MEASURES TO REDUCE THE IMPACT OF SMOKING ON MORTALITY RATES FROM CARDIOVASCULAR DISEASES: SYSTEMATIC LITERATURE REVIEW

MEDIDAS PARA REDUÇÃO DO IMPACTO DO TABAGISMO NOS ÍNDICES DE MORTALIDADE POR DOENÇAS CARDIOVASCULARES: REVISÃO SISTEMÁTICA DE LITERATURA

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ABSTRACT

Introduction: The prevalence of smoking and its health risks remain high. Considered a predictor for cardiovascular diseases, health interventions and policy changes regarding tobacco consumption are increasingly necessary to reduce morbidity and mortality in the population.

Aims: To identify the measures used to reduce smoking impact on mortality from cardiovascular diseases.

Materials and Methods: Systematic review study using PubMed, SciELO and VHL databases to search for studies published from 2017 to 2022. The search was conducted considering the terms *"cigarettes"*, *"smoking"*, *"heart disease"*, *"mortality"*, *"rates"* and "*reduce*". The article's quality was assessed using the Study Quality Assessment Tool from the Department of Health and Human Services (NHLBI).

Results: A total of 29 studies were identified; 13 studies were eligible and included. The most prevalent ischemic and non-ischemic cardiovascular diseases associated with smoking were coronary heart disease, ischemic heart, stroke and heart attack. The increase in cigarette taxes and tobacco products, the use of pictorial warning labels on cigarette packaging, implementation of the Tobacco Control Law were the measures that demonstrated a significant reduction in mortality rates from cardiovascular diseases associated with smoking, followed by initiatives of public health and health education and prevention. **Conclusion**: Economic measures, especially those that attributed an increase in the price of cigarettes and tobacco-related products, educational and public health initiatives positively impacted the reduction of smoking, and minimization of morbidity, mortality of individuals from cardiovascular diseases and health expenses.

Keywords: tobacco; cardiovascular disease; morbidity; mortality; health impact assessment.

RESUMO

Introdução: A prevalência do tabagismo e seus riscos à saúde permanecem elevados. Considerado um preditor para doenças cardiovasculares, intervenções em saúde e mudanças nas políticas de consumo de tabaco são cada vez mais necessárias para reduzir a morbimortalidade da população.

Objetivos: Identificar as medidas utilizadas para reduzir o impacto do tabagismo na mortalidade por doenças cardiovasculares.

Materiais e Métodos: Estudo de revisão sistemática utilizando as bases de dados PubMed, SciELO e BVS para busca de estudos publicados de 2017 a 2022. A busca foi realizada considerando os termos "cigarettes", "smoking", "heart disease", "mortality", " taxas" e "reduzir". A qualidade do artigo foi avaliada por meio do Study Quality Assessment Tool do Departamento de Saúde e Serviços Humanos (NHLBI).

Resultados: Foram identificados 29 estudos; 13 estudos foram elegíveis e incluídos. As doenças cardiovasculares isquêmicas e não isquêmicas mais prevalentes associadas ao tabagismo foram as doenças coronarianas, isquêmicas do coração, acidente vascular cerebral e infarto. O aumento dos impostos sobre os cigarros e produtos derivados do tabaco, o uso de rótulos de advertência pictóricos nas embalagens dos cigarros, a implementação da Lei de Controle do Tabaco foram as medidas que demonstraram redução significativa nas taxas de mortalidade por doenças cardiovasculares associadas ao tabagismo, seguidas de iniciativas de saúde pública e educação e prevenção em saúde. Conclusão: Medidas econômicas, principalmente aquelas que atribuem aumento no preço dos cigarros e produtos relacionados ao tabaco, iniciativas educativas e de saúde pública impactaram positivamente na redução do tabagismo e na minimização da morbidade, mortalidade de indivíduos por doenças cardiovasculares e gastos com saúde.

Palavras-chave: tabaco; doença cardiovascular; morbidade; mortalidade; avaliação

de impacto na saúde.

1   INTRODUCTION

In the last decades, literature has shown a constant association between smoking habits and chronic diseases, such as cardiovascular diseases [1-3]. According to the World Health Organization (WHO), tobacco is considered to be the cause of 10% of all cardiovascular disease cases, and 12% of all annual death cases among over 30 years of age individuals worldwide [3].

Considered a risk factor to cardiovascular diseases, such as coronary disease, cerebrovascular and atherosclerotic disease, and population mortality [3], tobacco, a persistent smoking habit, also increases acute myocardial infarction recidivism risk and sudden cardiac death among individual with prior arterial disease [2,3]. Another important tobacco related aspect is the irreversibility of the clinical condition in some specific health conditions, even if the individual has stopped smoking [4].

Time of consumption and the intensity of smoking habits are directly related to major cardiovascular disease risk. The eminent and incident atrial fibrillation risk is an example directly associated to the years of tobacco exposure and consumption. Systematic review study identified that the incident atrial fibrillation risk was considerably larger in heavy smokers' groups. (> 15 g/day of tobacco) when compared to light and moderate smokers (1–14 g/day). Another finding in this study was the resemblance on the atrial fibrillation (AF) recurrence rate a year after cardioversion of persistent atrial fibrillation and catheter ablation of AF among current smokers (58% vs. 61%) and ex smokers (47% vs. 40%)[4].

Smoking is also indirectly related to cardiovascular diseases. For example, patients with chronic obstructive pulmonary disease (COPD), who in short, have at least one comorbidity and cardiovascular disease risk factors [5]. According to Sin et al.[6], 50% of hospitalizations and 20% of COPD patients cause of death are due to

cardiovascular diseases. Smoking, dyslipidemia and depression are the most prevalent cardiovascular disease risk factors in light/moderate COPD patients [5].

Given the recognition of cardiovascular diseases associated with smoking risks, attempts to reduce/cease smoking and therefore experience sustained absence are becoming increasingly common. In this scenario, individuals are securely seeking Reduced Risk Tobacco Product (RRP) as an alternative to reduce possible morbidity and mortality risks in the future [7]. Recent study performed by Lee and collaborators [8], tried to predict health impacts of America's population by introducing a specific product in the market, known as Reduced Risk Tobacco Product (RRP). Regardless of the population's smoking habits, one of the effects observed with the introduction of the RRP was the reduction in the number of deaths in men and women, and in the health risks of individuals considered smokers. On the other hand, a risk, albeit minimal, was observed that the use of RRP will increase the rate of former smokers who return to smoking or decrease the rate of smokers who stop smoking [8].

Overall, the close relationship of the world population with tobacco use still reflects a low concern for health, as rates of heart disease remain high and the experiences of cardiac complications that are still happening do not promote changes in lifestyle or behavior related to tobacco consumption. In addition to health damage, smoking has a negative impact on the world economy [5]. Health interventions and policy changes concerning tobacco consumption are necessary to reduce cardiovascular morbidity and mortality [4]. Therefore, the aim of this study was to investigate and understand measures used to reduce the impact of smoking on cardiovascular diseases mortality.

2   METHODS

Study design

Systematic literature review study registered in PROSPERO, international systematic review database in health and social assistance of *Center for Reviews and Dissemination of Universidade de York*.

Search strategy

Three online databases were selected to participate in this study: Pubmed/Medline, *Scientific Eletronic Library Online (*SciELO) and Biblioteca Virtual em Saúde (BVS). With a controlled vocabulary in the search strategy in each of the bibliographic databases, Pubmed/Medline (*MeSH terms*), SciELO (*DeCs terms*) e BVS (*DeCs terms*), the following therms were used: *"cigarettes", "smoking, "heart disease", "mortality"*, *"rates"*, "*reduce*" as their synonyms and combinations.

Study selection

The following interrogative was made to accomplish this literature review research: What are the possible ways to reduce the impact of smoking on cardiovasculardiseases mortality rates?

The study population included adults or elderly people diagnosed with some type of cardiovascular disease. The intervention studied was smoking. A comparison group was not needed. The following outcome was necessary: some measure or implication to reduce the impact of smoking on cardiovascular disease mortality rates in adult or elderly smokers. Those results include both quantity and quality results (**Table 1**).

Table 1. Elegibility criterea PICOT.

PICOT interrogative	What are the possible ways to reduce the impact of smoking on cardiovascular diseases mortality rates?
Population	adults and/or elderly people diagnosed with some type of cardiovascular disease
Intervention	Smoking
Comparison	-
Outcome	The study reported some measure or implication to reduce the impact of smoking on cardiovascular disease mortality rates in adult or elderly smokers. These include quantitative and qualitative results.
Type of study	Experimental and observational.

All studies identified by the initial research on the databases were filed in a database in Excel software (Version 16.4). The following eligibility criteria were

adopted: (1) studies published in the last 5 years (2017 to March 2022); (2) studies without age restriction or a specific age group within the adult or elderly population; (3) studies without restriction cardiovascular disease type in adults or the elderly; (3) studies without country of origin restriction; (4) studies in English and Portuguese; (4) studies that included the assessment of the impact of smoking on cardiovascular diseases; (5) studies that analyzed at least one measure or implication to reduce the impact of smoking on mortality rates in adult or elderly smokers with cardiovascular disease; and (6) gray literature, case series, case studies, proceedings and conference abstracts, study protocols, comment articles, letters to editors and policy briefs were excluded. By the end of this process, the full texts of the studies considered potentially relevant and independently selected by three study authors were obtained for final inclusion or exclusion based on the present criteria. The quality evaluation tools from the study of the *Department of Health and Human Services*[10] were used to evaluate the quality of included articles.

Stage 1: identification of the articles by electronic database research.

The electronic database research was made by two independent reviewers. Posteriorly, the titles and identified study abstracts were independently evaluated as to suitability for the aims of the research. Were excluded the studies that did not approach the incidence of infectious and contagious bacterial diseases. Disagreements were resolved by consensus between the two reviewers, or by a third reviewer when necessary. Duplicate studies were removed.

Stage 2: Eligibility assessment of full-text articles

Studies selected according to eligibility criteria were read in full text. Throughout the selection process, uncertainties were discussed among the authors until a consensus was reached. In the different phases of the systematic review, a flow of information is originated. As for information related to eligibility, studies that did not specifically address possible explanations for the increase in infectious diseases during the pandemic were excluded.

Assessment of the methodological quality of the reviewed articles was performed using the quality assessment tools available from the *US Department of Health and Human Services*[10].

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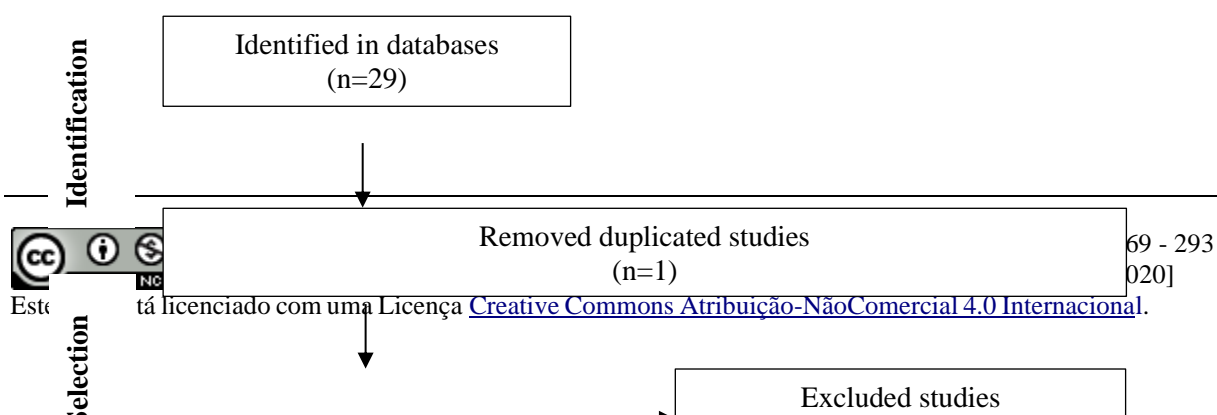**Stage 3: studies included in the qualitative synthesis**

The number of articles identified, screened, assessed for eligibility and included in this review were recorded, as were the reasons for exclusion. The characteristics (location, design, sample size, methods, results and conclusions) of each study were recorded and summarized. The methodology of the studies and the measures of evaluation of the results were varied, therefore it was chosen to carry out a qualitative synthesis, instead of combining the data in a meta-analytical statistical approach.

This systematic review was performed based on the guidelines proposed by the *Preferred Reporting Items for Systematic Reviews* (PRISMA)[11] A flowchart with the different phases of a systematic review, and the description of information regarding thenumber of articles identified, included and excluded and the reasons for exclusions, originated in this review (**Figure 1**).
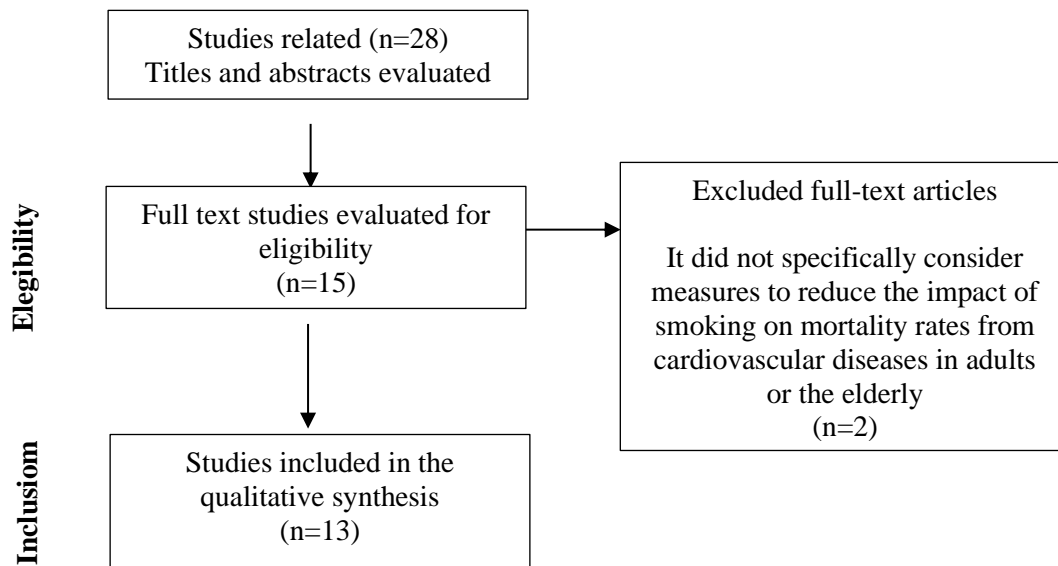
3   RESULTS

According to the electronic search, a total of 29 references were found in 3 different databases: 11 (PubMed/Medline), 14 (BVS) and 4 (SciELO). After excluding 1 duplicate reference, 28 references were selected for eligibility assessment. After reading the titles and abstracts (n=28), a total of 13 studies were excluded because they did not meet the pre-established criteria (**Figure 1**).

The full text of the remaining 15 articles was evaluated for eligibility, and 2 articles were excluded for the following reasons: one study investigated the efficacy of nicotine dose titration from transdermal patch use in the treatment of smokers; a study specifically aimed at the prevalence of comorbidities and risk factors in patients with COPD. At the end of the entire process, 13 articles were selected for inclusion in this review (**Figure 1**).

Identified in databases
(n=29)

Identification

Removed duplicated studies
(n=1)

69 - 293
020]

Selection

Excluded studies

Figure 1 - Flowchart with the systematic review phases (PRISMA)

Table 2 presents the characteristics of the selected articles. These articles were analyzed in terms of objective, study design, population studied, smoking-related data, smoking-related cardiovascular consequences, measures to minimize smoking-related risks, especially mortality, and health promotion actions. Quantitative methodology was predominant among the included studies, 12 of which were observational [1,2,7,8,12-19] and 1 clinical trial [20]. The studies were accomplished in different countries, most frequently in the United Kingdom (n=3)[12,17,18] followed by the United States of Americas (USA) (n=2)[7,8] and Russia (n=2)[2,20]. The remaining countries were Brazil [15], Chile [14], South Korea [19], Czech Republic [13], Norweg [1], Finland [16] with one study each.

Overall, the studies were primarily based on a population characterized by individuals of both sexes (male/female); adults and elderly of different age groups; smokers, ex-smokers and never-smokers as comparison groups; period and intensity of use/consumption of cigarettes and tobacco products; cardiovascular diseases and other types of diseases (example: cancer, COPD, among others) associated with smoking.

Smoking was evidenced as a life habit adopted by the population of the

studies and considerably one of the risk factors associated with the development of cardiovascular diseases. Among the main ischemic and non-ischemic cardiovascular diseases associated with smoking, the highest prevalence of coronary heart disease[2,14,15,17,18] ischemic heart[8,14,15,19,20], stroke[8,14,17,18], heart attack (myocardial infarction)[7,12,14], congestive heart failure, arterial embolisms[12], atherosclerosis[12] e Heart rate variability (HRV) associated with several pathologies, including cardiac mortality[16]. One study evaluated the interactions of smoking with non-tobacco risk factors. Body mass index, waist/hip ratio, diabetes mellitus, hypertension, glucose, insulin, high and low density lipoproteins and total cholesterol were the factors identified and considered as etiological and biological mechanisms cardiovascular diseases risk[18].

Regarding the measures adopted to reduce the impact of smoking on mortality rates from cardiovascular diseases, an increase in taxes on cigarettes and tobacco products was observed [14,15,17], introduction of pictorial warning labels (PWLs) on cigarette packaging [19],and Reduced Risk Tobacco Product (RRP) in market for smokers consumption [8], implementation of Tobacco Control Law (TCL)[20], changes in attitudes towards tobacco use in individuals who have had a recent myocardial infarction [7], and preventive strategies for the population of female smokers due to the risk of heart disease and mortality due to the specific findings of the study [1]. As with King et al. [12], studies based on their findings generally propose public health initiatives that highlight the severe damage caused by the intensity of smoking and the potential benefits when reducing or, ideally, quitting smoking [2,12,13,16,18].

All included studies were analyzed using the *Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies (U.S. Department of Health & Human Services)* and had sufficient information to determine that the risk of allocation bias was low for more than half of the studies (**Table 3**).

Table 2-Studies characteristics included in the systematic review.

Study (Reference)	Place	Population	Cardiovascular and other diseases associated with smoking	Measures to reduce smoking and health promotion	Results
Lee et al.[8] (2017)	USA	-Men and women, between 10 and 79 years of age, smokers, ex-smokers and non-smokers. -Population health impacts modelation with USA populationaldatabase from 1990 to 2010.	- Ischemic heart disease and stroke. - Chronic obstructive pulmonary. - Lung cancer.	- Reduced Risk Tobacco Product (RRP) was introduced in the market and its impact on population health was predicted.	- RRP reduces effective dosage by 80% in conventional smokers and 40% in double users(cigar and RRP). -Was not observed a clear reduction in the death numbers associated with RRP introduction.
Lubin et al.[18] (2017)	UK	-Men and women, between 45 and 64 years of age, smokers(evaluated by cigars/day and years/pack) and ex-smokers (years since the last time they smoked).	Cardiovascular disease, which encompasses coronary heart disease and stroke. The occurrence of hypertension, diabetes and cholesterolemia.	- No specific measure. -Evaluation of smoking interactions with non-tobacco risk factors, including additive (non-synergistic) and multiplicative (synergistic) and cardiovascular diseases. - We used data from the Prospective Atherosclerosis Risk in Communities Study of participants recruited from 1987-1989 in four different areas of the United States and followed up to 2008.	- The associations for cigarette smoking and non-tobacco risk factors were distinct and considered as etiological factors and biological mechanisms: body mass index, waist/hip ratio, diabetes mellitus, glucose, insulin, high-density lipoproteins; and hypertension, total cholesterol, low-density lipoproteins. This association may help to better define the public health burden of smoking on cardiovascular disease risk.
Kang E[19] (2017)	South Korea	- Men and women with age >/= 19 , smokers, ex-smokers and non-smokers. - Demographic and epidemiological data were obtained in populational database.	- Ischemic heart disease and stroke. - Diabetes, chronic obstructive pulmonary disease, lung and oral cancer.	- Introduction of pictorial warning labels (PWLs) on cigarette packaging.	PWLs introduction over the years could lead to smoking reduction and therefore, prevent cases of diabetes, chronic obstructive pulmonary disease, ischemic heart disease, lung cancer, and oral cancer.
Takano et al.[17] (2018)	UK	- Men, women, adults of different age groups and smokers. - Population database extracted from the UK National Health Service program with epidemiological	- Coronary heart disease, chronic obstructive pulmonary disease stroke Cancer (acute myelogenous leukemia, bladder, cervical, chronic myelogenous leukemia, colorectal,	- Increasing the existing cigarette tobacco duty escalator (TDE) in the UK from the current 2% above consumer price inflation to 5%.	- Reduction in the prevalence of smoking from approximately 10% to 6% in the UK, which could prevent 75,200 cases of disease over the next

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		parameters, data on 17 different types of smoking-related illnesses and disease budget costs.	gallbladder, kidney, laryngeal, liver, lung, esophageal, oral, ovarian and pancreatic).		twenty years, and reduce healthcare costs.
Gaalema et al.[7] (2018)	USA	- Men and women with age >/= 18 , smokers, ex-smokers and non-smokers. - Data were obtained from the first and second waves of the Population Assessment of Tobacco and Health study.	-High cardiovascular disease group: no chronic condition, high blood pressure/cholesterol, heart attack (myocardial infarction) and new heart attack (myocardial infarction).	- No specific measure. - Estimate the use of and attitudes towards tobacco products as a function of the level of cardiac risk. - Explore changes in attitudes and tobacco use among adults who have had a recent myocardial infarction.	- Populations who had lifetime myocardial infarction were more likely to believe that smoking and using tobacco products was causing a health problem and promoting a worsening of their health. - Populations with recent myocardial infarction were associated with increased tobacco-related risk and with reduction and cessation attempts.
Gambaryan et al.[20] (2018)	Russia	- A synthetic control was created as a comparator, using data from a weighted combination of populations from other countries that are similar in observable characteristics, but that have not implemented the Tobacco Control Law as comprehensively as Russia.	- Acute circulatory diseases including ischaemic heart disease.	- Implementation of Tobacco Control Law (TCL) on the reduction of hospital discharge due to rates of acute circulatory diseases.	- Comprehensive tobacco control has promoted a reduction in tobacco consumption and smoking-related cardiovascular disease morbidity. Smoking-related deaths may need a longer post-intervention period to be detected.
Pinto et al.[15] (2019)	Brazil	- Demographic population data obtained through the population projection for 2015 from the Brazilian Institute of Geography and Statistics. - The parameters used were supported by the Brazilian demographic structure and individualrisk of death by cause, age (35 - 100 years) and sex (men and women), andthe prevalence of smoking.	- Ischemic and non-ischemic heart disease, chronic obstructive pulmonary disease, pneumonia, influenza, stroke, cancer (lung, mouthand pharynx, esophagus, stomach, pancreas, kidneys and renal pelvis, larynx, bladder, cervix and myeloid leukemia) .	-Increase in cigarette prices throughtaxes.	- The increase in taxes by a 50% increase in the price of cigarettes may be able to prevent deaths, illness from cardiovascular diseases, cancer and stroke, and reduce costs to society due to smoking.

Arkhipova et al.[2] (2019)	Russia	- Men and women, between 60 - 90 years of age, smokers, ex-smokers and never smoked, diagnosed with chronic coronary artery disease and of different ethnicities (indigenous and non-indigenous).	- Chronic coronary artery disease.	- No specific measure. - Prevalence and intensity analysis of smoking and its correlation with other risk factors for chronic coronary artery disease in patients with chronic coronary artery disease.	- A smoking rate, greater than 25 pack/year is observed in both ethnic groups, being 1.5 times more common in non-indigenous patients. - Risk factors associated with smoking: blood lipids, blood pressure, body mass index and abdominal obesity. Dependent relationship between myocardial infarction and smoking history.
Murgia et al.[16] (2019)	Finland	- Population-based study composed of adult men and women (age range 18–93 years), smokers, former smokers and never smokers and presence/absence of hypertension, history of cardiovascular events, and diabetes.	- Heart rate variability (HRV), associated with several pathologies, including cardiac mortality. - Cardiometabolic risk factors as potential confounders: body-mass-index, hypertension, diabetes, history of cardiovascular events, and physical activity.	- No specific measure. - The effects of multiple dimensions of smoking on cardiac autonomic function using HRV metrics in a large general adult population sample.	- Former smokers had higher levels of HRV than those who never smoked. For smokers, greater smoking intensity (grams of tobacco/day) can gradually impair HRV. - Smoking status and intensity were associated with HRV regardless of the most common cardiometabolic conditions.
King et al.[12] (2020)	UK	- UK Biobank data from men and women white smoker patients, between 39 and 73 years of age.	- Circulatory disease: atherosclerosis, myocardial infarction, congestive heart failure, arterial embolisms - Respiratory diseases: pneumonia, emphysema, obstructive chronic, bronchitis, pleurisy, pulmonary collapse, respiratory failure. - Cancer, renal failure, septicaemia, and retinal disorders.	- Based on the findings of the study, public health initiatives were proposed that highlight the harm caused by the intensity of smoking and the potential benefits of reducing or, ideally, quitting smoking.	- Genetic data from patients demonstrate the adverse health impacts caused by the intensity of smoking and increased risk of various diseases. - Every cigarette smoked a day substantially increases the chances of respiratory and circulatory diseases.
Cifkova et al.[13] (2020)	Czech Republic	- Men and women, age group 25 - 64 years and smokers (use of at least one cigarette per day). - 1% population sample within each district (n=6) was selected from the	Cardiovascular risk factors: obesity, hypertension and dyslipidemia.	- No specific measure. - Avaliação dos principais fatores de risco para doenças cardiovasculares na República Tcheca ao longo do tempo	- Decreased prevalence of smoking among men; control of hypertension and decrease of total cholesterol among men and women.

				(1985 a 2016/17), cobrindo a transiçãodo regime totalitário para a democracia.	- Significant improvement in mostrisk factors over the years and decrease in mortality from cardiovascular diseases (more than60% in both genders).
		National Population Register or Health Insurance Company registry.			
Riquelme et al.[14] (2020)	Chile	-Mathematical model used to estimate the probabilities of people getting sick or dying from conditions associated with smoking. Data were derived from Chilean national health evidence and statistics. The population included adult women andmen aged between 35 and 100 years old, smokers, former smokers and never smokers.	- Coronary and non-coronary heart disease, cerebrovascular disease. - Chronic obstructive pulmonary disease, pneumonia. - Lung, mouth, larynx, pharynx, esophagus, stomach, pancreas, kidney, bladder and cervix cancer, and leukemia.	-Increase in cigarette prices throughtaxes.	- A 50% increase in cigarette and tobacco products price could prevent13,665 deaths and 360,476 disability-adjusted life-years fromdiseases caused by smoking in 10years, in addition to savings in healthcare costs and increased taxrevenue.
Hall et al.[1] (2022)	Norway	- Patient database from four large randomized clinical trials. - Male, female, adult and elderly patients, smokers and never smokers at high risk for myocardial infarction.	- Myocardial infarction.	- Proposed preventive strategies for women as a result of the study findings. - Investigated the association of smoking with hospitalizations and deaths of patients at high risk of myocardial infarction.	- The impact of smoking on hospitalization was greater in women. - Men had a higher risk of mortality. - The risk of adverse outcomes wasincreased for smokers in most age and sex groups investigated. The influence of smoking on morbiditydiffered according to sex.

Abreviations: UK, United Kingdom; USA, United States of America; Heart rate variability, HRV; Pictorial warning labels, PWLs; Tobacco duty escalator, TDE; Reduced Risk Tobacco Product, RRP; Pictorial warning labels, PWLs; Tobacco Control Law, TCL.

Table 3- assessment U.S. of Health & Services).

Study quality (Tool from Department Human

Criteria – Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies	Lee et al. (2017)	Lubin et al. (2017)	Kang E (2017)	Takano et al. (2018)	Gaalema et al. (2018)	Gambaryan et al. (2018)	Pinto et al. (2019]	Arkhipovaa et al. (2019)	Murgia et al. (2019)	Cifkova et al. (2020)	Riquelme et al. (2020)	Hall et al. (2022)
1. Was the research question or objective in this paper clearly stated and appropriate?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
2. Was the study population clearly specified and defined?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NR
3. Was the participation rate of eligible persons at least 50%?	YES	YES	YES	YES	YE	YES	YES	YES	YES	YES	YES	NR
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

uniformly to all participants?												
5. Was a sample size justification, power description, or variance and effect estimates provided?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NR
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?	NA	YES	YES	YES	YES	YES	YES	YES	YES	YES	NA	YES
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	NA	YES	YES	NA	YES	YES	YES	YES	YES	YES	NA	YES
10. Was the exposure(s) assessed more than once over time?	NA	YES	YES	NA	YES	YES	YES	YES	YES	YES	YES	NA

11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	NA	YES	YES	NA	YES	YES	YES	YES	YES	YES	YES	NA
12. Were the outcome assessors blinded to the exposure status of participants?	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
13. Was loss to follow-up after baseline 20% or less?	NA	YES	YES	NA	YES	NR	NR	NR	NA	NA	NR	NA
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	NA	YES	YES	NA	YES	YES	NA	YES	YES	NR	NR	NA
Score	7 fair	13 good	13 good	8 fair	13 good	12 good	11 good	12 good	12 good	11 good	9 fair	6 poor
Criteria – Quality Assessment of Case-Control Studies	King et al. (2020)	-	-	-	-	-	-	-	-	-	-	-
1. Was the research question or objective in this paper clearly stated and appropriate?	YES	-	-	-	-	-	-	-	-	-	-	-
2. Was the study population clearly specified and defined?	YES	-	-	-	-	-	-	-	-	-	-	-
3. Did the authors include a sample size justification?	YES	-	-	-	-	-	-	-	-	-	-	-
4. Were controls selected or recruited from the same or similar population that gave	YES	-	-	-	-	-	-	-	-	-	-	-

rise to the cases (including the same timeframe)?													
5. Were the definitions, inclusion and exclusion criteria, algorithms or processes used to identify or select cases and controls valid, reliable, and implemented consistently across all study participants?	YES	-	-	-	-	-	-	-	-	-	-	-	-
6. Were the cases clearly defined and differentiated from controls?	YES												
7. If less than 100 percent of eligible cases and/or controls were selected for the study, were the cases and/or controls randomly selected from those eligible?	YES	-	-	-	-	-	-	-	-	-	-	-	-
8. Was there use of concurrent controls?	YES	-	-	-	-	-	-	-	-	-	-	-	-
9. Were the investigators able to confirm that the exposure/risk occurred prior to the development of the condition or event that defined a participant as a case?	NR	-	-	-	-	-	-	-	-	-	-	-	-
10. Were the measures of exposure/risk clearly defined, valid, reliable, and implemented consistently (including the same time period) across all study participants?	NR												
11. Were the assessors of													

Legend: YES = determine = 0; applicable = 0; reported = 0.	exposure/risk blinded to the case or control status of participants?	NA	-	-	-	-	-	-	-	-	-	-	-	1; CD, cannot NA, not NR, not
	12. Were key potential confounding variables measured and adjusted statistically in the analyses? If matching was used, did the investigators account for matching during study analysis?	NR	-	-	-	-	-	-	-	-	-	-	-	
	Score	8 fair												

4 DISCUSSION

According to the characteristics of the 13 articles included, it was possible to observe that ischemic and non-ischemic cardiovascular diseases are the main causes of death associated with smoking in the world population. The measures used to reduce the impact of smoking on mortality from cardiovascular diseases were economic, educational and public health initiatives. The taxes increase on cigarettes and tobacco products were measures observed in three studies [14,15,17]. One study considered the introduction of pictorial warning labels (PWLs) on cigarette packaging[19], one study attributes the analyzes to the implementation of the Tobacco Control Law[20], and Reduced Risk Tobacco Product in the market for the consumption of smokers was the measure used in one study [8]. Posteriorly, five studies emphasized public health initiatives aimed at the severe harm caused by the intensity of smoking and the potential benefits obtained from the reduction or cessation of smoking. [2,12,13,16,18], one study specifically looked at behavior change regarding tobacco use in individuals with prior cardiovascular disease [7], and one study prevention strategies [1].

Based on the findings of the present study, it is noted that in today's society, taxation on tobacco products has been one of the main ways to reduce smoking and, consequently, avoid its damage, which is often devastating to the health of the population and a country's economy [14,15,17]. In the UK apolicy called *tobacco duty escalator* (TDE)was criated, which raises tobacco products 5% above consumer price inflation. Thus, a survey with longitudinal projections from 2015 to 2035 sought to verify a possible reduction in smoking from the implementation of the TDE and estimated a 6% decrease in the prevalence of smoking among adults in 2035. After the sustained increase in the TDE, 65% of women and 60% of men smokers would continue to be active smokers in 2035. The results seen through this projection show that itwould be possible to avoid in the period from 2015 to 2035 about 75,200 new cases of smoking-related diseases and savings to the United Kingdom's coffers of 192 million pounds in social costs of premature mortality and morbidity [17.]

It is known that 15% of the total expenditure attributed to the health sector in some countries is on health care for the population, and 8.3% of this total is equivalentto the expenditure of seven Latin American countries [21]. In Chile, smoking

is associated with an estimated 16,742 deaths, 11,386 of myocardial infarction and other cardiovascular events, 4,761 of strokes and 9,113 new cases of cancer [14]. Based on these health data, Riquelme et al. [14] seek to describe the diseases, mortality and medical costs associated with tobacco in Chile through a 50% increase in taxation on tobacco consumption. The results showed that this measure reduces the prevalence of smoking between 2010 (40.6%) and 2017 (33.3%), and could prevent 13,665 deaths and 360,476 disability-adjusted life-years (DALYs) from diseases caused by smoking in 10 years, in addition to significant savings in health care costs and increased tax collection [14].

Brazil, despite the National Tobacco Control Policy, is still among the leading countries in the number of smokers, and according to 2011 data, the number of diseases associated with smoking remains high, accounting for 147,000 deaths and 23, 37 billion reais of annual cost to the health system [22]. Pinto et al. [15] A study was made with the objective of estimating in 2015 the possible impact of smoking on health outcomes and the economy of Brazil with a 50% increase in cigarette prices. The data showed that 136,482 deaths, 507,451 cardiovascular diseases cases, 64,382 cases of cancer, 100,365 strokes could be avoided and an economic benefit of R$ 97.9 billion to the health system [15].

In addition to Brazil and other countries in the world, Russia also has the Tobacco Control Law (TCL) implemented comprehensively in the year 2013 and with results of a relevant decrease of 21.5% in the prevalence of smoking in adults in the year 2016 when compared to the year 2016. year 2009. Therefore, Gambaryan et al. [20], were the first researchers to investigate the effects of tobacco control policy on reducing hospital discharge rates for acute circulatory diseases in Russia during the period 2003-2015. The findings could elucidate that comprehensive tobacco control was able to promote a reduction in consumption and morbidity from cardiovascular diseases. However, to detect clearer and more accurate results regarding the effective decrease in smoking related to mortality rates, a longer post-intervention evaluation period is necessary [20].

Another alternative verified in some countries was the use of pictorial warning labels (PWLs) on cigarette packaging [19]. In South Korea, for example, Kang E [19] conducted a study to predict the impact of the introduction of PWLs in 2016 on the

prevalence of smoking over a 10-year period. To meet the objective of the study, a tool was developed capable of quantifying exposures to health risks and their impacts from the analysis of demographic and epidemiological data obtained from the population database. In an optimistic context, the results showed that PWLs could reduce the smoking rate by 4.79% in men and 0.66% in women when compared to the baseline scenario in 2017, and prevent 85,238 cases of diabetes, 67,948 of COPD, 31,526 from ischemic heart disease, 21,036 from lung cancer, and 3,972 from oral cancer over 10 years due to reduced smoking prevalence among men and women in Korea [19].

Another relevant point to be considered is related to smoking as one of the main risk factors for the development of cardiovascular diseases and mortality from these diseases [23]. In addition to this context, smoking is a major predictor of future morbidity and mortality rates in people already suffering from cardiovascular diseases, especially a potential direct relationship with biochemical, genetic and environmental factors. Therefore, smokers, for example, who continued to smoke after myocardial infarction are substantially more likely to die as a result of this habit/lifestyle. This group of individuals are often motivated to quit smoking, however, continued abstinence is challenging and most return to smoking within an average time of just 19 days after hospitalization [7].

A systematic review and meta-analysis study investigated the association between smoking and the risk of developing heart failure. Findings from the 26 prospective studies included, suggested a 75%, 16% and 44% increase in the relative risk (RR) of developing heart failure among current, former and ever smoking individuals, respectively, when compared with never smokers. In the comparison of current smoking with non-current smoking, a 59% increase in the RR of developing heart failure was evidenced. In the analysis of the association between smoking cessation time and the risk of heart failure, a significant association was observed from 15 years of smoking cessation, and at 30 years the RR was 0.72 (95% CI: 0 .57-0.90). The findings lead to a reflection on the importance of additional support for public policies and health interventions capable of reducing the prevalence of current smokers, as well as preventing more people from starting to smoke, since smoking is a direct factor in the development of cardiovascular diseases. and increase in death

rates [23].

This study had some limitations. This is a systematic review; although the research was developed within the guidelines proposed by PRISMA, the main search strategy was more specific and, together with the selection criteria, articles may have been lost. For the literature search, the descriptors *"rates"* and *"reduce"* were used. Although *"rates"* and *"reduce"* are well-defined terms in publications related to the topic under study, they are outside the controlled vocabulary, and therefore it was difficult to predict synonyms. Overall, the studies were heterogeneous in terms of results and study design, but they had enough information to determine the assessment of methodological quality and a low risk of allocation bias for more than half of the studies (92%). More studies are needed to better characterize the measures assigned in the search to reduce smoking and its impact on mortality from cardiovascular diseases.

5   CONCLUSION

The economic, educational, and public health initiatives measures adopted to reduce smoking had a direct impact on aspects related to health and the economy of a country, since with the prevalence of smoking reduced, the incidence of cardiovascular diseases and deaths are consequently also reduced, such as a country's health and social support costs to these individuals. The increase in cigarette prices and taxes attributed to tobacco products demonstrated a significant reduction in the prevalence of smoking, minimizing morbidity, mortality, disabled individuals, and health care expenses.

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