**The burden of high fasting plasma glucose in South American Countries, 1990–2019: a systematic analysis for the Global Burden of Disease Study**

Running head: The burden of high fasting plasma glucose in South American

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**Abstract (contagem de palavras)**

**Objective:** to describe the burden of hyperglycemia, characterized by the Global Burden of Disease Study as high fasting plasma glucose (HFPG), in South American countries from 1990 to 2019

**Study design:** epidemiological study.

**Methods:** The burden attributable to HFPG in adults aged 25 years or older in twelve South American countries from 1990 to 2019 using the Global Burden of Disease (GBD) 2019 estimates. A systematic analysis was performed on mortality and morbidity data to estimate disability-adjusted life years (DALYs), years of life lost (YLLs), years lived with disability (YLDs), and summary exposure value (SEV). We also evaluated the data across the Socio-Demographic Index (SDI). All estimates were for both sexes, age-standardised, and 95% uncertainty intervals (95% UI) were described.

**Results:** The burden of HFPG is large and growing in South America. In 2019, Guyana had the highest rate of YLLs (5,419.6; 95% UI 4,115.1-6,924.2), YLDs (1,212.5; 95% UI 838-1,649.2), DALYs (6,632.1; 95% UI 5,237.1-8,243.3), SEV (23.2; 95% UI 21.1-25.2), and deaths (254.5; 95% UI 193.9-324.1). Peru had the lowest rates of YLLs (746.5; 95% UI 538.6-1,035.4), DALYs (1,143.1; 95% UI 889.2-1,445.9), SEV (7.7; 95% UI 6.6-8.9), and deaths (41.2; 95% UI 29.6-57), whereas Uruguay had the lowest rate of YLDs (357.9; 95% UI 242.4-485.6). Between 1990 and 2019, in most countries, DALYs, YLLs, and deaths decreased, while the SEV and YLDs increased.

**Conclusions:** South America´s HFPG burden is large and heterogeneous across countries. While its mortality has decreased, the underlying cause – increased hyperglycemia – has risen, and with it, an increase in disability. These changes indicate a shift of the burden from mortality to morbidity and health systems must abide by the added workload.

**Keywords:** hyperglycaemia, disability-adjusted life years, life Expectancy

**Introduction**

Diabetes is one of the leading causes of mortality and disability globally. In 2021, there were 529 million (95% uncertainty interval [UI] 500–564) people living with diabetes worldwide, with a predicted rise to 1.31 billion (1.22–1.39) by 2050 (1) (Global regional national, 2023). Hyperglycemia, defined in the Global Burden of Disease context as High Fasting Plasma Glucose (HFPG), is an essential risk factor for diabetes. Diabetes and, to some extent, lesser hyperglycemia are independent risk factors for numerous adverse outcomes (2) (Liang, 2022). In the Americas in 2019, diabetes and high fasting plasma glucose were responsible for 2266 (1930-2649) and 4401 crude DALYs (3685-5265) per 100,000 adults, respectively, with considerable variation across regions (3) (Cousin, 2022). Kanyin Liane Ong,

High prevalence and burden of diabetes have been reported in the Americas (3) (Cousin, 2022). Still, a comprehensive analysis of the high fasting plasma glucose burden and the compound effect of severity and prevalence for the South American region is scarce.

Given the heterogeneity of diabetes morbidity and mortality burden across countries in America, it is essential to have more detailed data for more accurate planning of public health policies. This article describes the burden of hyperglycemia in South American countries from 1990 to 2019. Furthermore, we aim to evaluate the relationship of HFPG to the level of socioeconomic development of these countries.

**Methods**

We analyzed the burden of HFPG in twelve South American countries (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, and Venezuela) from 1990 to 2019 using estimates from GBD 2019. The territory of French Guyana was not included since it is part of France.

HFPG is classified as a risk factor in GBD study. The GBD 2019 organizes risk factors into four hierarchical categories. At the highest level (level 1), risk factors are split into behavioral, environmental, occupational, and metabolic groups. HFPG is a level 2 metabolic risk factor for GBD (4) (Supplement app1 87 risk).

The GBD methodology for defining HFPG was described elsewhere, in the official appendices of the group, but briefly mentioned here. The HFPG was measured with differing types of hyperglycemia – fasting glucose, 2 hour glucose within an oral glucose tolerance test (2h glucose), and glycated hemoglobin A1c (HbA1c) [ref].

The HFPG was measured as the mean fasting plasma glucose in a population, a continuous exposure in units of mmol/L. Since plasma fasting glucose is a continuous variable, HFPG is defined as any level above the theoretical minimum risk exposure level (TMREL), which is 4.8-5.4 mmol/L [ref (4)] or 86.4-97.2 [ref (5)], depending on the outcome being considered.

The burden of HFPG is calculated by joining the estimated excess risk of undesirable outcomes at different levels of hyperglycemia with estimates of the frequency of these levels across the distribution of hyperglycemia. The estimated excess risk of HFPG is obtained through literature review of risk across the spectrum of hyperglycemia across the HFPG-outcome cause pairs.

We described the burden of HFPG due to all causes, as well as the fifteen conditions attributable to HFPG, level 3, in the 2019 GDB Study as follows: diabetes, ischemic heart disease, stroke, chronic kidney disease, alzheimer's disease, tracheal, bronchus and lung, cancer, colorectal cancer, breast cancer, pancreatic cancer, tuberculosis, blindness and vision loss, peripheral artery disease bladder cancer, ovarian cancer, liver cancer [ref (6)].

The HFPG burden was assessed for both nonfatal and fatal estimation. Fatal events was estimated as years of life lost (YLLs) due to premature death. Non-fatal events were estimaed as years lived with disability (YLDs) and disability-adjusted life years (DALYs) lost, which is the sum of YLLs and YLDs. YLLs are calculated subtracting the age at death from the longest possible life expectancy for a person at that age. YLDs are calculated as the prevalence of the disabilities (outcomes and their sequela) for those with HFPG multiplied by the disability weights for those conditions. The disability weight expresses the relative valuations of the health state caused by the diverse disabilities on an interval scale. In the GBD, health state valuations lie between 0 (full health) and 1 (states equivalent to death) (7) (supplement 369 diseases).

To estimate the extent of population exposure to risk factors, GBD employs the Summary Exposure Value (SEV), which is expressed as a continuous variable (3) (Cousin E, 2022). The SEV for HFPG is calculated as the weighted prevalence of hyperglycemia, in which each level of glucose above the TMREL is weighted by the excess risk of outcomes produced at that level (8) (Supplement Cousin E, 2022). It varies from 0% to 100%, zero indicating minimal risk, and 100% maximum possible risk. The SEV thus provides an excess risk-weighted prevalence (9) (Murray 87 risk factors, 2020). Though not useful for comparisons across risk factors, it permits comparison of exposure to a given risk factor across different populations and at different times.

The Sociodemographic Index

The Socio-demographic Index (SDI) is a composite indicator of social development (4) (Supplement app1 87 risk, 2020). It is derived from the average of lag-distributed income per capita, total fertility rate in women under 25 years and average education in people over 15 years in populations (3,4) (Cousin E 2022) (Supplement app1 87 risk, 2020). The closer its value is to zero, the worse the estimated social development, with a value of zero representing a theoretical minimum level of socio-demographic development relevant to health issues and a value of one representing a theoretical maximum level of development (4) (Supplement app1 87RF, 2020).

All estimates were performed for both sexes, age-standardized, and generated from data available from the Global Health Data Exchange GBD Results Tool (http://ghdx.healthdata.org/gbd-results-tool). The figures were done using the R package version 4.02.

**Results**

**Discussion**

**Funding**

**Authors contributions**

Autor 1: Conception of the study, data analysis, interpretation of results, writing the manuscript, and final approval of the version to be published.

Autor 2: interpretation of the data, revising the manuscript for intellectual content, and final approval of the version to be published.

Autor 3:Conception of the study, interpretation of results, writing the manuscript, and final approval of the version to be published.

**Additional information**

ORCID

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**References**

Inserir aqui a lista de referências gerada pelo Zotero

**Figuras e Tabelas**