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TERRITORIAL DISTRIBUTION OF CHAGAS DISEASE AND SOCIOECONOMIC INEQUALITIES IN MINAS GERAIS: AN ECOLOGICAL STUDY

DISTRIBUIÇÃO TERRITORIAL DA DOENÇA DE CHAGAS E DESIGUALDADES SOCIOECONÔMICAS EM MINAS GERAIS: UM ESTUDO ECOLÓGICO

DISTRIBUCIÓN TERRITORIAL DE LA ENFERMEDAD DE CHAGAS Y DESIGUALDADES SOCIOECONÓMICAS EN MINAS GERAIS: UN ESTUDIO ECOLÓGICO

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ABSTRACT

Introduction: Chagas disease remains a relevant public health problem in Brazil, with a heterogeneous distribution and a close relationship with social determinants of health. In Minas Gerais, historical regional inequalities influence the occurrence of the disease, especially between more vulnerable areas and economically developed regions.

Objective: To analyze the territorial distribution of Chagas disease in Minas Gerais and its association with socioeconomic indicators.

Methods: This is an ecological, descriptive, and analytical study, with a qualitative approach, based on secondary data from the Notifiable Diseases Information System (SINAN), the Brazilian Institute of Geography and Statistics (IBGE), and the Caravela Portal. Socioeconomic indicators such as gross domestic product (GDP) per capita, infant mortality, and schooling level were analyzed across different territorial groupings within the state, comparing regions with similar demographic characteristics.

Results: A higher concentration of reported Chagas disease cases was observed in the North and Northeast regions of Minas Gerais compared to the Central-South region of the state. Municipalities with poorer socioeconomic indicators showed a higher number of notifications, even when compared to locations with similar population sizes. Relevant differences were also identified in indicators such as GDP per capita and infant mortality among the analyzed groupings.

Conclusion: The distribution of Chagas disease in Minas Gerais is associated with socioeconomic and territorial inequalities. The findings reinforce the need for integrated strategies that combine epidemiological surveillance, improvement of housing conditions, and strengthening of Primary Health Care, aiming to reduce inequalities and control the disease.

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Keywords: Chagas Disease. American Trypanosomiasis. Epidemiology. Pirmary Health Care. Social Determinants of Health.

RESUMO
Introdução: A doença de Chagas permanece um relevante problema de saúde pública no Brasil, apresentando distribuição heterogênea e estreita relação com os determinantes sociais da saúde. Em Minas Gerais, desigualdades regionais históricas influenciam a ocorrência da doença, especialmente entre áreas mais vulneráveis e regiões economicamente desenvolvidas.

Objetivo: Analisar a distribuição territorial da doença de Chagas em Minas Gerais e sua associação com indicadores socioeconômicos.

Métodos: Trata-se de um estudo ecológico, descritivo e analítico, com abordagem qualitativa, baseado em dados secundários do Sistema de Informação de Agravos de Notificação (SINAN), do Instituto Brasileiro de Geografia e Estatística (IBGE) e do Portal Caravela. Foram analisados indicadores socioeconômicos, como produto interno bruto (PIB) per capita, mortalidade infantil e escolaridade, em diferentes agrupamentos territoriais do estado, comparando regiões com características demográficas semelhantes.

Resultados: Observou-se maior concentração de casos notificados de doença de Chagas nas regiões Norte e Nordeste de Minas Gerais em comparação à região Centro-Sul do estado. Municípios com piores indicadores socioeconômicos apresentaram maior número de notificações, mesmo quando comparados a localidades com tamanhos populacionais semelhantes. Diferenças relevantes também foram identificadas em indicadores como PIB per capita e mortalidade infantil entre os agrupamentos analisados.

Conclusão: A distribuição da doença de Chagas em Minas Gerais está associada a desigualdades socioeconômicas e territoriais. Os achados reforçam a necessidade de estratégias integradas que articulem vigilância epidemiológica, melhoria das condições habitacionais e fortalecimento da Atenção Primária à Saúde, visando reduzir desigualdades e controlar a doença.

Palavras-chave: Doença de Chagas. Tripanossomíase Americana. Epidemiologia. Atenção Primária à Saúde. Determinantes Sociais da Saúde.

RESUMEN
Introducción: La enfermedad de Chagas continúa siendo un importante problema de salud pública en Brasil, con una distribución heterogénea y una estrecha relación con los determinantes sociales de la salud. En Minas Gerais, las desigualdades regionales históricas influyen en la ocurrencia de la enfermedad, especialmente entre áreas más vulnerables y regiones económicamente desarrolladas.

Objetivo: Analizar la distribución territorial de la enfermedad de Chagas en Minas Gerais y su asociación con indicadores socioeconómicos.

Métodos: Se trata de un estudio ecológico, descriptivo y analítico, con enfoque cualitativo, basado en datos secundarios del Sistema de Información de Enfermedades de Notificación (SINAN), del Instituto Brasileño de Geografía y Estadística (IBGE) y del Portal Caravela. Se

analizaron indicadores socioeconómicos, como producto interno bruto (PIB) per cápita, mortalidad infantil y nivel educativo, en diferentes agrupamientos territoriales del estado, comparando regiones con características demográficas similares.

Resultados: Se observó una mayor concentración de casos notificados de enfermedad de Chagas en las regiones Norte y Nordeste de Minas Gerais en comparación con la región Centro-Sur del estado. Los municipios con peores indicadores socioeconómicos presentaron un mayor número de notificaciones, incluso cuando se compararon con localidades de tamaño poblacional similar. También se identificaron diferencias relevantes en indicadores como PIB per cápita y mortalidad infantil entre los agrupamientos analizados.

Conclusión: La distribución de la enfermedad de Chagas en Minas Gerais está asociada a desigualdades socioeconómicas y territoriales. Los hallazgos refuerzan la necesidad de estrategias integradas que articulen vigilancia epidemiológica, mejora de las condiciones habitacionales y fortalecimiento de la Atención Primaria de Salud, con el objetivo de reducir desigualdades y controlar la enfermedad.

Palabras clave: Enfermidad de Chagas. Tripanossomiasis Americana. Epidemiologia. Atencion Primária de Salud. Determinantes Sociales de la Salud.

1 INTRODUCTION

Chagas disease, or American trypanosomiasis, was described in 1909 by Carlos Chagas, a physician and infectious disease specialist from Minas Gerais, in a landmark event in Brazilian medical history, by detailing the parasite, the vector, the hosts, the clinical manifestations, and the entire transmission cycle. However, despite the precocity and comprehensiveness of this discovery, the disease remained, throughout the 20th century, profoundly invisible, due to its epidemiological dynamics, primarily affecting historically marginalized populations (1).

Before its systematization, the disease was recognized by different popular names, such as “enlarged heart disease,” “choking disease,” and “nervous disease,” expressions that reveal not only the diversity of its clinical manifestations but also the sanitary neglect to which rural territories, Indigenous peoples, and impoverished populations in the North, Northeast, and interior of Minas Gerais were subjected. It is a disease that, for decades, did not occupy a central place in public health policies, and this scenario remains perceptible 116 years after its discovery (2).

Chagas disease can be transmitted through different routes, including contact with triatomine feces, vertical transmission, oral transmission, and exposure to contaminated biological materials, such as blood. Despite this diversity of mechanisms, its historical impact has been deeply linked to the social conditions of affected individuals, with a strong relationship to housing conditions, adequate food security, and the screening of biological materials (1).

In this context, the Northern region of Minas Gerais, historically marked by structural poverty, recurrent drought, and territorial isolation, associated with limited state presence, became consolidated throughout the 20th century as one of the regions with the highest burden of Chagas disease in the state. This pattern of epidemiological inequality, far from being restricted to the past, remains visible to this day, especially when comparing municipalities in the northern interior of the state to those located in the more developed central-southern regions (2).

Given the significant economic, structural, and cultural diversity of the state of Minas Gerais, combined with a historically unequal pattern of Chagas disease occurrence across its territory, it becomes essential to analyze the disease from a territorial perspective. In this context, the assessment of socioeconomic indicators across the state’s micro- and macro-

regions emerges as a strategic tool for recognizing chronic illness, addressing underdiagnosis, and reducing the inequalities historically associated with the disease.

This study aims to analyze the relationship between socioeconomic vulnerability and the distribution of Chagas disease in Minas Gerais, seeking to identify priority territories for the formulation of public policies, the planning of Primary Health Care actions, and the development of care and surveillance strategies.

2 METHODS

This is an ecological observational study, with a descriptive and analytical design, combined with a narrative literature review, aimed at analyzing the relationship between socioeconomic indicators and the distribution of Chagas disease in the state of Minas Gerais.

The study setting comprises the state of Minas Gerais, Brazil, considering territorial groupings constructed for analytical purposes, the territorial groupings were constructed to allow comparisons between regions with similar demographic characteristics while minimizing biases related to population size differences.

The literature review was conducted through a systematized search in the SciELO, PubMed/MEDLINE, LILACS, and Google Scholar databases, including articles published in Portuguese and English, with no initial time restriction. Controlled descriptors and keywords were used, combining the terms “Chagas disease,” “American trypanosomiasis,” “epidemiology,” “primary health care,” and “social determinants of health” using Boolean operators (AND/OR). Original articles, reviews, technical documents, and institutional reports addressing epidemiological, social, and territorial aspects of Chagas disease were included, with emphasis on studies conducted in Brazil. Studies of an exclusively experimental or laboratory nature, without relevance to social determinants of health, were excluded.

The ecological analysis was conducted based on secondary data obtained from official sources, including the Ministry of Health, the Brazilian Institute of Geography and Statistics (IBGE), and the Caravela Portal. Data collection was carried out from November 10, 2025, to December 18, 2025, through direct access to institutional platforms, in order to ensure traceability and reproducibility. The analytical organization of the data and territorial grouping strategy may be made available by the authors upon reasonable request.

The dependent variable was the number of reported cases of Chagas disease, including records classified as suspected and confirmed, as provided by the Notifiable Diseases Information System (SINAN) and the Minas Gerais State Health Department.

Independent variables included socioeconomic and demographic indicators, such as total gross domestic product (GDP), GDP per capita, infant mortality rate, level of schooling, and municipal public revenues.

Data were organized in a descriptive and comparative manner and analyzed through comparisons between territorial groupings with similar demographic characteristics, in order to minimize biases related to population size. No inferential statistical tests were performed, and the analysis was based on direct comparison of the selected indicators.

The possibility of biases inherent to the use of secondary data is acknowledged, particularly those related to underreporting of cases and the lack of distinction between suspected and confirmed cases in the analyzed databases. Additionally, the use of socioeconomic indicators from different time periods may introduce limitations related to the temporal comparability of the data.

As this study used publicly available secondary data without individual participant identification, submission to a Research Ethics Committee was not required, in accordance with current guidelines. Patients and community members did not participate in the planning, design, analysis, or dissemination of this study.

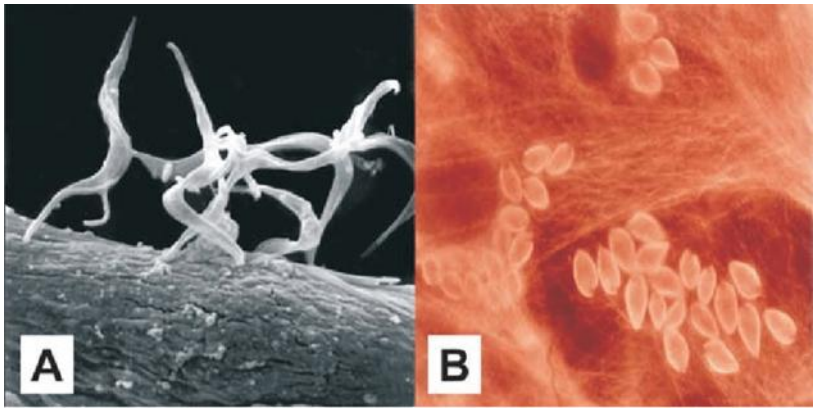
3 CHAGAS DISEASE

Chagas disease is a zoonosis caused by the protozoan *Trypanosoma cruzi*, described in 1909 by the Brazilian physician Carlos Chagas. It is a disease typical of tropical regions, with higher prevalence in South and Central America, although cases have been reported in other countries, including the United States, especially in areas bordering Mexico (3).

The main route of transmission occurs through triatomine insects, popularly known as kissing bugs, whose life cycle and behavior favor their adaptation to human dwellings. These vectors tend to inhabit cracks in buildings, roofs, mud walls, chicken coops, and areas with accumulated materials, establishing a direct relationship between disease transmission and housing conditions. As shown in Figure 1, the parasite presents different morphological forms in vertebrate hosts, including the trypomastigote and amastigote stages. In the Brazilian context, this dynamic has historically affected territories marked by social vulnerability more intensely, especially rural areas and regions where constructions made of wattle and daub, mud, and thatch predominate, such as the North and Northeast (3).

Figure 1

Forms of *Trypanosoma cruzi* in vertebrate hosts: (A) trypomastigote (bloodstream form); (B) amastigote (intracellular form in muscle cells)



Source: Fundação Oswaldo Cruz. *Chagas disease and its main vectors in Brazil*. Rio de Janeiro: Fiocruz; 2008

Female triatomines have a greater need for blood feeding compared to males due to oviposition. When infected with *Trypanosoma cruzi*, these insects typically perform blood meals on exposed areas of the human body, commonly on the face, during the nighttime. Unlike other vector-borne diseases, transmission of Chagas disease does not occur directly through the bite, but through the deposition of feces contaminated with the parasite near the site of the bite. Local pruritus facilitates the inoculation of *T. cruzi* through skin friction or contact with mucous membranes (5).

In addition to classical vector transmission, Chagas disease can occur through other routes, including vertical transmission from mother to fetus, blood transfusion, organ transplantation, and oral transmission. The latter has been associated with the consumption of food contaminated with *Trypanosoma cruzi*, especially in contexts of artisanal processing and inadequate hygienic conditions, and has been responsible for outbreaks reported mainly in the Northern region of Brazil (7).

Chagas disease is classified according to its clinical and evolutionary phases. The phases are defined based on chronological criteria and are divided into acute and chronic. Classification by clinical form refers to the patient's clinical profile and is based on syndromic diagnosis or the predominance of involvement of target organs. In this context, the chronic phase can be subdivided into indeterminate, cardiac, digestive, or mixed (cardiodigestive) forms (6).

The acute phase occurs in the first days following infection with *Trypanosoma cruzi*, generally between 4 and 10 days. During this period, many individuals present nonspecific

symptoms such as persistent fever, general malaise, fatigue, and hyporexia, which often makes recognition of the disease difficult. In some cases, an inflammatory reaction at the site of inoculation may be observed, known as a chagoma, in addition to lymphadenomegaly, hepatosplenomegaly, and systemic manifestations resulting from high parasitemia. Although less frequent, the acute phase may progress to severe forms, including cardiac involvement, especially in children and immunosuppressed individuals (6).

The chronic phase is traditionally subdivided into three main clinical forms. The indeterminate form corresponds to a condition in which the individual remains asymptomatic despite confirmed infection and may maintain this state throughout life. The cardiac form is characterized by involvement of the heart muscle, manifesting as arrhythmias, heart failure, thromboembolic events, and an increased risk of sudden death, being the main contributor to disease-related morbidity and mortality. The digestive form results from involvement of the enteric nervous system, leading to severe motility disorders of the esophagus and colon, with the development of megaesophagus and megacolon (8).

4 MINAS GERAIS AND THE HISTORICAL SOCIOCULTURAL AND ECONOMIC DIFFERENCES BETWEEN THE NORTH AND SOUTH

The colonization of the state of Minas Gerais occurred throughout history in a profoundly unequal manner when comparing the Northern and Southern regions. While the South and Central regions of the state, between the 17th and 18th centuries, experienced intense economic dynamism driven by the gold rush, with emphasis on cities such as Mariana, Vila Rica, and São João del-Rei, the Northern region underwent a slower process of occupation. Largely linked to cattle expansion and colonial expeditions (*bandeiras*), under strong influence from large landowners from Bahia, this region developed within a context marked by geographic isolation, land concentration, and recurrent droughts, with more significant growth occurring only from the 19th and 20th centuries onward (11).

Currently, significant inequalities can be observed among municipalities in Minas Gerais, even when comparing cities with similar population sizes but located in different regions of the state. Variations in socioeconomic indicators, such as the Human Development Index (HDI), gross domestic product (GDP), and GDP per capita, as well as infant mortality and literacy rates, demonstrate the persistence of these regional disparities. Major urban centers in Northern Minas Gerais, such as Teófilo Otoni, Montes Claros, Unaí, and Janaúba, show lower performance in several of these indicators when compared to municipalities with

similar demographic characteristics located in the Southern region of the state, such as Governador Valadares, Ipatinga, Juiz de Fora, and Divinópolis (12).

Chagas disease remained, for many years, on the margins of the sanitary priorities of the Brazilian State, constituting a condition widely neglected by public authorities. Since the 19th century, governmental efforts have been primarily focused on combating diseases considered strategic for the national modernization project, such as smallpox, malaria, tuberculosis, and other tropical diseases. This logic persisted into the early 20th century, as demonstrated during the government of Rodrigues Alves (1902–1906), marked by major sanitary campaigns aimed at urban sanitation and the protection of economically central areas of the country (9).

Unlike diseases widely discussed in the 19th century, such as tuberculosis, often associated, in the urban imagination of the time, with intellectualism and even a romanticized aesthetic of illness. Chagas disease predominantly affected impoverished rural populations living in precarious housing and distant from centers of medical knowledge production. This peripheral social position decisively contributed to its historical invisibility, delayed institutional recognition, and the persistent neglect in public health policies (10).

The Brazilian Institute of Geography and Statistics (IBGE) represents the development of Brazilian municipalities through various socioeconomic and demographic indicators. However, many of these data do not fully reflect the current reality of cities due to delays in their updates. The Human Development Index (HDI), for example, had its most recent historical series published in 2010, while more recent population data derive from the 2022 Census, released between 2023 and 2024, which has been subject to criticism regarding the accuracy of some estimates. Therefore, for comparative purposes, the present analysis uses indicators from different years, acknowledging the lack of homogeneous temporal standardization as a methodological limitation of the study (13).

Regarding the notification of Chagas disease cases, it is a notifiable condition in Brazil, both in suspected and confirmed diagnoses. However, the data on Chagas disease cases in Minas Gerais, made available by the Minas Gerais State Health Department (SES-MG), also face important challenges related to data updating and standardization. Several municipalities do not consistently appear in official listings, and the state platform does not adequately distinguish between suspected and confirmed cases, grouping them into a single analytical category. Data from all Brazilian municipalities are recorded through notification

forms completed in health services and subsequently entered into the Notifiable Diseases Information System (15).

5 EPIDEMIOLOGY OF CHAGAS DISEASE CASES IN MINAS GERAIS

In order to more objectively analyze the socioeconomic differences associated with the occurrence of Chagas disease in the state of Minas Gerais, it was necessary to divide municipalities into representative groupings of the Northern and Southern regions of the state, as well as into metropolitan regions, whether officially established or analytically constructed, with proportional populations. This strategy allowed for a more balanced comparison between territories with similar demographic sizes. Initially, the selected socioeconomic indicators were analyzed; subsequently, the occurrence of Chagas disease was evaluated across these different territorial groupings.

An important economic region and the main industrial hub of eastern Minas Gerais, the Metropolitan Region of Vale do Aço, composed of the municipalities of Ipatinga, Coronel Fabriciano, Timóteo, and Santana do Paraíso, has an estimated population of 458,846 inhabitants, according to the 2022 Census. In the same year, the average level of schooling reached 98.76%. The average infant mortality rate was 6.31 deaths per 1,000 live births, according to 2023 data. In 2024, the group of municipalities recorded gross revenues of approximately 2.74 billion reais. The average gross domestic product (GDP) per capita was 41,548.67 reais, based on 2021 data, and the total GDP of the region reached 25.95 billion reais, corresponding to approximately 2.55% of the gross domestic product of the state of Minas Gerais in the same period. For better visualization and comparison of the described socioeconomic and epidemiological indicators, the data are presented in Table 1 (14).

Table 1

Comparison of socioeconomic indicators and Chagas disease cases in selected regions of Minas Gerais (2020–2024)

REGION–MUNICIPALITY	**POPULATION**	**GDP per capita** (Gross Domestic Product per capita)	**Infant mortality rate** (per 1,000 live births)	**Chagas disease cases** (2020–2024)
Metropolitan Belt of Vale do Aço	458.846	41.548,67	6,31	90
Norte de MG	485.672	25.638	11,52	----
Poços de Caldas	163.50.234	50.234	11,68	4
Teófilo Otoni	127.418	20.893,97	14,79	46

Source: prepared by the authors based on data from IBGE, the Ministry of Health, and Caravela.info.

For comparison purposes, a metropolitan region with similar demographic characteristics was analytically constructed for this study in Northern Minas Gerais, comprising the municipalities of Montes Claros, Bocaiúva, and Francisco Sá. In this territorial grouping, the estimated population was 485,672 inhabitants, with a total gross domestic product (GDP) of 12.45 billion reais, an average GDP per capita of 25,638 reais, gross revenues of 2.49 billion reais, and an approximate infant mortality rate of 11.52 deaths per 1,000 live births. Differences between the regions can be observed despite similar population sizes and comparable levels of public revenue, particularly regarding GDP per capita and infant mortality rates, which are higher in the Northern Minas Gerais grouping (14).

In the state of Minas Gerais, according to the historical series from 2020 to 2024, a total of 1,346 cases of Chagas disease were reported to the Notifiable Diseases Information System (SINAN) and incorporated by the State Health Department, including notifications classified as suspected and confirmed. When analyzing the distribution of these cases across health macro-regions, it is observed that the Metropolitan Belt of Vale do Aço, composed of 24 municipalities, recorded 90 notifications during the period, with the municipality of Ipatinga, the largest urban center in the region, accounting for only 3 cases. In contrast, during the same time interval, the municipality of Montes Claros reported 26 cases of Chagas disease, while the other cities comprising the analytically constructed metropolitan region of Northern Minas Gerais did not appear in official listings, either due to the absence of recorded notifications or limitations in the reporting process (15).

When jointly analyzing data from Northern Minas Gerais and the Jequitinhonha Valley, regions that together comprise approximately 4.5 million inhabitants (about 21% of the state's

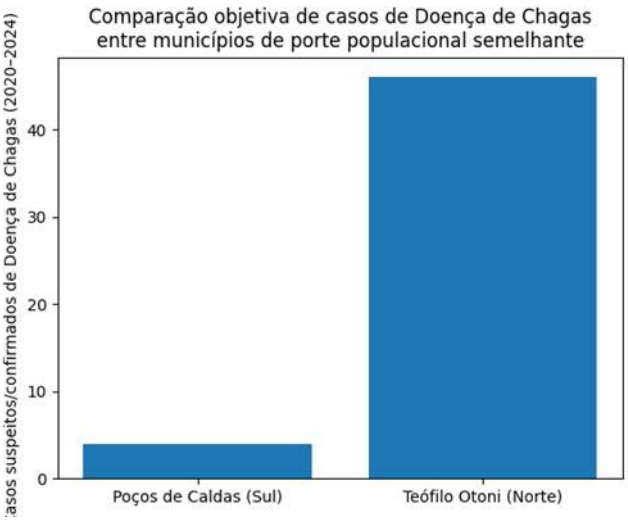
population), 322 cases of Chagas disease were reported between 2020 and 2024, corresponding to 24% of the total cases recorded in Minas Gerais during this period. When adjusted for population, a rate of 7.2 suspected or confirmed cases per 100,000 inhabitants is observed in these regions, higher than that found in the rest of the state, which presented a rate of 6.1 cases per 100,000 inhabitants in the same interval (15).

When the analysis shifts to municipalities located in opposite extremes of the state, the differences become even more pronounced. Cities with similar population sizes, such as Poços de Caldas and Teófilo Otoni, allow for an illustrative comparison of these regional asymmetries. Poços de Caldas, an important urban center in Southern Minas Gerais, has an estimated GDP of 8.5 billion reais, a population of 163,742 inhabitants, a schooling rate of 98.93%, a Municipal Human Development Index (MHDI) of 0.779, an infant mortality rate of 11.68 deaths per 1,000 live births, revenues exceeding 1.3 billion reais, and a GDP per capita of 50,234 reais. Despite these favorable socioeconomic indicators, the municipality reported 4 cases of Chagas disease, classified as suspected or confirmed, between 2020 and 2024 (14).

In contrast, the municipality of Teófilo Otoni, located in the Northeast of Minas Gerais, has a population of 127,418 inhabitants, a schooling rate of 98.53%, a Municipal Human Development Index (MHDI) of 0.701, an infant mortality rate of 14.79 deaths per 1,000 live births, gross revenue of approximately 844 million reais, an estimated GDP of 3 billion reais, and a GDP per capita of 20,893.97 reais. In this less favorable socioeconomic context, the municipality reported 46 cases of Chagas disease classified as suspected or confirmed between 2020 and 2024, a number significantly higher than that observed in Poços de Caldas during the same period, as shown in Figure 2**.** (14).

Figure 2

Bar chart comparing the number of suspected or confirmed Chagas disease cases reported between 2020 and 2024 in the municipalities of Poços de Caldas (Southern Minas Gerais) and Teófilo Otoni (Northeastern Minas Gerais)



Source: prepared by the authors based on data from Minas Gerais State Health Department (2026).

6 DISCUSSION

The present study demonstrated an unequal territorial distribution of Chagas disease in Minas Gerais, with higher notification rates in historically vulnerable regions such as Northern Minas Gerais and Jequitinhonha Valley. Municipalities with less favorable socioeconomic indicators, including lower GDP per capita and higher infant mortality rates, presented a greater number of reported cases, even when compared to territories with similar population sizes.

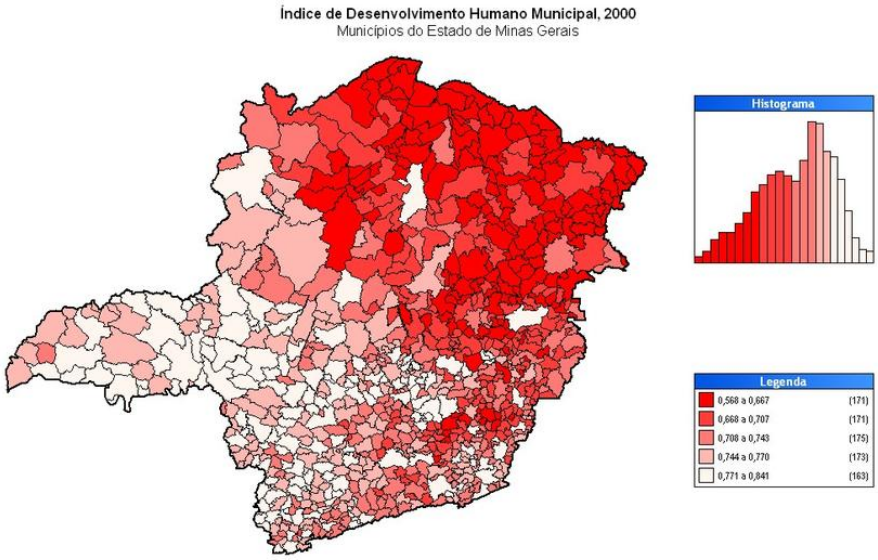
Concepts of poverty are multiple and are not limited exclusively to the idea of income. As systematized by Hagenaars and De Vos, these conceptions can be organized into three main axes: absolute poverty, related to the absence of objectively defined minimum resources for subsistence; relative poverty, characterized by having fewer resources compared to other individuals in society; and subjective poverty, associated with the individual perception of material insufficiency for full social integration. In this regard, most studies use relative poverty as a social determinant; however, when analyzing the epidemiological and economic performance of Northern Minas Gerais in comparison with the rest of the state, several factors must be considered (16).

In an attempt to mitigate the number of people living in extreme poverty, the Brazilian State began implementing, starting in the 1990s, still during the government of Fernando

Henrique Cardoso, income transfer programs and subsidies targeted at the most vulnerable populations, with the aim of reducing levels of indigence to socially acceptable thresholds. These initiatives were subsequently expanded, reformulated, and maintained by subsequent governments, consolidating themselves as central instruments of Brazilian social policy. However, populations in Northern Minas Gerais face challenges that go beyond the strictly monetary dimension, involving structural, territorial, and historical limitations that are not fully captured by income indicators alone, **as illustrated in Figures 3 and 4 (17).**

Figure 3

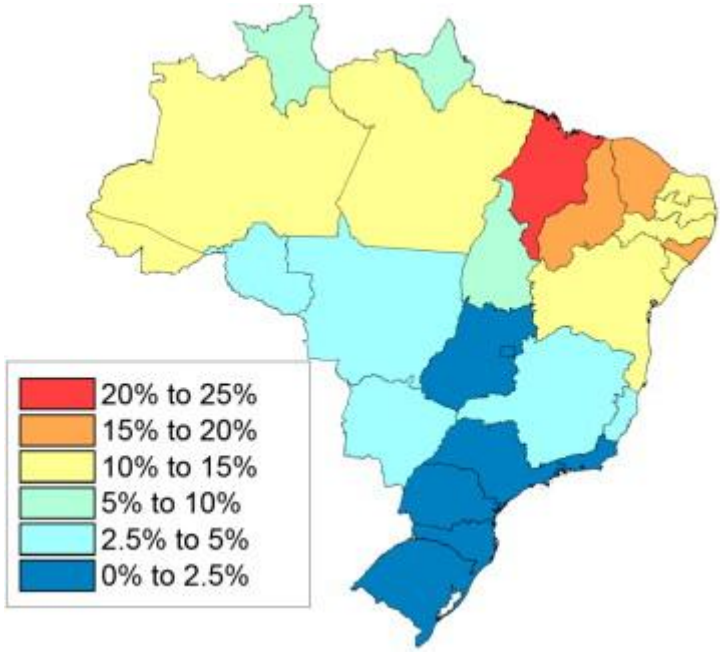
Map of the Human Development Index (HDI) of municipalities in Minas Gerais, 2000



Source: Fundação João Pinheiro. *Atlas of Human Development in Minas Gerais*. Belo Horizonte: FJP; 2000.

Figure 4

Percentage of the population living in extreme poverty, with income below US$70 per month



Source: prepared by the authors based on data from Instituto Brasileiro de Geografia e Estatística (IBGE). *Municipal Social Indicators: an analysis of the results of the 2010 Demographic Census*. Rio de Janeiro: IBGE; 2011.

Historically, several diseases, such as diarrheal diseases, schistosomiasis, malaria, and trachoma, have maintained a close association with contexts of poverty and social deprivation. Within this group, Chagas disease stands out for its particularly direct relationship with socioeconomic determinants. This association largely derives from the ecological characteristics of its main vector, the triatomine insect, popularly known as the kissing bug, whose habitat is closely linked to precarious housing conditions. These insects tend to shelter in cracks and crevices of walls, especially in constructions made of mud or wattle and daub, as well as behind furniture, beds, and mattresses, in addition to peridomestic structures such as chicken coops and corrals. Thus, the persistence of Chagas disease reflects not only the presence of the vector but, above all, historical inequalities related to housing, sanitation, and the living conditions of vulnerable populations (8).

As evidenced by the present analysis, Chagas disease constitutes a socially localized condition, historically neglected due to its predominant impact on socially invisible populations. The findings indicate that income transfer policies, although fundamental for mitigating extreme poverty, are not sufficient, in isolation, to break the transmission cycle of the disease. As long as precarious housing conditions persist—especially in rural settings,

where housing acts as a direct determinant of contact between humans and the vector—transmission of Chagas disease tends to remain higher in traditionally rural territories. This pattern is further supported by the observation that, even in the presence of high levels of schooling, municipalities in Northern Minas Gerais exhibit higher incidence rates, indicating that this is a phenomenon associated with structural poverty rather than exclusively with the educational dimension (9).

In addition to the set of social and epidemiological determinants previously discussed, there is an important institutional barrier that hinders the control of neglected tropical diseases: limitations in the notification system. In the case of Chagas disease, the interpretation of official data is affected by inconsistencies in reporting, as the Notifiable Diseases Information System (SINAN) does not clearly distinguish between suspected and confirmed cases, aggregating them into a single analytical category. Furthermore, the absence of records in certain municipalities should not be interpreted as absence of transmission, but rather as a possible reflection of limited local capacity for epidemiological surveillance and reporting. In this sense, the fact that Northern Minas Gerais presents a higher number of reported cases suggests that the true magnitude of the problem may be even greater, reinforcing the hypothesis of underreporting and institutional inequality in disease control.

This study has important limitations. The ecological design does not allow causal inferences at the individual level. Furthermore, the use of secondary databases may be associated with underreporting and inconsistencies in notification systems. Another relevant limitation is the absence of inferential statistical analyses, which restricts the interpretation of associations between socioeconomic indicators and disease distribution.

The results also allow for an interpretation centered on the individual historically most exposed to these conditions: populations residing in rural areas of Northern Minas Gerais, often engaged in agricultural activities and sometimes subject to labor relations marked by informality and low social protection. This is a worker who lives and produces in territories characterized by geographic isolation, with limited access to paved roads, railways, medium- and high-complexity healthcare services, and continuous care networks. Under these conditions, precarious housing, proximity to peridomestic structures favorable to vector presence, and difficulties in accessing diagnosis and clinical follow-up converge to sustain preventable diseases such as Chagas disease (9).

Thus, the illness and death of this individual cannot be understood as isolated or inevitable events, but rather as direct expressions of an exclusionary territorial development model, in which economic production does not necessarily translate into social protection or the guarantee of the right to health. The persistence of Chagas disease in this context demonstrates that, for a significant portion of the rural population of Northern Minas Gerais, the risk of illness and death from preventable causes remains conditioned by one's position in the rural space and by the historical absence of the State (19).

7 CONCLUSION

The results of this study indicate that Chagas disease maintains an unequal territorial distribution in Minas Gerais, with a higher concentration of cases in regions historically marked by socioeconomic vulnerability and structural fragility. The analysis suggests an association between higher incidence and precarious housing conditions, persistent rural characteristics, and lower institutional capacity for epidemiological surveillance.

Furthermore, it is observed that income transfer policies, although essential for reducing extreme poverty, are not sufficient, in isolation, to significantly impact the transmission dynamics of the disease. The persistence of the vector is directly related to environmental and housing determinants, particularly in areas with dwellings susceptible to triatomine colonization. Additionally, limitations in notification systems may contribute to underestimation of the true magnitude of the condition, particularly in municipalities with weaker surveillance structures.

The findings reinforce the need for integrated strategies that combine qualified epidemiological surveillance, improvements in housing conditions, strengthening of Primary Health Care, and continuous vector control actions. Chagas disease remains a relevant regional public health problem, requiring an intersectoral and sustained approach to reduce transmission and its chronic complications.

Strengthening Primary Health Care and territorial epidemiological surveillance is essential to reduce regional inequalities and improve the control of Chagas disease in vulnerable territories.

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