

Characteristics of mortality due to ischemic heart disease in Costa Rica from 1970 to 2014

Características de la mortalidad por enfermedad isquémica del corazón en Costa Rica de 1970 al 2014

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Abstract

Objective: To update some important aspects of the descriptive epidemiology of ischemic heart (EIC) disease in Costa Rica during the period 1970-2014. **Methods:** EIC death rates were obtained in two periods: from 1930 to 1969 and then, for a more specific analysis, from 1970 to 2014, using moving and five-year averages, based on data from the Instituto Nacional de Estadística and the Centro Centroamericano de Población, to analyze them according to age, sex, geographical location and percentage contribution to the general mortality. Information was also obtained to determine the burden of the disease, in this case through Years of Adjusted Life for Disability, Years of Life Lost and Years of Life lost due to Disability.

Results: There was a rise in rates in the general population, with greater momentum in the population from 35 to 74 years, up to the five-year period 1995-1999, after which a decline began that apparently stopped during the five-year period 2010-2014 (both sexes: $r = 0.9964$, $r^2 = 0.9928$, $\beta = -2.4950$, $p = 0.04$; men: $r = 0.9994$, $r^2 = 0.9988$, $\beta = -2.770$, $p = 0.02$; women: $r = 0.9896$, $r^2 = 0.9793$, $\beta = -2.4950$, $p = 0.07$). The highest rates occur in the provinces of the center of the country. It predominates during the whole period in the male sex and represents on average 14% of the general mortality.

Conclusions: Mortality due to EIC is in a phase of decline but the increase in obesity and overweight in the country threatens to slow down this trend, at least during the last five years.

Key words: Mortality. Ischemic heart disease. Descriptive studies. Descriptive epidemiology. Costa Rica.

Resumen

Objetivo: Actualizar algunos aspectos importantes de la epidemiología descriptiva de la enfermedad isquémica del corazón (EIC) en Costa Rica durante el periodo 1970-2014. **Métodos:** Se obtuvieron las tasas de mortalidad por EIC en dos períodos.

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De 1930 al año 1969 y luego, para un análisis más específico, de 1970 al 2014, utilizando promedios móviles y quinquenios, a partir de datos del Instituto Nacional de Estadística y del Centro Centroamericano de Población, para analizarlos en relación con edad, sexo, ubicación geográfica y aporte porcentual a la mortalidad general. También se obtuvo información para determinar la carga de la enfermedad, en este caso mediante años de vida ajustados por discapacidad, años de vida perdidos y años de vida perdidos por discapacidad. **Resultados:** Se apreció ascenso de las tasas en la población general y con mayor empuje en la población de 35 a 74 años, hasta el quinquenio 1995-1999, a partir del cual se inicia un descenso que aparentemente se detiene durante el quinquenio 2010-2014 (ambos sexos: $r = 0.9964$, $r^2 = 0.9928$, $\beta = -2.4950$, $p = 0.04$; hombres: $r = 0.9994$, $r^2 = 0.9988$, $\beta = -2.770$, $p = 0.02$; mujeres: $r = 0.9896$, $r^2 = 0.9793$, $\beta = -2.4950$, $p = 0.07$). Las tasas más altas se presentan en las provincias del centro del país. Predomina durante todo el periodo en el sexo masculino y representa en promedio el 14% de la mortalidad general. **Conclusión:** La mortalidad por EIC está en fase de disminución, pero el aumento de la obesidad y el sobrepeso en el país amenaza con frenar dicha tendencia, al menos durante el último quinquenio.

Palabras claves: Mortalidad. Enfermedad isquémica del corazón. Estudios descriptivos. Epidemiología descriptiva. Costa Rica.

Introduction

Diseases of the circulatory system (cardiovascular diseases [CVD]), understanding as such the fatal events included in the 10th International Classification of Diseases under codes I00-I99, Q20 and Q28 when the latter two are available, have been known for several decades to be the world's leading cause of death and, among them, ischemic heart disease (IHD) is ranked at first place, even in the poorest countries on earth. In 2013, there were 17.3 million deaths from CVD, which accounts for 31% of all deaths in the world and approximately 50% of total chronic non-communicable diseases. By 2030, it is estimated that the number of deaths for these causes will amount to 23.6 million¹. However, the rates are fortunately decreasing. Thus, for example, the rate in 2005 was 338.1 per 100,000, but in 2015 it dropped to 285.5 per 100,000, which meant a decrease of 15.6%².

In the year 2010, CVDs caused the loss of 293 million disability-adjusted life years (DALYs) in the world³. Globally, CVDs were the first cause of years of life lost (YLLs)⁴.

To avoid confusion, CVDs and circulatory system diseases will henceforth be considered as synonyms.

Worldwide, there are large differences in circulatory system disease standardized mortality rates. Several countries have rates for males that are higher than one thousand per one hundred thousand population, like Russia (1,087.9), Ukraine (2,012.0) and Belarus (1,178.0), followed with slightly lower rates by Bulgaria (783.3), Romania (594.6) and Hungary (499.7). In general, the highest rates in Europe correspond to eastern countries formerly under communist regimes¹.

In the USA, since 1900 (with exception of 1918, year of the great influenza pandemic), CVDs have caused

more deaths than any other important mortality cause. In the year 2013, CVDs were the cause of 30.8% of total deaths, which equals to about one in every three deaths; on average, every 40 seconds an American dies from CVD. It has been estimated that if all main CVD causes were eliminated, life expectancy could increase by seven years¹.

IHD is the leading cause of death among all CVDs and its standardized rate has been decreasing in almost every region of the world in the last quinquennia, but their disease global burden has increased by 29%, mainly due to population growth and to the phenomenon of an increasingly larger longer-lived population. In nearly all developed countries, the reduction exceeds 50% since 1990; in Denmark, the Netherlands, Norway and Israel it even reached 70%⁵. In the Americas, CVDs have similarly been occupying the leading positions of mortality already since several decades ago, with IHD standing out at first place. Table 1 shows the IHD rates in relation to gender, for a relatively recent date⁶.

Costa Rica is a small country, since it has a territorial extension of 51,100 km² and a population of five million inhabitants (October 2018). As it can be appreciated in the map (Fig. 1), it is divided into seven provinces; on the north it borders with Nicaragua and on the south with Panama. In Costa Rica, as in practically all over the world, chronic non-communicable diseases have been the main causes of death in the country for several decades, to the point of accounting for 79% of all of them⁷. Something similar occurs all over the world, since said conditions were the cause of 72.3% of all deaths in 2016 (95% confidence interval [CI]: 71.2-73.2)⁸. Within this large group, CVDs have become the leading cause of death since several decades ago. In the year 2015, CVDs caused 5,689 deaths in Costa Rica, with

Table 1. Mortality rates from ischemic heart diseases in America for the year 2015. Rates per 100,000 population

Regions and countries	Total	Men	Women
The Americas	63.1	82.8	46.6
North America	61.6	83.1	43.3
Bermuda	54.9	66.0	44.3
Canada			
USA	61.6	83.1	43.3
Latin America and the Caribbean	63.7	82.4	48.2
Latin America	63.8	82.5	48.3
Mexico	74.9	94.0	58.3
Central American Isthmus	63.7	75.2	54.0
Belize	55.5	81.7	30.4
Costa Rica	57.6	75.5	41.6
El Salvador	55.8	64.4	48.9
Guatemala	65.7	77.3	56.1
Honduras	48.2	51.2	44.9
Nicaragua	95.5	111.4	82.5
Panama	59.1	75.4	44.2
Latin Caribbean	88.9	106.0	73.4
Cuba	80.7	95.5	66.9
Guadeloupe	11.9	14.7	9.5
French Guiana	8.8	9.3	7.6
Haiti			
Martinique	10.5	16.1	6.2
Puerto Rico	49.0	67.8	34.8
Dominican Republic	119.9	139.3	101.4
Andean area	77.7	100.0	59.0
Bolivia			
Colombia	102.6	126.3	83.2
Ecuador	46.5	61.3	33.1
Peru	29.1	38.2	21.1
Venezuela	104.3	142.8	72.6
Brazil	54.4	72.7	39.6
Southern cone	37.6	54.8	24.1
Argentina	34.7	52.3	21.4
Chile	33.7	49.4	21.0
Paraguay	67.5	83.9	52.0
Uruguay	36.4	55.4	23.1

Adapted from Pan American Health Organization, 2016⁶.

a rate of 98.07 per 100,000 population. Among all of them, IHD has always been ranked at first place and, as specific cause, myocardial infarction appears first, while the second cause of CVD-related death are cerebrovascular diseases. IHD was the cause of 2,690 deaths, with a rate of 47.93 per 100,000, which is equivalent to 47.3% of the group. Meanwhile, acute myocardial infarction (AMI), which is the main cause of death within the IHD segment, caused 1,383 deaths, with a rate of 28.6 per 100,000, equivalent to 51.2% of deaths within said segment, always for the same year 2015⁹.

In Costa Rica, few works have been published on IHD descriptive epidemiology. Roselló and Guzman¹⁰ analyzed mortality during the 1970-2002 period according to its geographical distribution and place of occurrence. Subsequently, these two researchers published another article on the same subject, in this case with greater extension and depth, since they also included CVD, IHD and AMI mortality evolution during the 1970-2001 period¹¹.

Hence the importance of updating and expanding the existing information in this regard, which is the main purpose of our collaboration.

The objective of this work is to describe and update some aspects of IHD descriptive epidemiology, especially its mortality, during the years encompassed between 1970 and 2014.

Methods

Initially, IHD mortality figures for all ages in Costa Rica from 1930 to 1969 were obtained from the statistics yearbooks of the National Institute of Statistics (INEC – *Instituto Nacional de Estadística de Costa Rica*)¹², and subsequently, from the Central American Population Center (CCP – *Centro Centroamericano de Población*) database of the University of Costa Rica from 1970 to 2014¹³. From those same sources, total population of the country for the same years of the studied period was obtained, in order to calculate the crude rates “smoothed” by three-year moving averages and also for five-year periods (quinquennia). Moving averages are used in this sense^{14,15}, with three years being chosen each time for this purpose: first, the first three rates are added and divided by three, with the rate being placed in front of the intermediate year of that first triennium, then, the successive total values will be obtained by excluding the first year of the triennium from the preceding total value and adding the next year until the series is completed.

Subsequently, total deaths from said causes (ICD 10, I20 - I25) were obtained, classified by gender, of the



Figure 1. Costa Rica Map (adapted from Caja Costarricense de Seguro Social, 2014).¹²

population aged 35 to 74 years for the period between January 1, 1970 and December 31, 2014. With the population of that age group, the respective standardized rates were calculated, given that this is the age group with the highest risk for dying from such diseases, as well as to enable international comparisons. The Latin American population was taken as the standard population.

To assess IHD mortality rates secular trends or changes, percentage changes thereof were used in the first term and, in second place, regression techniques, with correlation or determination coefficients (r^2), beta estimation and, finally, the degree of significance (p) being obtained in order to determine if the changes were statistically significant or not.

Crude and typified mortality rates were also calculated per hundred thousand population by Costa Rica provinces and regions. Standardization was also made using 2015 Latin America population age distribution (Latin American and Caribbean Demographic Center [CELADE – *Centro Latinoamericano y Caribeño de Demografía*])¹⁶. We have used this population standard

in other works, since it allows the best comparison of rates versus those in the other Latin American countries.

In order to obtain the IHD-related mortality figures, we used the 8th International Classification of Diseases (ICD), specifically the 410 codes, for the years 1970-79, ICD-9 410 codes for the 1980-1996 period and ICD-10 I21 codes for the period between 1997 and 2014. The latter distinguishes the following entities:

- Ischemic heart diseases (I20 to I25)
 - I20 Angina pectoris.
 - I21 ST elevation (STEMI) and non-ST elevation (NSTEMI) acute myocardial infarction.
 - I22 subsequent ST elevation (STEMI) and non-ST elevation (NSTEMI) acute myocardial infarction.
 - I23 Certain current complications, following ST elevation (STEMI) and non-ST elevation (NSTEMI) myocardial infarction (within the 28-day period).
 - I24 Other acute ischemic heart diseases.
 - I25 Chronic ischemic heart disease.

Regarding the change of codes from ICD-9 to ICD-10 we verified that the rates practically did not vary

Table 2. Ischemic heart disease mortality crude rates moving averages in Costa Rica, 1930-2014

Year	Moving averages	Year	Moving averages
1930	1.76	1973	37.00
1931	1.88	1974	38.16
1932	1.86	1975	37.84
1933	1.68	1976	35.56
1934	1.76	1977	36.52
1935	2.09	1978	39.02
1936	2.28	1979	42.68
1937	2.50	1980	44.33
1938	2.95	1981	46.10
1939	2.94	1982	48.63
1940	3.82	1983	51.91
1941	3.64	1984	55.32
1942	3.89	1985	55.96
1943	2.65	1986	55.09
1944	3.05	1987	53.64
1945	3.01	1988	54.28
1946	3.28	1989	55.08
1947	2.56	1990	54.43
1948	2.43	1991	53.80
1949	2.65	1992	55.17
1950	2.86	1993	56.95
1951	5.12	1994	58.30
1952	8.44	1995	58.88
1953	11.84	1996	57.74
1954	13.18	1997	56.47
1955	13.55	1998	56.12
1956	13.79	1999	57.68
1957	13.62	2000	59.21
1958	14.07	2001	58.97
1959	15.14	2002	57.53
1960	15.82	2003	55.72
1961	16.67	2004	55.81
1962	17.43	2005	54.52
1963	20.81	2006	54.62
1964	22.94	2007	54.47

*(Continues)***Table 2.** Ischemic heart disease mortality crude rates moving averages in Costa Rica, 1930-2014 (Continued)

Year	Moving averages	Year	Moving averages
1965	26.67	2008	54.73
1966	28.44	2009	54.84
1967	33.25	2010	56.04
1968	36.87	2011	56.33
1969	37.02	2012	56.85
1970	34.19	2013	57.29
1971	31.50	2014	60.07
1972	33.64		

Own creation with data from statistical yearbooks and from Centro Centroamericano de Población.

between 1990 and 1999, which was the decade in the middle of which the change between both classifications occurred. On the other hand, the percentage contribution of IHD mortality to general mortality did not vary either between the immediate years before and after the ICD change (it remained between 14.41 and 14.24%). At the international level, changes occurred between the ICD-9 and ICD-10 criteria were not a cause for concern in Spain, since the figures have remained relatively stable¹⁷.

In the case of mortality prior to 1970, it was addressed with current ICD codes, just as they appeared in the INEC statistical yearbooks. For the tabulation and analysis of data, the STATA® program was used¹⁸.

To omit the problem of inappropriate classification, which has been studied by the World Health Organization¹⁹, the percentage of poorly-defined pathologies, many of which actually correspond to IHD, such as paroxysmal ventricular tachycardia, ventricular fibrillation, cardiac arrest, heart failure and not otherwise specified heart failure, among others, was determined for two specific periods: the first one from 1980 to 1999, and the second from 2000 to 2016. In the first case there was a persistent decrease in their percentage with regard to total number of heart diseases, ranging from a maximum of 27.1% in the 1980 to 10.19% in 1995. In the case of the years corresponding to ICD-10, average percentage of wrongly defined pathologies was 4.30, with extreme values of 4.94% (year 2001) and 3.13% (2008). According to these low percentages, Costa Rica is in the group of countries considered as “low miscoding”, and therefore it is possible to assume that these errors have not significantly affected the IHD rates.

Table 3. Ischemic heart disease mortality crude rates in Costa Rica, 1930-2014. Quinquennial averages and percentage ratio with overall mortality

Quinquennium	Average death no.	Average rate	Percentage change	Percentage ratio
1930-1934	9	1.7		0.08
1935-1939	15	2.6	52.92	0.13
1940-1944	21	3.2	22.86	0.18
1945-1949	21	2.9	-10.40	0.21
1950-1954	79	8.3	187.32	0.80
1955-1959	157	14.0	69.27	1.58
1960-1964	257	18.8	33.96	2.36
1965-1969	537	33.1	75.73	4.76
1970-1974	645	34.5	4.43	6.10
1975-1979	808	38.0	9.92	8.96
1980-1984	1197	48.9	28.93	12.69
1985-1989	1550	55.4	13.09	14.46
1990-1994	1766	55.6	0.37	14.41
1995-1999	2067	57.3	3.12	14.24
2000-2004	2298	57.3	-0.07	14.76
2005-2009	2256	52.0	-9.19	13.27
2010-2014	2726	58.58	-0.12	14.01

Own creation with data from statistical yearbooks and from Centro Centroamericano de Población.

Results

Table 2 shows IHD crude mortality rates moving averages evolution in Costa Rica from 1930 to 2014. In general terms, a continued rise is observed until 2004, after which the rates tend to stabilize until 2009. As of that year, rates rather show a moderate elevation.

Table 3 shows the above information, but this time taking into account the quinquennial averages and their percentage relationship with general mortality. The same trend is observed when average rates are studied by quinquennia in the same time period, but the decline until the 2004-2009 quinquennium is interrupted, since it is followed by a slight increase in the next period, similar to the behavior observed in table 2.

IHD mortality percentage contribution with respect to overall mortality was practically insignificant during the 1930-1954 period (less than 1%), but in the time span between the 1955-1959 and 1975-1979 quinquennia, the increase is notorious, especially after 1980, when the percentage reached two digits until stabilizing at 14%.

Average quinquennial rates were also analyzed adjusted for the 35 to 74-year age group between the years 1970-1974 and 2010-2014. At first sight, the rates per hundred thousand population are observed to increase until the 1995-1999 quinquennium, after which a significant and sustained decline is observed in the three subsequent quinquennia (Table 4), both in men and in women. The percentage decrease between the extreme quinquennia for women was 44.19, while for men it was 13.16. In this case, the huge decline difference in favor of women draws the attention. For both genders, the decrease corresponded to 25.88%.

When this analysis is carried out according to gender (Tables 4 and 5, Fig. 2), when the series is divided in two periods (1970-1999 and 2000-2014), no decrease in the rates is observed to have occurred during the first period (except in males, $p = 0.05$) and there was rather an increase in women and in total rate, but the opposite occurred during the 2000-2014 period, given that, for males, a significant trend towards a decrease is observed ($r = 0.994$, $r^2 = 0.9884$, $\beta = -2.7270$, $p = 0.02$)

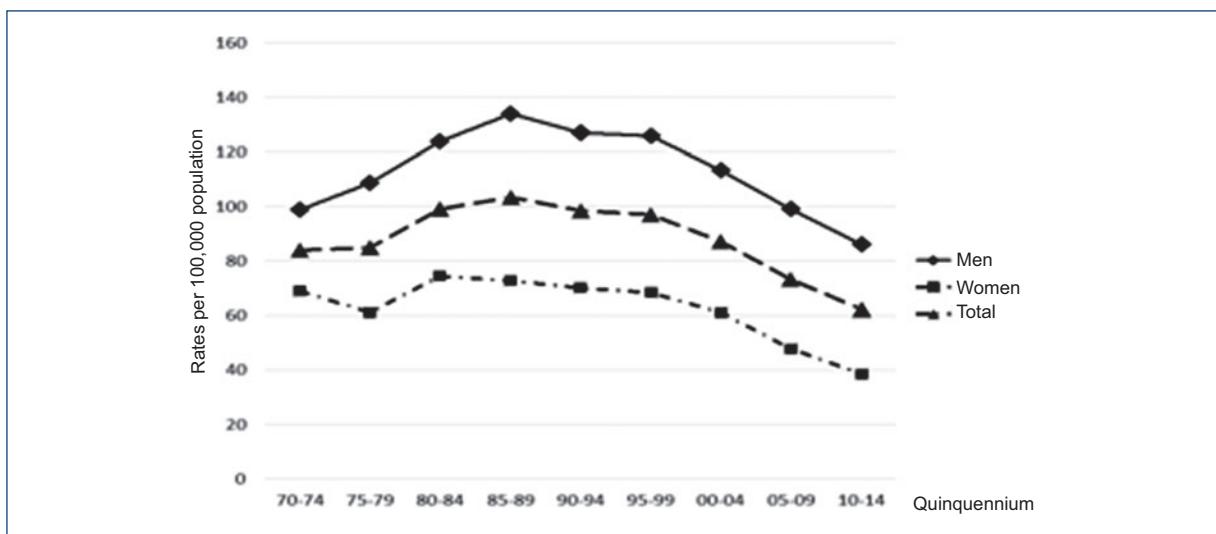


Figure 2. Ischemic heart disease mortality adjusted rates in people aged 35 to 74 years, according to gender. Costa Rica, 1970-214 (prepared based on data from statistical yearbooks and from Centro Centroamericano de Población).

Table 4. Ischemic heart disease mortality in people aged between 35 and 74 years by quinquennia in Costa Rica, 1970-2014. Adjusted rates per 100,000 population

Quinquennium	Women	Men	Total
1970-1974	68.83	98.93	83.88
1975-1979	61.15	108.55	84.85
1980-1984	74.32	123.88	99.10
1985-1989	72.61	134.07	103.34
1990-1994	69.92	127.02	98.47
1995-1999	68.35	125.67	97.01
2000-2004	61.05	113.18	87.12
2005-2009	47.72	98.97	73.35
2010-2014	38.41	85.91	62.17

Own creation with data from statistical yearbooks and from Centro Centroamericano de Población.

and the same occurred when both genders were taken into account ($r = 0.9964$, $r^2 = 0.9928$, $\beta = -2.4950$, $p = 0.04$). For women, the rates also decreased, but the trend was not significant by a slight margin ($p = 0.07$).

Other indicators of disease burden

In addition, other indicators were obtained, in this case extracted from the Institute for Health Metrics and Evaluation (IHME) of the University of Washington, Seattle²⁰, in order to complement the burden of the disease by IHD

Table 5. Regression (r) and determination coefficient (r^2), b coefficient and significance (p) for coronary ischemic heart disease mortality adjusted rates in people aged from 35 to 74 years, according to gender. Costa Rica 1970-2014

Gender and total	r	r^2	β	p
1970-1999				
Men	0.6530	0.4264	1.1389	0.05
Women	0.0677	0.0046	0.1269	0.62
Total	0.5354	0.2867	0.6329	0.10
2000-2014				
Men	0.9994	0.9988	-2.7270	0.02
Women	0.9896	0.9793	-2.2640	0.07
Total	0.9964	0.9928	-2.4950	0.04

in Costa Rica. In the first place, Disability-Adjusted Life Years during the 1990-2014 period, as shown in figure 3. A continuous decline is observed until 2009, and then the trend stabilizes. Quantitatively, DALYs between the years 1990 and 2014 decreased from 2,505 (95% CI: 2,378.99-2,642.33) to 1,319.57 (95% CI: 1,233.86-1,421.17), for a percentage decline of 47.3%.

Figure 4 shows the years of potential life lost (YPLL) evolution, also for the same 1990-2014 period, with a decrease during this period being observed, just as in the previous figure, as well as a stabilization of rates in the last five years. During the first of the aforementioned years, a figure of 2,401 per one hundred

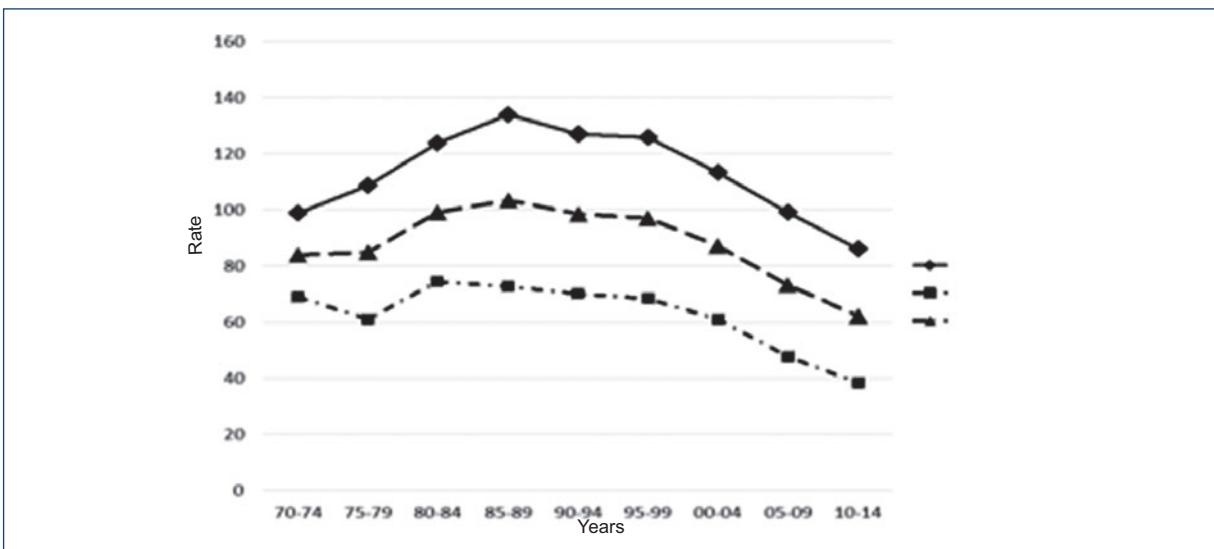


Figure 3. Disability-adjusted life years lost due to ischemic heart disease in Costa Rica, 1990-2014 period. Rates per 100,000 population (*created based on data from the Institute for Health Metrics and Evaluation*²⁰).

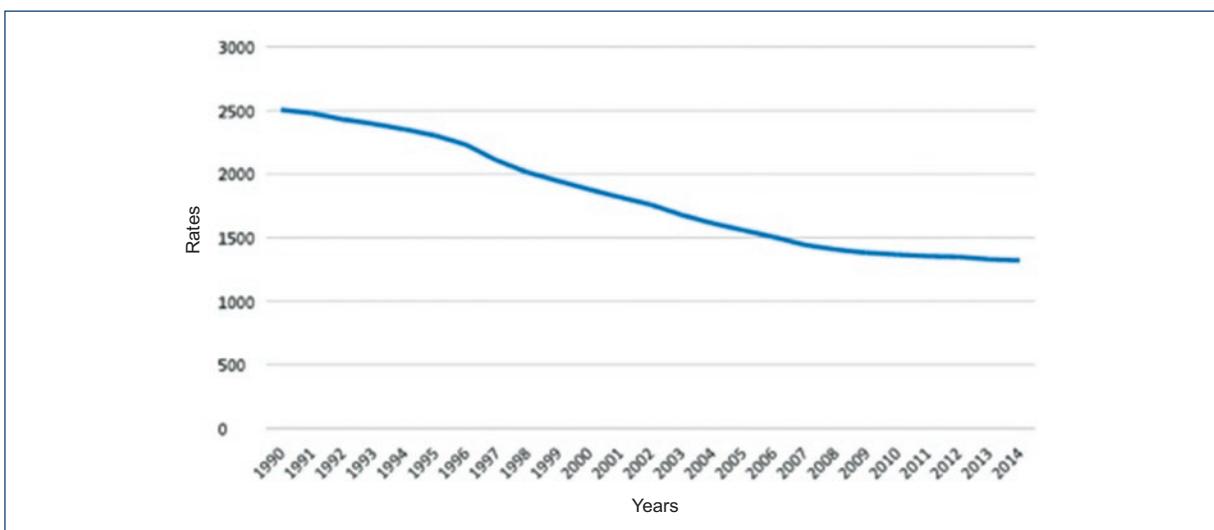


Figure 4. Years of potential life lost due to ischemic heart disease in Costa Rica, 1990-2014 period. Rates per 100,000 population (*created based on data from the Institute for Health Metrics and Evaluation*²⁰).

thousand population was obtained (95% CI: 2,286.98-1,533.93), which decreased to 1,214.93 (95% CI: 1,129.17-1,311.83), for a percentage decrease of 50.14%.

As for years lived with disability (YLDs), **figure 5** shows an increase of rates during the initial decade to then stabilize until the final years of the study. YLDs between 1990 and 2014 went from 103.41 per one hundred thousand population (95% CI: 71.01-147.14) to 104.75 (95% CI: 73.70-147.14); i.e. they remained practically the same (0.1% increase).

Geographical distribution

The highest crude rates during the first five quinquennia corresponded to the provinces of Heredia, San José and Cartago. Then, Heredia gave up its place to Alajuela and Cartago went to second place, while San José has had the highest rate throughout the last thirty years. The lowest rate corresponded to the province of Guanacaste, although in the last quinquennia, Puntarenas and Limón rates have approached much, almost getting even (**Table 6**).

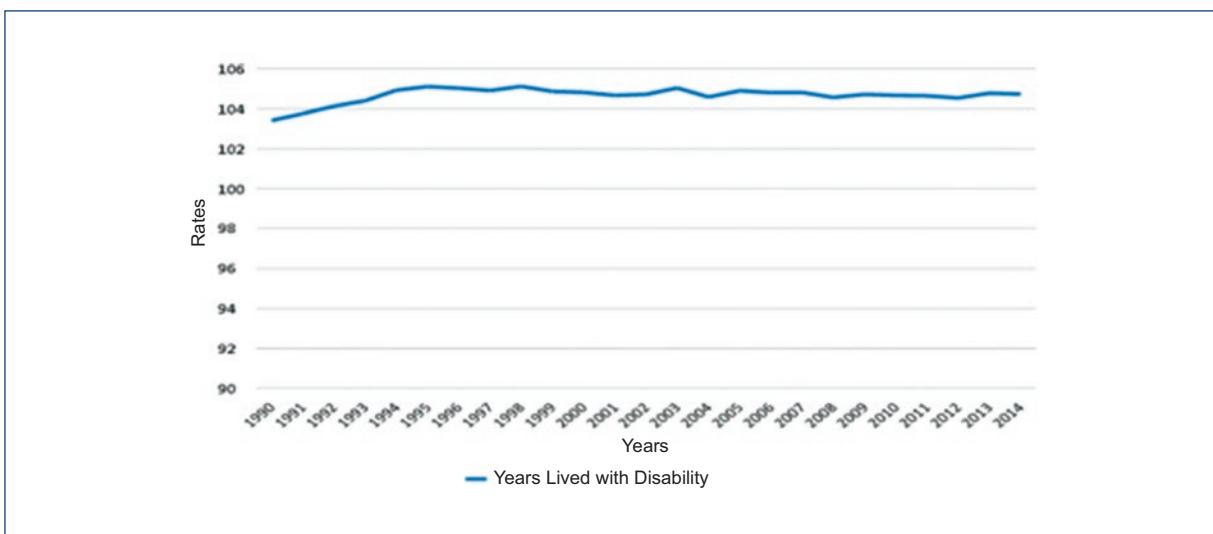


Figure 5. Years lived with disability due to ischemic heart disease in Costa Rica, 1990-2014 period. Rates per 100,000 population (created based on data from the Institute for Health Metrics and Evaluation²⁰).

Province-standardized rates have had a quite similar behavior to the previously indicated crude rates (Table 6).

For IHD mortality geographical distribution we also resorted to an analysis by Costa Rica socioeconomic regions, with crude and standardized rates also being taken into account. These can be appreciated in table 7.

In the case of crude rates, the highest corresponded to the Central region, followed by Huéstar Atlántica. The lowest rates were observed in the Chorotega and Huéstar Norte regions.

Regarding standardized rates evolution, it was quite similar to that of crude rates, with the highest being recorded in the central region (except for the first two quinquennia, in which they were surpassed by the Huéstar Atlántica region rates, which in the rest of the period were at second place), with the lowest corresponding to the Chorotega and Huéstar Norte regions.

Discussion

IHD accounted for 10.9% of mortality in Latin America and the Caribbean, ranked at first place as specific cause of death⁶, as it also did in the rest of the world²¹. Crude mortality rates for this cause in Costa Rica are slightly lower than the average for the Americas and in particular for Latin America, both for men and women and for both genders (Table 1). Rates are also higher in the Central American isthmus, given that Guatemala, Nicaragua and Panama have more

elevated rates, with Costa Rica rates being almost equal to those of El Salvador and Belize, but clearly surpassing the Honduras rate. These crude rates showed a clear upward trend during a large part of the analyzed period, except in the final years, where a decline could be appreciated that was only interrupted in the 2010-2014 quinquennium.

In a previous study carried out by other authors¹⁰ in relation with IHD mortality during the 1970-2002 period, mortality was found to increase by 18.4%, with 6.1% corresponding to females and 28.4% to males. In our research, an increase is also observed in IHD crude rates until the year 2002, after which a slight decline begins, which continues on a plateau until 2009, to be followed by an increase between the years 2010 and 2014. This is best observed when the information is presented by quinquennia (Table 3), with the 2000-2009 declining trend being abruptly interrupted in the following five years. We postulate that perhaps this behavior is because life expectancy in Costa Rica has significantly increased over the last quinquennia, thus allowing for a larger number people to be exposed to die from IHD. It is, in a certain sense, an emigration of previous mortality to older ages of life. The disproportionate increase in obesity and overweight in Costa Rica can also be mentioned.

As for standardized rates, those in the 35 to 74 years age group were obtained because this is the subset with the highest probability of experiencing a coronary event or dying from it. In this sense, rates were

Table 6. Ischemic Heart Disease crude and standardized mortality rates in people aged 35 to 74 years, by quinquennium according to province. Costa Rica 1970-2014

Quinquennium	Crude rates						
	Province						
Quinquennium	San José	Alajuela	Cartago	Heredia	Guanacaste	Puntarenas	Limón
1970-1974	108.8	88.8	100.3	129.4	39.4	61.7	126.8
1975-1979	101.5	106.4	90.7	118.7	60.3	61.4	102.1
1980-1984	125.9	115.7	108.2	127.4	69.3	89.5	100.7
1985-1989	129.1	102.4	106.1	120.5	76.1	83.1	114.5
1990-1994	108.1	92.7	104.9	106.2	70.0	78.7	108.1
1995-1999	105.7	93.3	99.0	90.8	60.3	92.9	75.2
2000-2004	96.5	81.0	88.8	80.6	65.6	76.8	65.8
2005-2009	83.6	72.6	82.6	71.8	63.1	64.7	62.7
2010-2014	86.3	71.1	76.8	73.5	62.2	64.4	61.2

Quinquennium	Standardized rates						
	Province						
Quinquennium	San José	Alajuela	Cartago	Heredia	Guanacaste	Puntarenas	Limón
1970-1974	109.7	86.3	104.4	124.4	39.0	68.9	134.2
1975-1979	99.1	102.6	92.9	116.4	58.5	65.8	106.0
1980-1984	119.8	110.5	109.1	123.4	64.3	90.8	101.1
1985-1989	123.5	99.2	107.4	117.8	71.1	83.7	117.3
1990-1994	106.2	93.0	109.3	109.4	67.0	79.8	116.7
1995-1999	106.4	96.9	105.4	96.5	58.7	95.2	86.4
2000-2004	96.5	83.9	93.9	86.2	64.5	78.5	75.9
2005-2009	79.3	71.8	83.5	72.7	60.4	64.2	69.1
2010-2014	78.3	67.5	74.8	71.1	58.8	61.9	63.9

Created with data from statistical yearbooks and from Centro Centroamericano de Población.

observed to continuously increase until the 1985-89 quinquennium, after which the trend was towards a straightforward decline, as it can be observed in **table 4** and **figure 2**. This decline in our study was statistically significant (**Table 5**) for both genders ($p = 0.04$) and for males ($p = 0.02$), but not for females ($p = 0.07$). The percentage decrease between both extreme periods was equivalent to 39.8%. In this case, a similar trend to that the developed countries have had is observed²², except that the decline in age-standardized rates began much earlier in said countries, starting in 1980, as a consequence of primary and secondary cardiovascular prevention success²¹. Despite this large IHD incidence decline that has occurred in developed nations, it

remains the cause of one out of every three deaths in the population older than 35 years²³.

The above information allows us knowing that, in all quinquennia comprised within the 1970-1974 and 2010-2014 periods, IHD rates were higher in men in comparison with women, with the ratio being lower at the beginning of the series (1.43:1) and higher at the end of it (2.23:1). In addition, the ratio in favor of males is observed to gradually increase throughout all quinquennia, a result that is consistent with another study conducted in the country¹¹, in addition to results obtained in other nations, such as Mexico^{24,25}. Life expectancy in Costa Rica has always been higher in women in comparison with men (82.2 years for women

Table 7. Ischemic heart disease crude and standardized mortality rates in people aged 35 to 74 years, by quinquennium according to socioeconomic region. Costa Rica 1970-2014

Quinquennium	Crude rates					
	Socioeconomic region					
	Central	Chorotega	P Central	Brunca	H Atlántica	H Norte
1970-1974	109.3	40.6	71.7	54.8	126.8	48.1
1975-1979	107.9	57.2	81.5	50.4	102.1	56.6
1980-1984	127.2	67.4	94.0	78.3	100.7	75.4
1985-1989	124.1	73.5	97.5	75.4	114.5	67.9
1990-1994	108.7	69.7	89.8	67.0	108.1	59.8
1995-1999	103.1	61.3	101.7	81.8	75.2	69.9
2000-2004	92.4	63.7	82.9	73.1	65.8	64.8
2005-2009	81.8	62.1	75.0	59.6	62.7	54.8
2010-2014	81.7	60.9	70.8	58.5	61.2	63.3
Standardized Rates						
Quinquennium	Socioeconomic region					
	Central	Chorotega	P Central	Brunca	H Atlántica	H Norte
	108.2	40.3	72.5	67.6	134.2	52.5
1970-1974	104.6	56.2	81.3	56.2	106.0	62.9
1975-1979	121.2	63.6	89.8	81.5	101.1	84.1
1980-1984	119.3	69.5	92.9	77.8	117.3	74.8
1985-1989	108.2	67.2	88.4	69.1	116.7	67.0
1990-1994	105.6	59.6	103.2	84.3	86.4	78.7
1995-1999	94.3	62.5	84.4	74.5	75.9	71.8
2000-2004	79.2	59.5	73.6	59.1	69.1	58.7
2005-2009	75.8	57.6	66.9	56.6	63.9	65.6

and 77.5 for men, year 2016), which would partly explain the above observation. Higher IHD-related mortality in males has also been reported to likely be due to higher rates of smokers (18.8% in males and 7.9% in females, for the year 2014) and consumers of alcoholic beverages (males 44.4% and females 26.8% during the same year). In the latter case, it refers to people who reported having consumed at least one alcoholic beverage within the previous twelve months²⁶. In the same sense, the same second survey on cardiovascular risk factors indicates that “a prevalence of high physical activity of 41.7% was obtained in individuals of the male gender, which was higher in the 20 to 39 years’ group (48%), while in the female gender, the prevalence of high physical activity was

26.2%, and it was higher in the 40 to 64 years’ group (28.9%)”²⁶.

Other of the most important risk factors recognized by multiple epidemiological investigations are overweight and obesity. Both conditions have significantly worsened precisely in Costa Rica. Thus, for example, overweight for both genders went from 24.9% in 1975 to 36.1% in 2014, for a percentage increase of 44.90%, with the peculiarity that males had higher prevalence than females, given that from 24.5% in 1975 they went to 39.3% in 2014, while females went from 25.4% to 33% in the same period. In the case of obesity (BMI equal than or greater than 30 kg/m²), it went from 6.3% in 1975 to 23.7% in 2014. In this case, women had higher prevalence, since from 8.5% it increased to 28.5%, while in men it went from 7.8 to 19.0%²⁷. It could

be postulated that the increase in IHD-related mortality observed during the last quinquennium (2010-2014) would be largely related to this increase in obesity and overweight in Costa Rica. In other countries, this negative effect of both conditions has also been reported, as well as that of diabetes, on CVD-related mortality, thus decreasing the possibility of a continuous decrease of their rates.

In addition, other indicators were obtained that do not only measure mortality but morbidity as well, expressed in this case by disability. Measurement of the burden of disease has been one of epidemiology paramount events in recent years, especially when in the 1990's, at the initiative of the World Bank, the first report on this matter was presented²⁸. From there did DALYs emerge, which managed to combine fatal and non-fatal consequences of diseases, injuries and risk factors, represented by the YLL indicator and by YLDs. When figures 4 (YLL) and 5 (YLDs) are analyzed, DALYs are found to be constituted in more than 90% by YLLs, with a percentage lower than 10% corresponding to YLDs, quite a similar situation to that which occurred in Spain, where 96% was contributed by years of life lost to premature death and barely 4% by disability²⁹; similar results have been reported in Colombia³⁰. Both the sum of DALYs and YLLs have a tendency to decrease, with the latter going from rate of 13,705 per one hundred thousand population in 1990 to 10,447 in 2010. Conversely, YLDs practically did not experience significant changes, since from a standardized rate of 11,672 per one hundred thousand population in 1990 they went to a rate of 10,948 in 2010³¹.

According to a publication of the *Caja Costarricense de Seguro Social*³², based on information provided by IHME, IHD-associated YLLs went from being the second specific cause of death in 1990 to constitute the first one in 2010. Also in that same publication, IHDs were the leading cause of DALY in Costa Rica, while as a cause of YLD, their contribution was practically insignificant, given that they were at 25th place.

IHD percentage contribution to overall mortality also did increase over time, but from the 1985-89 quinquennium on, the percentage stabilized around 14%, which is quite higher than that in Latin America, as previously mentioned.

With regard to IHD specific components percentage distribution, in our study we found that AMI occupied the main position, although with important variations that have ranged from 55 to 70%. In a research carried out in Mexico, the percentages found were 81.24% in 2001 and 82.75% in the year 2002²⁵.

Conclusions

In the evolution of IHD-related mortality in Costa Rica, three rather clear stages can be identified. The one first spreads from 1930 to 1964, and is characterized by a slow but continuous increase, which is followed by an explosive increase in the rates until the year 1984. Subsequently, the rates show a trend towards stabilization and decrease, which is interrupted in the last quinquennium.

When mortality of the 35 to 74 years' age group is taken into account by quinquennia, in this case during the 1970-1974 and 2010-2014 periods, standardized rates allow for two to very clear periods to be identified. The first one, which goes from the beginning to the 1985-1989 quinquennium, is characterized by a continuous increase of rates, which is followed by an uninterrupted decrease until the final quinquennium of the time period. In this case, unlike IHD-related mortality for the entire population, the clear downward trend does not stop at the end of the series.

Conflicts of interest

The authors declare not having any conflicts of interest or having received specific financial assistance from public or commercial sector agencies or non-profit entities

Ethical disclosures

Protection of people and animals. The authors declare that no experiments have been conducted on humans or animals for this research.

Confidentiality of data. The authors declare having followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

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