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Trends of premature mortality due to chronic non-communicable diseases in the state of São Paulo

Tendência de mortalidade prematura por doenças crônicas não transmissíveis no estado de São Paulo

Tendencia de la mortalidad prematura por enfermedades crónicas no transmisibles en el estado de São Paulo

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ABSTRACT

Objective: to analyze the trend of premature deaths related to chronic non-communicable diseases and their relationship with the level of education and income of the population in the state of São Paulo. **Method:** ecological study, using data from the Department of Informatics of the Unified Health System (DATASUS), referring to deaths registered between 2012 and 2019 of people aged 30 to 69 years due to cardiovascular and respiratory diseases; neoplasms and diabetes mellitus. The data were analyzed using a generalized linear model of negative binomial distribution with a logarithmic link function. **Results:** the premature mortality rate due to chronic non-communicable diseases increased, from 313.16 deaths/100,000 inhabitants in 2012 to 315 .08/100,000 inhabitants in 2019. **Conclusion:** there is a need for special attention from health management to chronic non-communicable diseases, actions for prevention, promotion and early diagnosis, highlighting the relevant role of primary health care services.

Descriptors: Epidemiology; Health Promotion; Noncommunicalbe Diseases; Mortality, Premature.

RESUMO

Objetivo: analisar a tendência de óbitos prematuros relacionados às doenças crônicas não transmissíveis e sua relação com o nível de escolaridade e renda da população do estado de São Paulo. **Método:** estudo ecológico, utilizando dados do Departamento de Informática do Sistema Único de Saúde (DATASUS), referentes aos óbitos registrados no período de 2012 a 2019, de pessoas na faixa etária de 30 a 69 anos em decorrência de doenças cardiovasculares e respiratórias; neoplasias e diabetes mellitus. Os dados foram analisados por meio de modelo linear generalizado de distribuição binomial-negativa com função de ligação logarítmica **Resultados:** o coeficiente de mortalidade prematura por doenças crônicas não transmissíveis apresentou aumento, passando de 313,16 óbitos/ 100.000 habitantes no ano de 2012 para 315,08/100.000 habitantes em 2019. **Conclusão**: há necessidade de uma atenção especial da gestão em saúde às doenças crônicas não transmissíveis, ações para a prevenção, promoção e diagnóstico precoce, destacando-se o papel relevante dos serviços da atenção primária à saúde.

Descritores: Epidemiologia; Promoção da Saúde; Doenças Crônicas não Transmissíveis; Morte Prematura.

RESUMEN

Objetivo: analizar la tendencia de muertes prematuras relacionadas con enfermedades crónicas no transmisibles y su relación con el nivel de educación y de ingresos de la población en el estado de São Paulo. **Método:** estudio ecológico, utilizando datos del Departamento de Informática del Sistema Único de Salud (DATASUS), relativos a muertes registradas entre 2012 y 2019 de personas de 30 a 69 años, por enfermedades cardiovasculares y respiratorias, neoplasias y diabetes mellitus. Se analizaron los datos utilizando un modelo lineal generalizado de distribución binomial negativa con una función de enlace logarítmica. **Resultados:** la tasa de mortalidad prematura por enfermedades crónicas no transmisibles aumentó, de 313,16 muertes/100.000 habitantes en 2012 a 315,08/100.000 habitantes en 2019. **Conclusión:** es necesaria una atención especial desde la gestión sanitaria a las enfermedades crónicas no transmisibles, acciones de prevención, promoción y diagnóstico temprano, destacando el papel relevante de los servicios de atención primaria de salud.

Descriptores: Epidemiología; Promoción de la Salud; Enfermedades no Transmisibles; Mortalidad Prematura.

INTRODUCTION

Chronic Non-Communicable Diseases (CNCDs) are illnesses that manifest themselves throughout life and can exert personal, social and family impacts[1,2]. In Brazil, the Ministry of Health points out that 54.7% of the recorded deaths were attributed to CNCDs in 2019[3]. Among these, cardiovascular diseases (CVDs), neoplasms, chronic respiratory diseases and Diabetes *Mellitus* (DM) stand out[4]. According to data from the World Health Organization (WHO) World Health Observatory, these diseases are responsible for more than 80% of the premature deaths due to CNCDs worldwide[4].

Regarding the risk factors that can lead to the development of a CNCD and its worsening, it is verified that these four main CNCDs have risk factors classified as modifiable or non-modifiable. Modifiable factors are related to Systemic

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Arterial Hypertension (SAH), excessive alcohol intake, smoking, sedentary lifestyle, stress, obesity and dyslipidemia[1]. Non-modifiable factors include age, heredity, gender and race[1]. In addition to these risk factors, diverse evidence indicates that the prevalence of CNCDs is also related to schooling, occupation and income[1,5].

In this sense, the geographic location related to the Human Development Index (HDI) assists in understanding the premature mortality coefficients. The characteristics of the population's place of residence have significant implications for economic and social opportunities and can lead to exclusion processes, acting as a barrier to access to education, health and transportation services and even impacting a person's employment opportunities[6].

In this context, when considering the need for the literature to analyze the influence of modifiable factors, such as schooling and income, on premature mortality in different regions of the same state, this study aimed at analyzing the trend of premature deaths related to chronic non-communicable diseases and its relationship with the schooling and income levels of the population of the state of São Paulo.

METHOD

This is a longitudinal and ecological study, carried out with data from the Informatics Department of the Unified Health System (DATASUS) related to the state of São Paulo. The trend analyses carried out followed the administrative structure of the state's health system, which is divided into 17 Regional Health Departments (*Departamentos Regionais de Saúde*, DRSs), including 645 municipalities: DRS I — Greater São Paulo; DRS II — Araçatuba; DRS III — Araraquara; DRS IV — Baixada Santista; DRS V — Barretos; DRS VI — Bauru; DRS VII — Campinas; DRS VIII — Franca; DRS IX — Marília; DRS X — Piracicaba; DRS XI — Presidente Prudente; DRS XII — Registry; DRS XIII — Ribeirão Preto; DRS XIV — São João da Boa Vista; DRS XV — São José do Rio Preto; DRS XVI — Sorocaba; and DRS XVII — Taubaté[7].

The study population consisted of individuals aged from 30 to 69 years old who died due to CNCDs between 2012 and 2019 in the state of São Paulo. The CNCD mortality data were obtained from the DATASUS Mortality Information System (*Sistema de Informação de Mortalidade*, SIM), whereas those related to Gross Domestic Product (GDP) were collected on the SEADE Foundation website – State Data Analysis System[8].

It should be noted that only deaths whose cause was categorized as CNCDs were included in the study, according to the 10th International Statistical Classification of Diseases and Related Health Problems (ICD-10), with the following codes: cardiovascular diseases (I00 — I99); respiratory diseases (J30 — J98); neoplasms (C00 — C97); and diabetes *mellitus* (E10 — E14), grouped according to the WHO categorization. The contextual variables analyzed were the municipality where the death occurred, gender, detailed age, race/skin color, basic cause of death and schooling, obtained from the database available in DATASUS.

The Excel software was used for data organization and tabulation, for relating the databases researched and for formatting the results (tables and figures). The statistical analyses were performed in *R Studio®*, version 4.1.0.

When evaluating the coefficients of premature mortality due to CNCDs, the calculations were carried out by group of CNCDs (cardiovascular diseases, neoplasms, chronic respiratory diseases and DM) and by each of the four main diseases separately, according to gender and year of occurrence, expressed per 100,000 inhabitants according to the formula used by the Department for the Surveillance of Non-Communicable Diseases and Health Promotion[9]:

$$\frac{Number\ of deaths\ (30-69\ years\ old)\ due\ to\ CNCDs\ recorded\ in\ the\ corresponding\ codes,\ in\ a\ given\ year\ and\ place}{Resident\ population\ (30-69\ years\ old), in\ a\ given\ year\ and\ place} X 100{,}000$$

Source: Ministry of Health, 2018[9]

To evaluate the annual trend in deaths, a generalized linear model with a negative binomial distribution was used, with a logarithmic link function and an offset equal to the log of the population divided by 100,000[10]. In addition to that, sine- and cosine-based functions were used to improve the estimation of peaks and valleys in the series. According to the linear model proposed:

$$y_i = \beta_0 + \beta_1\, time_i + \beta_2\, DRS_i + \beta_4\, time_i \cdot DRS_i + e_i$$

The β_4 coefficient indicates the strength and direction of the annual trend in each DRS. A positive sign for this coefficient means that there is a tendency for a percentage increase in the number of cases each year for a given DRS[10].

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The significance level adopted for the analyses was 5%. It is noted that this study used public domain data, which did not require consideration by any Research Ethics Committee.

For the analysis of the GDP corresponding to the DRSs, the arithmetic mean of the *per capita* GDP values for each municipality in the state of São Paulo was calculated between 2012 and 2019; and they were subsequently organized by DRS to generate the mean *per capita* GDP of the DRSs.

As data available in public format were used, consideration by a Research Ethics Committee was not required.

RESULTS

The rate of premature mortality due to CNCDs in the state of São Paulo between 2012 and 2019 showed increase signs during the period analyzed, rising from 313.16 deaths/100,000 inhabitants in 2012 to 315.08 deaths/100,000 inhabitants in 2019.

Between 2012 and 2019, 557,964 premature deaths due to CNCDs were recorded in the 17 DRSs from the state of São Paulo, with cardiovascular diseases accounting for 47% (n=260,143) of these deaths. In relation to neoplasms, 223,380 deaths were notified in the state's 17 DRS during the period analyzed, corresponding to 40% of the total premature deaths recorded in the state of São Paulo. There was also stability in the number of cases of DM and chronic respiratory diseases during the period analyzed. The results of the analyses performed are presented in Table 1.

Table 1: Annual trend of premature deaths due to cardiovascular diseases and neoplasms from 2012 to 2019 in the DRSs of the State of São Paulo - SP. São Carlos, SP, Brazil, 2021.

	Annual trend (%)	95% CI		p-value
Cardiovascular diseases				
DRS I — GREATER SÃO PAULO	-0.395	-0.820	0.031	0.069
DRS II — ARAÇATUBA	0.226	-1.145	1.616	0.748
DRS III — ARARAQUARA	-2.144	-3.275	-0.999	<0.001
DRS IV — BAIXADA SANTISTA	-0.303	-1.071	0.472	0.442
DRS V — BARRETOS	-1.582	-3.176	0.038	0.056
DRS VI — BAURU	-1.904	-2.793	-1.007	<0.001
DRS VII —CAMPINAS	-0.347	-0.997	0.306	0.297
DRS VIII — FRANCA	-1.922	-3.268	-0.558	0.006
DRS IX — MARÍLIA	-1.799	-2.870	-0.715	0.001
DRS X — PIRACICABA	-1.030	-2.043	-0.007	0.048
DRS XI — PRESIDENTE PRUDENTE	0.143	-1.176	1.480	0.833
DRS XII — REGISTRY	2.755	0.586	4.971	0.013
DRS XIII — RIBEIRÃO PRETO	-1.241	-2.250	-0.223	0.017
DRS XIV —SÃO JOÃO DA BOA VISTA	-0.127	-1.341	1.102	0.839
DRS XV — SÃO JOSÉ DO RIO PRETO	-0.444	-1.397	0.517	0.364
DRS XVI — SOROCABA	-0.629	-1.431	0.179	0.127
DRS XVII —TAUBATÉ	-0.037	-0.869	0.800	0.930
Neoplasms				
DRS I — GREATER SÃO PAULO	-0.001	-0.332	0.331	0.994
DRS II — ARAÇATUBA	2.133	0.761	3.524	0.002
DRS III — ARARAQUARA	-0.016	-1.183	1.166	0.980
DRS IV — BAIXADA SANTISTA	0.168	-0.690	1.035	0.701
DRS V — BARRETOS	1.427	-0.340	3.225	0.114
DRS VI — BAURU	1.341	0.423	2.266	0.004
DRS VII —CAMPINAS	0.812	0.195	1.432	0.010
DRS VIII — FRANCA	1.221	-0.282	2.744	0.112
DRS IX — MARÍLIA	1.253	0.125	2.395	0.029
DRS X — PIRACICABA	0.453	-0.525	1.441	0.365
DRS XI — PRESIDENTE PRUDENTE	1.347	-0.022	2.734	0.054
DRS XII — REGISTRY	2.180	-0.115	4.526	0.063
DRS XIII — RIBEIRÃO PRETO	-0.031	-1.036	0.983	0.951
DRS XIV — SÃO JOÃO DA BOA VISTA	1.102	-0.192	2.412	0.095
DRS XV — SÃO JOSÉ DO RIO PRETO	1.556	0.586	2.535	0.002
DRS XVI — SOROCABA	1.306	0.479	2.141	0.002
DRS XVII – TAUBATÉ	1.733	0.915	2.558	<0.001

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The analysis corresponding to the behavior of premature deaths distributed by DRS showed a reduction in deaths caused by cardiovascular diseases in most of the state's DRSs, only with the increase in DRS XII — Registry standing out with statistical significance (p=0.013). Of the 17 DRSs in the state, six presented a decreasing trend in deaths, with DRS III — Araraquara (p<0.001), DRS VIII — Franca (0.006) and DRS VI — Bauru (p<0.001) standing out.

The deaths due to neoplasms had an increasing trend in 7 DRSs of the state, with emphasis on DRS II — Araçatuba (0.002) and DRS XVII — Taubaté (p<0.001).

In relation to respiratory diseases, no DRS presented increasing trends in premature mortality due to CNCDs with statistical significance, as shown in Table 2.

Table 2: Annual trend of premature deaths due to respiratory diseases and Diabetes *Mellitus* from 2012 to 2019 in the DRSs of the State of São Paulo - SP. São Carlos – SP, Brazil, 2021.

	Annual trend (%)	95% CI		p-value
Respiratory diseases				
DRS I — GREATER SÃO PAULO	-0.086	-1.004	0.839	0.853
DRS II — ARAÇATUBA	4.340	0.954	7.840	0.012
DRS III — ARARAQUARA	-0.470	-3.440	2.590	0.760
DRS IV — BAIXADA SANTISTA	-1.469	-3.320	0.418	0.126
DRS V — BARRETOS	2.322	-1.518	6.314	0.240
DRS VI — BAURU	0.465	-1.706	2.685	0.677
DRS VII — CAMPINAS	-0.897	-2.417	0.646	0.253
DRS VIII — FRANCA	2.864	-0.292	6.119	0.076
DRS IX — MARÍLIA	-0.323	-2.874	2.295	0.807
DRS X — PIRACICABA	0.756	-1.488	3.050	0.512
DRS XI — PRESIDENTE PRUDENTE	0.649	-2.570	3.973	0.697
DRS XII — REGISTRY	-0.971	-6.124	4.464	0.720
DRS XIII — RIBEIRÃO PRETO	3.005	0.470	5.603	0.020
DRS XIV — SÃO JOÃO DA BOA VISTA	1.542	-1.215	4.376	0.276
DRS XV — SÃO JOSÉ DO RIO PRETO	-0.321	-2.678	2.092	0.792
DRS XVI — SOROCABA	-1.368	-3.140	0.437	0.136
DRS XVII – TAUBATÉ	1.816	-0.141	3.814	0.069
Diabetes *Mellitus*				
DRS I — GREATER SÃO PAULO	-0.236	-1.103	0.637	0.594
DRS II — ARAÇATUBA	-0.806	-3.936	2.425	0.621
DRS III — ARARAQUARA	1.433	-1.598	4.558	0.358
DRS IV — BAIXADA SANTISTA	2.760	0.900	4.656	0.003
DRS V — BARRETOS	-6.169	-10.160	-1.999	0.004
DRS VI — BAURU	0.036	-2.051	2.169	0.973
DRS VII — CAMPINAS	-0.006	-1.747	1.766	0.995
DRS VIII — FRANCA	0.476	-2.947	4.021	0.788
DRS IX — MARÍLIA	5.379	2.759	8.064	<0.001
DRS X — PIRACICABA	-0.315	-2.813	2.249	0.808
DRS XI — PRESIDENTE PRUDENTE	0.558	-2.666	3.891	0.738
DRS XII — REGISTRY	-3.364	-7.673	1.144	0.141
DRS XIII — RIBEIRÃO PRETO	-1.158	-3.711	1.463	0.383
DRS XIV — SÃO JOÃO DA BOA VISTA	1.206	-1.579	4.069	0.400
DRS XV — SÃO JOSÉ DO RIO PRETO	-2.818	-5.184	-0.394	0.023
DRS XVI — SOROCABA	-0.487	-2.181	1.238	0.578
DRS XVII – TAUBATÉ	2.169	0.298	4.073	0.023

An increasing annual trend was found for DM, with emphasis on DRS IX — Marília (p<0.001) and DRS IV — Baixada Santista (p<0.003); whereas a decreasing trend was observed in DRS V — Barretos (p<0.004).

In relation to the analysis of premature deaths due to CNCDs distributed by gender, in the period studied, deaths due to CVDs, respiratory diseases, neoplasms and DM were more prevalent in males: 62% (162,246), 58% (23,658), 53% (117,898) and 55% (18,387), respectively. There is a caveat for DM in 2014, where the number of female deaths exceeded the one for males; among the health problems analyzed, CVDs had the highest difference in deaths between the genders (Figure 1).

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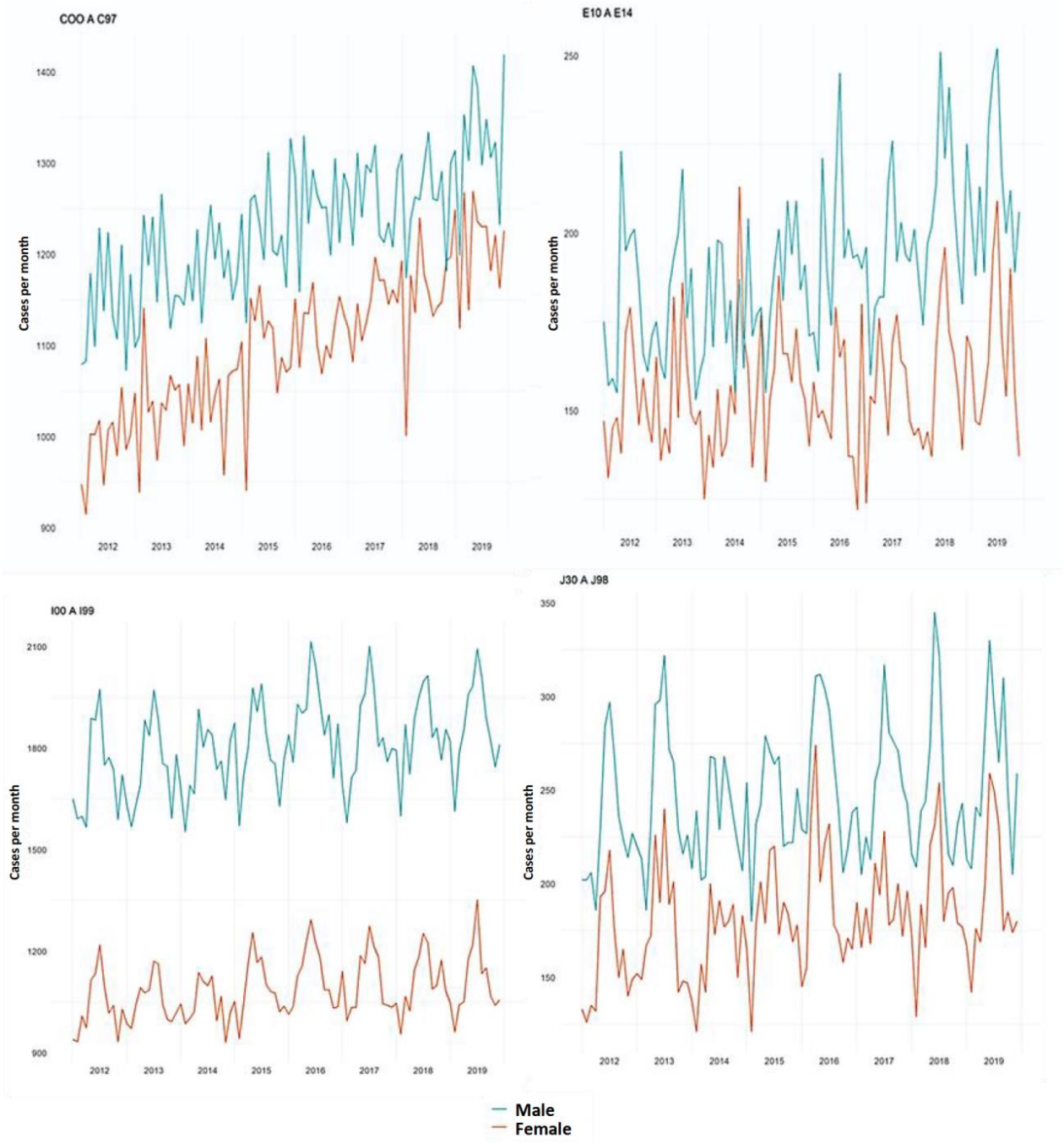

Figure 1: Analysis of premature deaths due to CNCDs distributed by gender in the state of São Paulo, from 2012 to 2019. São Carlos, SP, Brazil, 2021.

Premature deaths were concentrated in the oldest age groups covered, between 60 and 69 years old, with 49% of the deaths due to cardiovascular diseases occurring in this age group. The same pattern was repeated for respiratory diseases, neoplasms and DM: 56%, 55% and 57%, respectively.

In relation to schooling level, there is greater concentration of premature deaths in the group of people with Elementary School. For cardiovascular diseases, 48.1% (125,055) of the people who died had 1 to 7 years of study, whereas only 6.8% (17,588) had 12 or more years. Respiratory diseases and DM presented a similar pattern: 48.2% (19,781) and 48% (16,045) for people with one to seven years of study; and 5.9% (8,450) and 6.1% (2,032) for those with 12 or more years, respectively. Neoplasms accounted for 42% (94,488) and 12% (26,409), respectively.

The income component was approached through the analysis of the *per capita* GDP of the municipalities that make up the state's DRSs. For CVDs, it was not possible to establish a statistical relationship between a lower mean

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per capita GDP and an increase in mortality cases. In relation to neoplasms, DRS II — Araçatuba and DRS XVII — Taubaté, which stood because of the increasing trend of deaths due to neoplasms, are among the seven lowest *per capita* GDPs in the state (15th and 11th, respectively). In relation to DM, the *per capita* GDP for the Marília DRS is the 5th lowest and the Baixada Santista DRS has the 6th lowest GDP.

The socioeconomic analysis using the mean *per capita* GDP of the municipalities that are part of the DRSs and the relationship with premature deaths due to CNCDs between 2012 and 2019 shows that DRS VII — Campinas has the highest *per capita* GDP and presented a reduction in mortality in three of the health problems analyzed; in turn, DRS XI — Presidente Prudente presented the lowest *per capita* GDP and increased mortality in all four diseases analyzed. DRS I — Greater São Paulo also stands out, which presented the second best *per capita* GDP and the best results among the DRSs, with a reduction in all four diseases analyzed.

DISCUSSION

It is noted that the variations observed in the state of São Paulo showed a worrying trend in meeting the target of reducing the premature mortality rate by 2% per year, across the four main CNCDs in the country, established in the 2021-2030 Strategic Action Plan for tackling CNCDs in Brazil[5].

The analysis about mortality in the Brazilian population showed that deaths due to CNCDs were reduced by 2.2% per year and were higher in the age group from 60 to 69 years old in 2013, with 209.9 deaths/100,000 inhabitants for deaths due to ischemic heart disease, 157.2 deaths/100,000 inhabitants for cerebrovascular diseases and 116.8 deaths/100,000 inhabitants for DM[11]. In view of the country's demographic transition, IBGE estimates indicate that, by 2060, the group of people over the age of 65 will make up 25% of the Brazilian population[12]. This change in the demographic profile will certainly impact the epidemiological profile of CNCDs, making these diseases increasingly occupy a prominent role in Brazilian public policies[13].

A study carried out in the city of Ribeirão Preto found similar proportions of deaths caused by cardiovascular diseases (45.3% [2,157]), corroborating the results of this study[14]. Although the mortality coefficients due to cardiovascular diseases are decreasing due to advances in treatments, diagnoses and early treatments, the total number of people affected by these diseases has been increasing[3,5]. This situation is related to the demographic transition and to the increase in life expectancy, which does not always mean healthy life expectancy, impacting epidemiological indicators and the need to target public health policies[3,5,15].

In relation to the socioeconomic factor, it was not possible to conclude through a statistical relationship the relationship between the mean *per capita* GDP of the municipalities that make up the DRSs and the number of premature deaths; however, when comparing the results of the DRSs, the Departments with the highest *per capita* GDPs present a reduction in preventable deaths; whereas DRSs with lower GDPs had difficulties maintaining a decreasing trend in premature deaths. The literature shows that the socioeconomic component plays a central role in the decreasing trend in cases of deaths due to cardiovascular diseases; in other words, at the national level, states with better economic indicators presented greater reductions when compared to economically vulnerable states[16].

Therefore, given the impact caused by cardiovascular diseases, it is necessary that prevention of these diseases through PHC services is strengthened and that tackling these diseases plays a prominent role when planning public health policies[11]. Data from the 2019 *Global Burden of Disease Study* point out the high number of deaths caused by cardiovascular diseases as a result of population growth and aging; thus, the increase in longevity was not accompanied by an increase in healthy life expectancy[15].

Nationwide studies show an increasing trend in deaths due to neoplasms and point to unbalanced diet, overweight, obesity, smoking, excessive consumption of alcoholic beverages and exposure to UV radiation as potential risks for the development of these diseases[17-19]. On the other hand, in the United States, a study by the National Cancer Institute showed that the coefficient of new cancer cases between 2013 and 2017 was 442.4/100,000 inhabitants per year, and that the mortality rate was 158.3 deaths/100,000 inhabitants, evidencing a reduction in the number of deaths due to malignant neoplasms in recent years. In this context, the importance of screening, early diagnosis and medical advances should be highlighted, enabling longer survival for the patients[20].

In relation to mortality due to DM, even with the DM mortality rate in the state of São Paulo remaining unchanged, Brazil is the fifth country with the highest incidence of the disease in the world. Data from the tenth edition of the Diabetes Atlas of the International Diabetes Federation (IDF) place Brazil in first place among the five

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countries with the highest number of adults (from 20 to 79 years old) with DM in South and Central America[21]. Difficulties analyzing the data relating to DM mortality are due to the multicausal nature of the deaths, which are oftentimes not addressed on death certificates. Therefore, the data available on the official platforms sometimes do not correspond to reality, presenting an underestimated burden of the disease[22].

In other American countries, such as the United States, some studies indicate estimates that the prevalence of DM (types 1 and 2) will increase by 54%, rising to more than 54.9 million cases from 2015 to 2030; annual deaths attributed to DM increased by 38%[23]. According to the Ministry of Health, in Brazil there was a 60% increase in diagnoses of the disease between 2006 and 2016[24].

In relation to mortality due to respiratory diseases, this study points out that there was a reduction in these deaths in both genders between 2010 and 2017, in addition to other studies carried out at the regional level in the city of Ribeirão Preto[15] and at the national level showing the same trend[14,25].

In this sense, the Ministry of Health's finding regarding the reduction in the number of smokers aged over 18 years old in Brazil stands out, dropping from 34.8% in 1989 to 12.6% in 2019, which may have contributed significantly to reducing the number of deaths due to respiratory diseases[18]. In addition to active and passive smoking, biomass burning, exposure to air-borne allergens and occupational exposure are considered modifiable risk factors that should be avoided or mitigated through public policies and proper use of Personal Protective Equipment[26,27].

In this context, the Global Alliance against Chronic Respiratory Diseases was created in 2004 to assist developing countries in the fight against these diseases, through training for professionals working in the Public Health network on the importance of spirometry, pulse oximetry and arterial blood gas analysis in the early diagnosis and management of Chronic Obstructive Pulmonary Disease (COPD), reducing underdiagnoses and inadequate treatments[27].

In relation to the results obtained in the analysis by gender, it is noted that the greater occurrence of deaths in males can be related to the higher frequency with which women resort to health services, both in consultations and hospitalizations, a factor that can be related to the fewer women affected by health problems that result in premature death in this group[14,28,29].

In relation to the schooling results, the findings indicate higher concentration of premature deaths in the group of people with Elementary School levels of four to seven years. In this sense, the 2021-2030 Strategic Action Plan for Combating CNCDs in Brazil attributes this difference in the development of CNCDs to the combination of risk factors that the most vulnerable population has, such as smoking, consumption of meat with excess fat and obesity; in turn, protective factors such as physical activity, fruit and vegetable consumption are more prevalent in people with 12 or more years of study[5].

The prevalence of risk and protective behaviors for the development of a CNCD, based on data from Vigitel 2019 – Surveillance of risk and protective factors for chronic diseases by telephone survey, indicates that individuals with lower schooling and income levels were more exposed to modifiable factors such as smoking, insufficient physical activity, increased consumption of soft drinks and irregular consumption of fruits and vegetables[29]. However, the same study points out that people with higher schooling levels presented higher frequencies of alcohol abuse[30].

These data show that, although education is a protective factor against the development of a CNCD, health actions should be designed to take into account different groups of health system users. Lower schooling levels can act as a barrier to access, by influencing comprehension of the information and encouraging a shift towards unhealthy lifestyle habits, due to lack of understanding of what is harmful to health, increasing the risk of developing a CNCD[30-32].

Study limitations

The study has limitations regarding the quality of the data recorded by the Mortality Information System (SIM), as the data presented can be influenced by the quality of the information recorded on death certificates.

CONCLUSION

This study shows the differences in the trends of premature mortality due to CNCDs among the DRSs in the state of São Paulo, evidencing that schooling had an inverse relationship with the number of premature deaths due to CNCDs: the better the access to education, the higher the chances of better managing the disease.

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Although it did not present a statistical relationship in the trend analysis, the income variable also exerts a major impact when comparing the *per capita* GDPs of the DRSs and the premature mortality trend. Finally, the need to strengthen actions aimed at the effective management and control of modifiable risk factors for better monitoring and outcome of a CNCD condition is highlighted.

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Authors' contributions

Conceptualization, HNSP and SCSAU; methodology, Pereira HNSP and SCSAU; software, HNSP and SCSAU; validation, HNSP and SCSAU; formal analysis, HNSP and SCSAU; investigation, HNSP and SCSAU; resources, HNSP and SCSAU; data curation, HNSP and SCSAU; manuscript writing, HNSP and SCSAU; manuscript review and editing, HNSP and SCSAU; visualization, HNSP and SCSAU; supervision, HNSP and SCSAU; project administration, HNSP and SCSAU; financial aquisition, HNSP and SCSAU. All authors have read and agreed to the published version of the manuscript.