

Trajectories of non-communicable diseases according to sex, between 2005 and 2019

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Abstract:

Introduction. Non-communicable diseases are the leading causes of death worldwide and are considered a global epidemic due to their high mortality rate.

Objective. To evaluate the trajectory of noncommunicable disease in Guatemala, according to sex.

Methodology. Retrospective study to analyze the evolution of mortality from noncommunicable diseases between 2005 and 2019. Five large mortality groups were created, based on the 10th International Classification of Diseases: Cardiovascular, Central Nervous System, Chronic Respiratory, Metabolic, and Neoplastic Diseases. The Joinpoint Regression Program was used to evaluate mortality trajectories.

Results. Among men, all disease groups showed a statistically significant trend of increases during a large part of the study period. Mortality due to cardiovascular, central nervous, and chronic respiratory diseases was higher in men. Women also showed a positive trend during most of the first half of the study period. Mortality due to metabolic and neoplastic diseases was higher in women.

Conclusions. In Guatemala, non-communicable diseases are still an important public health problem for both sexes.

Keywords: Non-communicable diseases, mortality, sex trends, trajectory analysis, Joinpoint regression program

Introduction:

Non-communicable diseases (NCDs) are conditions recognized as not caused by acute infections but associated with long-term health consequences. These conditions include cardiovascular diseases (i.e., coronary heart disease and stroke), cancer, diabetes, and chronic respiratory diseases. As the leading global cause of death, NCDs represent a public health epidemic, affecting millions of people annually and posing significant challenges to healthcare systems worldwide.

A recent report by the World Health Organization (WHO) focused on global NCD trends through 2019, according to which they contribute 70% of deaths worldwide. Three-quarters of NCD deaths, as well as 86% of the 17 million people who die prematurely, i.e., before the age of 70, take place in low- and middle-income countries.

Globally, cardiovascular disease contributes the highest number of deaths from NCDs, with 17.9 million each year, followed by cancer with 9.0

million, chronic respiratory diseases with 3.9 million, and diabetes with 1.6 million.

Every two seconds, someone under 70 years old dies from NCDs. In 2021, over 43 million people worldwide died from NCDs, which accounted for 75 percent of deaths not related to pandemics. Three of the ten leading causes of death were linked to NCDs, including ischemic heart disease, stroke, chronic obstructive pulmonary disease, lung cancer, dementia, diabetes, and chronic kidney disease. Their effect on global health is often underestimated. However, globally and in all WHO regions, the likelihood of dying from any of the four main NCDs declined between 2000 and 2019.

Progress has slowed since 2015, the beginning of the Sustainable Development Goals era. The global rate of decline from 2015 to 2019 was more than halved compared to the first 15 years of the century. However, some countries have shown that this target is achievable: 19 individual countries and territories were estimated to be on track to meet the 2030 target. In high-income countries, where reliable data on NCD mortality is available, the risk of premature mortality from any of the four main noncommunicable diseases declined slightly between 2015 and 2019. Later, during the COVID-19 pandemic, those declines halted, however, and the risk plateaued.

In terms of gender, the risk for women of dying prematurely from NCDs is typically lower than it is for men. Some countries have achieved a risk of premature death from the four main NCDs of less than 6 percent among women. Women have also made more rapid progress in reducing the mortality risk from noncommunicable diseases^{1,2,3,4,5,6,7}.

The study aimed to evaluate the trajectory of five NCD groups in Guatemala, according to sex, between 2005 and 2019.

Methodology.

Retrospective study to evaluate the mortality trajectory from noncommunicable diseases in Guatemala, between 2005 and 2019. Data on mortality were obtained from the National Institute of Statistics (INE) and were disaggregated by calendar year and sex.

Five major groups of causes of mortality were created, using the 10th International Classification of Diseases (10-ICD) of the World Health Organization (WHO). Mortality was grouped as follows: Chapter II, Tumors (Neoplasia-codes C00-D48), IV Endocrine, nutritional and metabolic diseases (Metabolic-codes E00-E90), VI Diseases of the nervous system (ICD-codes G00-G99), IX Diseases of the circulatory system (CVD-codes I00-I99), and X Diseases of the respiratory system (Respiratory-codes J00-J99).

During the study period, 1,138,131 deaths from all causes were recorded; in 336,936 (29.6%) of these deaths, the basic cause of death was a noncommunicable disease, for which a database in Excel was elaborated and refined. The denominator for the specific rates by sex and calendar year, expressed by 100,000 inhabitants, was obtained from the population projections published by the National Statistics Institute (INE).

Mortality trajectories were evaluated using the Joinpoint Regression Program, which enables testing whether an apparent change in trend is statistically significant. Each join point denotes the Annual Percentage Change (APC) statistical change in trend. The program estimates it using a Monte Carlo Permutation Method, finding the best-fit line for each segment of the trend of interest^{8,9,10}. Statistical tests for trajectories were two-tailed, and statistical significance was assumed when the value of $p < 0.05$.

Results.

Table 1. Study population mortality rate, according to noncommunicable disease group, calendar year, and sex.

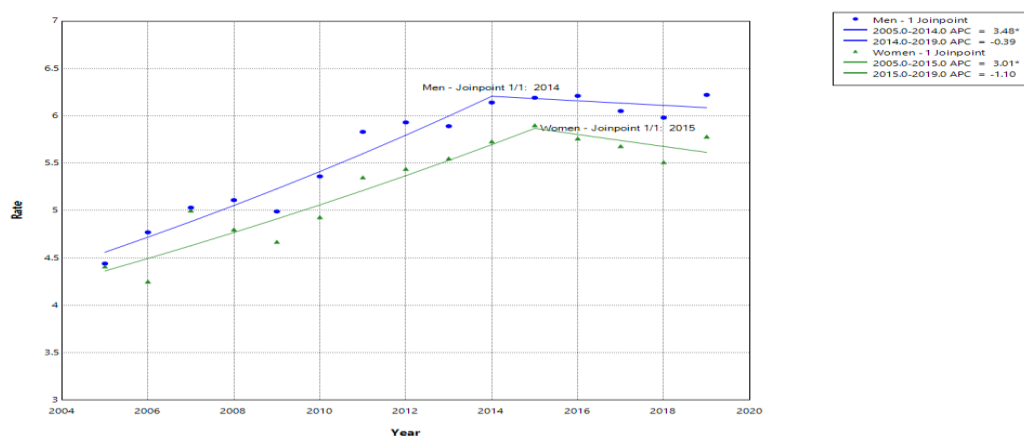
Group of Causes Year	Cardiovascular System		Nervous System		Respiratory System		Endocrine and Metabolic		Neoplasia	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
2005	44.4	44.1	3.0	1.9	6.7	6.5	19.3	25.1	46.6	52.5
2006	47.7	42.5	2.4	1.9	8.0	6.7	21.0	25.8	46.8	53.4
2007	50.3	50.0	2.5	1.9	8.7	7.0	19.7	27.8	46.9	54.7
2008	51.1	48.0	2.4	1.6	8.4	6.8	23.1	30.8	47.2	54.0
2009	49.9	46.7	2.6	1.8	7.3	7.1	25.4	34.1	49.1	57.3
2010	53.6	49.3	2.5	1.6	6.6	5.9	27.9	37.9	48.2	57.3

2011	58.3	53.5	2.6	2.1	7.2	7.4	26.6	39.0	46.7	55.3
2012	59.3	54.4	2.8	2.2	7.3	6.7	28.7	40.1	48.1	58.2
2013	58.9	55.5	2.4	1.9	7.1	6.8	29.9	42.0	48.2	57.5
2014	61.4	57.3	2.8	2.2	7.0	6.7	33.2	46.6	47.7	57.0
2015	61.9	59.0	2.5	2.0	8.3	7.2	32.8	46.6	47.7	55.4
2016	62.1	57.6	2.7	2.3	8.2	8.1	31.9	45.2	46.9	53.9
2017	60.5	56.8	2.5	2.0	8.2	7.7	32.0	45.9	46.5	54.5
2018	59.8	55.1	2.7	1.8	7.8	7.3	32.1	48.4	46.0	54.3
2019	62.2	57.8	2.6	1.9	8.1	7.2	34.8	50.0	46.2	53.5

Source: Estimation based on INE report.

Cardiovascular disease mortality trajectory in men presented a statistically significant positive trend, $\beta = 3.48$, $p < 0.05$, reaching its peak in 2014 and, thereafter, decreased, although without statistical significance, $\beta = -0.39$, $p > 0.05$. The trajectory among women was similar, with a peak in 2015, $\beta = 3.01$, $p < 0.05$, with a subsequent non-significant decrease, $\beta = -1.10$, $p > 0.05$. (Figure 1)

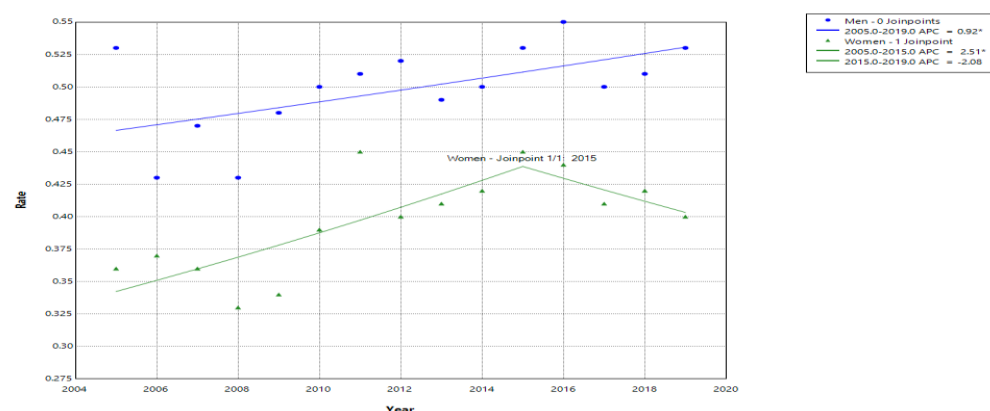
Figure 1. Cardiovascular disease trajectories according to sex and calendar year.



Source: Own estimation.

The mortality trajectory of central nervous system diseases in men presented a statistically significant positive linear trend, $\beta = 0.92$, $p < 0.05$, during the entire studied period. The trajectory among women presented a statistically significant trend towards an increase until 2015, $\beta = 2.51$, $p < 0.05$. Thereafter, there was a non-statistically significant trend to decrease, $\beta = -2.58$, $p > 0.05$. (Figure 2)

Figure 2. Nervous system disease trajectories according to sex and calendar year.

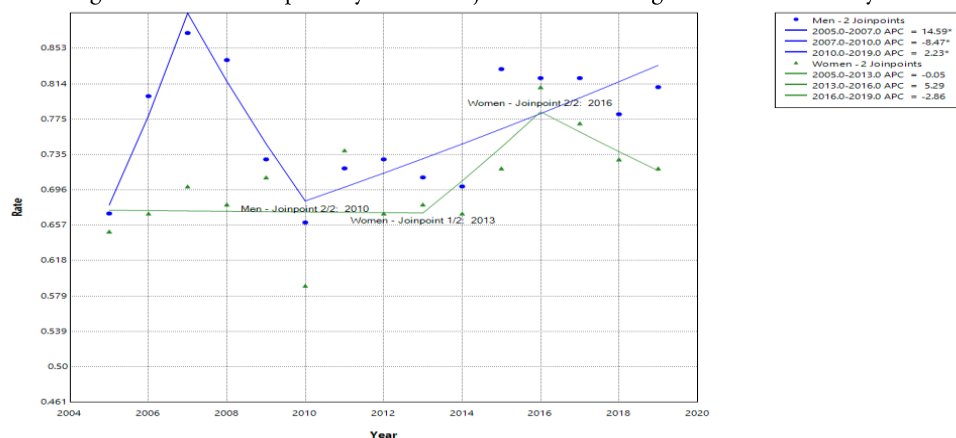


Source: Own estimation.

The mortality trajectory of respiratory diseases in men presented a trend to increase between 2005 and 2007, $\beta = 14.59$, $p < 0.05$; a decrease between 2008 and 2010, $\beta = -8.47$, $p < 0.05$, and again an increase between 2011 and 2019, $\beta = 2.23$, $p < 0.05$, all these trajectories were

statistically significant. There was no statistically significant trajectory among women. (Figure 3)

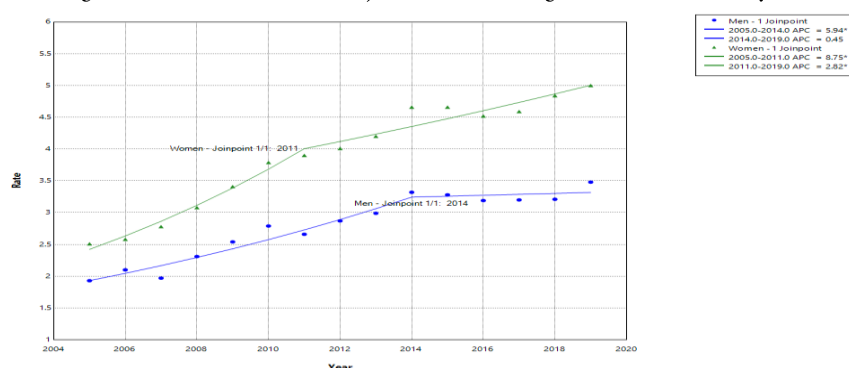
Figure 3. Chronic respiratory disease trajectories according to sex and calendar year.



Source. Own estimation.

The metabolic diseases mortality trajectory in men presented a statistically significant trend to increase between 2005 and 2014, $\beta = 5.94$, $p < 0.05$, subsequently continued to rise slightly without statistical significance, $\beta = 0.45$, $p > 0.05$. The trajectory among women presented a statistically significant trend to increase between 2005 and 2011, $\beta = 8.75$, $p < 0.05$. Afterward, the upward trend continued but at a slower speed, $\beta = 2.82$, $p < 0.05$. (Figure 4.)

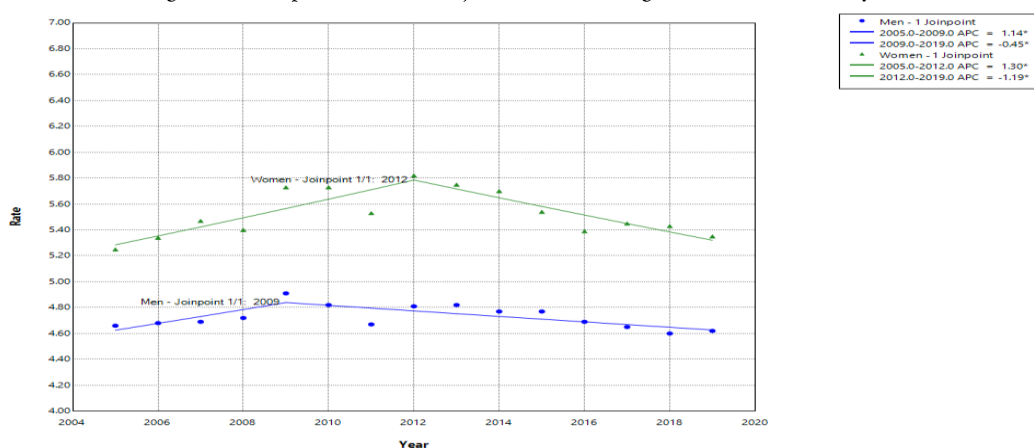
Figure 4. Metabolic disease trajectories according to sex and calendar year.



Source. Own estimation.

Neoplastic disease mortality trajectory in men presented a statistically significant increasing trend, between 2005 and 2009, $\beta = 1.14$, $p < 0.05$; thereafter, a statistically significant decrease, $\beta = -0.45$, $p < 0.05$. The trajectory among women presented a statistically significant positive trend until 2012, $\beta = 1.30$, $p < 0.05$; thereafter, a statistically significant decrease, $\beta = -1.19$, $p < 0.05$. (Figure 5)

Figure 5. Neoplastic disease trajectories according to sex, and calendar year.



Source. Own estimation.

Discussion.

The trajectory of the five major groups of noncommunicable diseases varied greatly in Guatemala between 2005 and 2019.

Cardiovascular diseases presented a statistically significant increase during the first fourteen years, with the highest rate among men $\beta = 3.48$ compared to $\beta = 3.01$ among women; later it decreased in both sexes, without statistical significance, with the greater decrease among women $\beta = -1.06$ compared to $\beta = -0.39$ among men. (Figure 1.)

Mortality from central nervous system diseases showed a statistically significant positive trend during the period studied in men, $\beta = 0.92$, $p < 0.05$ (Figure 2). Among women, the trend was statistically significant and positive until 2015, $\beta = 2.51$, $p < 0.05$. After that year, there was a non-statistically significant decreasing trend, $\beta = -2.58$, $p > 0.05$. (Figure 2)

Chronic respiratory diseases among men presented a trend to increase between 2005 and 2007, $\beta = 14.59$, $p < 0.05$; a decrease between 2008 and 2010, $\beta = -8.47$, $p < 0.05$, and again an increase between 2011 and 2019, $\beta = 2.23$, $p < 0.05$, all these trajectories were statistically significant. There was no statistically significant trajectory among women. (Figure 3)

The mortality trajectory of metabolic diseases in men showed a statistically significant increase between 2005 and 2014, $\beta = 5.94$, $p < 0.05$; thereafter, it kept rising but without statistical significance, $\beta = 0.45$, $p > 0.05$. The trajectory among women presented a statistically significant trend to increase between 2005 and 2011, $\beta = 8.75$, $p < 0.05$. Afterward, the upward trend continued at a slower speed, $\beta = 2.82$, $p < 0.05$. (Figure 4.)

The mortality trajectory of neoplastic diseases in men showed a statistically significant positive trend between 2005 and 2009, $\beta = 1.14$, $p < 0.05$; thereafter, a statistically significant decrease, $\beta = -0.45$, $p < 0.05$. Among women, the trajectory was statistically significant until 2012, $\beta = 1.30$, $p < 0.05$; thereafter, a statistically significant decrease, $\beta = -1.19$, $p < 0.05$.

A report in the United States stated that diabetes mellitus, chronic respiratory diseases, cancer, and cardiovascular disease mortality rates increased between 2015 and 2019¹¹. Findings are similar to those reported by this study, except for the cancer situation.

A study conducted in the Caribbean region, using age-standardized mortality rates due to cancer and heart disease, reported that mortality was higher for males than for females; there were no significant mortality trends in the region for any of the noncommunicable diseases¹². These results do not match those found in this study.

In Brazil, a study aimed to describe the mortality trends due to noncommunicable diseases between 1990 and 2017, reported a reduction of 35.3% from 509.1 in 1990 to 329.6 deaths/100,000 inhabitants due to these diseases in 2017¹³. Similar findings to those reported by this study regarding neoplastic and cardiovascular diseases during the second half of the study period.

A study aimed to map the trends in the incidence, prevalence, and mortality rates of NCD in Iraq between 2003 and 2021, reports that globally all NCD increased slightly by 0.1%, 95% CI (-2.2 to 2.4), with a notable decline in chronic respiratory diseases -14.4%, 95% CI: (-30.9 to 6.1) and a significant rise in neoplasms 32.7%, 95% CI (-5.9 to 81.3). Diabetes and kidney diseases showed the largest increase, 42.9%, 95% CI (28.4 to 59.3), while chronic respiratory diseases had the greatest decline, 12.1%, 95% CI (-36.8 to 22.5). Cardiovascular diseases remained the leading cause of mortality for both sexes, with a slight increase observed for males and a decrease for females over the period¹⁴. Some of these findings differ from those reported in this study, which suggests potential differences in the registered data, and the intensity and coverage of control programs implemented in those countries^{15,16,17,18}.

A study analyzed changes in the top 10 NCDs during the last century across the World Health Organization (WHO) regions and reported that mortality rates have declined across all world regions¹⁹. These findings coincide with what was reported in this study regarding the trajectory of neoplastic diseases. Cardiovascular diseases decreased during the last years, even though the decrease was not statistically significant, which suggests a possible random effect, whether due to an implemented strategy or the natural evolution of the disease in Guatemala.

A report prepared by Emory University in the United States provides a contemporary overview of the burdens caused by noncommunicable diseases, compiled from mortality data reported by authorities in forty-nine countries. The report pointed out that in low- and middle-income countries, patterns were mixed: Cardiovascular disease deaths remained relatively constant, while diabetes and certain types of cancer deaths increased over time^{20,21}. This report coincides with some findings of this study regarding diabetes, but not concerning neoplasms.

In summary, noncommunicable diseases continue to be an important public health problem in Guatemala, especially cardiovascular, chronic respiratory, and metabolic diseases among men, and metabolic, and neoplastic diseases in women. The different patterns observed in mortality probably reflect differences in sex exposure to different risk factors, as well as intensity, duration, and coverage achieved on the implementation of public health programs.

Finally, since non-communicable diseases are long-term and progressive, control measures must be applied over the long term to start seeing the expected results.

Ethics Approval and Consent to Participate. The Hospital Departmental Tomas Uribe Uribe ethics of investigation committee approved the development of this manuscript as recorded on Act No.01/2025, April 29, 2025.

Consent for Publication. Not applicable.

Conflict of interest. There is nothing to declare.

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