83	207.81	217.96	277.51	272.95	282.15
1998	355.36	346.99	363.89	218.25	213.21	223.40	276.05	271.52	280.65
1999	351.57	343.29	360.01	219.30	214.30	224.40	275.56	271.06	280.12
2000	367.06	358.67	375.61	234.42	229.31	239.64	290.45	285.89	295.09
2001	368.12	359.49	376.92	231.51	226.38	236.77	288.34	283.72	293.03
2002	357.23	348.65	365.99	225.89	220.79	231.11	280.35	275.77	285.00
2003	364.54	355.77	373.50	232.66	227.42	238.02	287.06	282.38	291.82
2004	352.28	343.74	361.01	223.13	218.06	228.32	275.97	271.43	280.58
2005	338.14	329.93	346.53	220.96	216.01	226.02	269.70	265.29	274.18
2006	316.03	308.28	323.96	197.49	192.92	202.17	246.35	242.23	250.54
2007	337.35	329.51	345.35	215.74	211.09	220.51	266.48	262.29	270.73
2008	357.44	349.45	365.59	222.80	218.17	227.54	278.25	274.04	282.52
2009	338.72	331.05	346.55	217.10	212.61	221.70	268.08	264.01	272.21
	Myocardial infarction								
1993	183.33	177.54	189.29	76.67	73.57	79.89	123.33	120.25	126.47
1994	168.86	163.06	174.85	70.14	67.10	73.30	112.64	109.61	115.73
1995	170.33	164.56	176.28	70.46	67.45	73.59	113.18	110.18	116.25
1996	163.76	158.16	169.53	68.15	65.22	71.20	108.95	106.04	111.93
1997	160.84	155.33	166.52	69.14	66.23	72.17	107.93	105.06	110.86
1998	111.53	106.99	116.23	48.20	45.80	50.73	75.23	72.86	77.67
1999	85.10	81.15	89.20	34.70	32.68	36.85	56.31	54.27	58.42
2000	71.35	67.77	75.08	28.30	26.49	30.22	46.75	44.91	48.66
2001	64.23	60.83	67.79	25.37	23.66	27.20	42.06	40.31	43.88
2002	60.63	57.33	64.11	23.48	21.84	25.24	39.54	37.85	41.30
2003	56.81	53.63	60.17	25.12	23.40	26.96	38.79	37.11	40.53
2004	57.54	54.36	60.91	21.49	19.94	23.16	36.79	35.18	38.46
2005	49.45	46.52	52.55	19.75	18.28	21.34	32.48	30.98	34.04
2006	47.25	44.41	50.26	17.43	16.07	18.92	29.96	28.54	31.45
2007	61.85	58.64	65.21	26.37	24.72	28.15	41.61	39.95	43.33
2008	102.37	98.25	106.63	41.73	39.67	43.90	67.14	65.06	69.29
2009	90.49	86.68	94.44	37.09	35.18	39.11	59.73	57.79	61.73
	Chronic ischaemic heart disease								
1993	147.73	142.36	153.26	108.24	104.67	111.91	125.17	122.12	128.28
1994	218.29	211.32	225.46	152.46	148.07	156.97	179.51	175.69	183.40
1995	202.66	196.01	209.49	141.08	136.92	145.36	166.09	162.46	169.78
1996	195.68	189.27	202.27	137.86	133.82	142.02	161.68	158.17	165.27
1997	197.13	190.81	203.62	137.61	133.62	141.71	161.92	158.45	165.46
1998	234.06	227.20	241.10	163.55	159.23	167.99	192.90	189.12	196.74
1999	256.19	249.06	263.47	179.70	175.20	184.30	212.07	208.14	216.07
2000	284.55	277.12	292.14	200.38	195.68	205.19	235.74	231.64	239.91
2001	294.68	286.88	302.65	201.03	196.26	205.92	239.40	235.19	243.68
2002	289.09	281.28	297.08	197.65	192.88	202.53	234.84	230.64	239.11
2003	299.93	291.87	308.18	203.67	198.78	208.69	242.74	238.42	247.13
2004	288.03	280.20	296.05	197.29	192.52	202.17	233.86	229.67	238.13
2005	282.81	275.23	290.57	196.91	192.24	201.69	232.23	228.13	236.40
2006	263.42	256.29	270.73	177.00	172.68	181.43	212.38	208.55	216.27
2007	271.15	264.06	278.40	185.98	181.68	190.39	221.01	217.20	224.89
2008	252.48	245.68	259.43	179.95	175.83	184.19	209.42	205.78	213.11
2009	246.79	240.17	253.57	179.30	175.25	183.46	207.37	203.80	211.00

Table 3. *Age-adjusted coronary heart disease, myocardial infarction and chronic ischaemic heart disease mortality rates per 100,000 inhabitants (working age) in the Slovak Republic between 1993–2009*

	Coronary heart disease								
	Males	95% CI		Females	95% CI		Both sexes	95% CI	
1993	204.73	196.26	213.48	52.87	48.95	57.05	123.20	118.74	127.80
1994	204.30	195.74	213.16	57.19	53.06	61.58	125.36	120.80	130.05
1995	200.64	192.15	209.42	55.86	51.77	60.20	122.80	118.29	127.44
1996	193.33	185.01	201.93	53.27	49.28	57.51	117.90	113.49	122.44
1997	181.09	173.07	189.39	54.74	50.70	59.02	113.27	108.97	117.71
1998	162.42	154.88	170.24	49.42	45.61	53.48	101.78	97.73	105.96
1999	161.48	154.00	169.24	43.60	40.05	47.39	98.20	94.24	102.28
2000	154.79	147.54	162.30	44.67	41.10	48.48	95.74	91.87	99.73
2001	148.31	141.26	155.63	36.57	33.37	40.00	88.22	84.53	92.03
2002	144.39	137.55	151.49	35.80	32.67	39.16	86.28	82.69	90.00
2003	135.11	128.60	141.87	35.98	32.88	39.30	82.22	78.76	85.80
2004	130.15	123.86	136.69	35.59	32.55	38.85	79.83	76.46	83.30
2005	124.87	118.77	131.21	31.49	28.67	34.53	75.14	71.91	78.47
2006	120.61	114.71	126.75	30.57	27.82	33.54	72.85	69.72	76.10
2007	131.37	125.31	137.66	35.91	32.95	39.08	80.91	77.65	84.28
2008	129.95	124.03	136.09	31.43	28.71	34.35	78.12	74.97	81.38
2009	130.93	125.07	137.00	33.23	30.47	36.18	79.53	76.39	82.78
	Myocardial infarction								
1993	146.63	139.47	154.08	33.17	30.07	36.53	85.76	82.03	89.61
1994	129.59	122.78	136.68	31.22	28.18	34.50	76.90	73.34	80.60
1995	129.24	122.46	136.31	31.22	28.17	34.52	76.64	73.09	80.32
1996	125.20	118.54	132.15	30.87	27.85	34.14	74.45	70.96	78.07
1997	117.58	111.15	124.29	30.88	27.87	34.14	71.08	67.68	74.60
1998	82.33	77.03	87.90	21.52	19.04	24.25	49.86	47.05	52.80
1999	66.37	61.64	71.37	14.75	12.72	17.02	38.79	36.33	41.38
2000	56.78	52.46	61.37	12.16	10.35	14.21	32.93	30.70	35.29
2001	52.17	48.07	56.53	10.49	8.82	12.40	29.88	27.77	32.11
2002	50.01	46.06	54.21	9.34	7.79	11.12	28.39	26.36	30.53
2003	43.02	39.41	46.88	10.74	9.08	12.63	25.90	23.98	27.93
2004	44.76	41.13	48.64	8.74	7.28	10.42	25.66	23.78	27.65
2005	39.17	35.82	42.77	6.94	5.65	8.43	22.09	20.37	23.92
2006	35.11	31.98	38.48	6.82	5.56	8.28	20.16	18.53	21.89
2007	45.86	42.33	49.62	10.33	8.77	12.09	27.15	25.28	29.12
2008	64.71	60.56	69.09	13.15	11.41	15.09	37.58	35.41	39.86
2009	62.40	58.38	66.63	12.72	11.04	14.61	36.27	34.16	38.49
	Chronic ischaemic heart disease								
1993	52.42	48.20	56.93	18.39	16.12	20.90	34.12	31.80	36.56
1994	67.26	62.39	72.43	23.91	21.26	26.80	43.89	41.21	46.70
1995	64.29	59.50	69.37	22.96	20.37	25.80	41.98	39.35	44.73
1996	63.28	58.54	68.31	20.48	18.04	23.17	40.16	37.60	42.86
1997	59.59	55.01	64.46	22.04	19.52	24.82	39.39	36.86	42.05
1998	74.80	69.67	80.20	25.94	23.19	28.93	48.43	45.64	51.36
1999	89.29	83.72	95.15	27.53	24.73	30.58	55.99	53.00	59.10
2000	92.43	86.83	98.31	30.99	28.02	34.20	59.41	56.36	62.59
2001	91.48	85.92	97.31	25.21	22.56	28.09	55.69	52.75	58.75
2002	89.95	84.54	95.63	25.28	22.65	28.13	55.21	52.33	58.21
2003	88.82	83.53	94.36	24.72	22.16	27.50	54.51	51.69	57.45
2004	82.10	77.10	87.35	25.15	22.59	27.91	51.71	49.01	54.54
2005	83.16	78.17	88.38	23.66	21.22	26.32	51.40	48.73	54.18
2006	83.16	78.25	88.30	23.29	20.89	25.90	51.34	48.71	54.08
2007	83.42	78.59	88.48	24.88	22.43	27.54	52.42	49.79	55.15
2008	64.27	60.12	68.63	18.28	16.22	20.53	40.08	37.82	42.43
2009	68.10	63.89	72.53	20.38	18.23	22.72	42.99	40.69	45.40

Another interesting fact resulting from our study is the development of age-adjusted MI and CHIHD mortality rates that can be labelled as ‘the mirror development’. We can assume that in the observed period some mistakes could occur in the coding causes of death – an overestimate of chronic ischaemic heart disease. The issue of objectivity in the coding causes of death in Slovakia was assessed by Brašeňová et al. The authors analysed 820 randomly selected death examination reports. Only 52.4% of all reports were filled correctly. In conclusion they stated that in high percentage of reports there is also missing important information about serious diseases including e.g. neoplasms. Instead of it, the cause of death provided is either heart failure or ischaemic heart disease. This occurs also in the case of death in hospital (30). Diagnosis I25 (CHIHD) is the most commonly mentioned cause of death in the death examination reports. In age groups 65+ this diagnosis represents 80–90% of all CHD and in the 25–64 years age group this diagnosis represents some 50–60% of all CHD (4). It can be assumed that this diagnosis is used routinely which may lead to an overestimate of the mortality rates of the whole CHD group. As a result, the trend of mortality rates decreases slowly. It would be interesting to examine how the mistakes in the coding causes of death influence the mortality rates in Slovakia. Baráková et al. found in their recent study that CVD mortality in the Slovak Republic in 2010 was overestimated by approximately 10% due to imprecisions in the coding causes of deaths in death reports (31).

The decline in MI mortality rates was recorded also elsewhere (26, 32, 33). For example in the Czech Republic, a decline in CHD mortality rates was also observed. This decline is mainly related to the decline in acute forms of CHD (i.e. MI) mortality and not in the chronic forms (26). The decline in MI mortality rates can be the result of risk factors reduction (i.e. prevention of MI development) and better treatment methods used in previous decades. In the Czech modelling study, a 7.5% decline in CHD mortality can be attributed to the initial treatment of acute myocardial infarction and unstable angina (26). Additionally, in the Slovak Republic, the treatment of acute myocardial infarction changed in previous years and this change influenced the survival of patients (34). This fact in combination with risk factors reduction (in particular total cholesterol reduction) can explain a decrease in the MI mortality rates. The authors of a recent British study concluded that both prevention and treatment methods contributed to the decline in acute myocardial infarction mortality observed in the last ten years in England (32).

In this study we described also another indicator – potential years of life lost (PYLL). This indicator expresses the burden of CHD on the younger population. In this context the decrease in PYLL per 100,000 can be viewed in a positive way. According to Leal et al., in 2009, the productivity losses due to mortality represent the sum of 89 million Euro in the Slovak Republic (2).

To conclude, the main findings of this study include a slight decrease of the age-adjusted CHD mortality rates in the whole population and a significant decrease of the age-adjusted CHD mortality rates in the working age group in the Slovak Republic between 1993 and 2009. In further research we recommend to focus on several issues: to examine the validity of coding causes of death, to examine the development of mortality rates in selected age groups, to find out the cause of differential development of mortality rates in the Slovak Republic in comparison with the Czech Republic and Poland, and to explain the causes of decrease in the age-adjusted CHD mortality rates in younger age groups in Slovakia.

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