Failure to use health services by people with Chagas disease: Multilevel analysis of endemic area in Brazil

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Abstract

This study aimed to assess the prevalence of non-use of health services in the last year by people with Chagas disease (CD) in an endemic area in Brazil and the contextual and individual factors associated with this non-use. This is a multilevel study that considered contextual and individual data. Contextual data were collected from official publicly accessible databases of the Brazilian government, at the municipal level. The individual data came from the first follow-up of a Brazilian cohort that assessed patients with CD in 21 municipalities in endemic area for the disease. The sample consisted of 1,160 individuals with CD. The dependent variable “use of health services in the last year” was categorized as yes vs. no. The analysis was performed using Poisson regression with robust variance. The prevalence of non-use of health services in the last year was 23.5% (IC95%: 21.1–25.9). The contextual factor “larger population” (PR: 1.6; 95% CI = 1.2–2.0) and individual factors related to the lower severity of the disease as a functional class without limitations (PR: 1.6; 95% CI = 1.2–2.1) and unaltered N-terminal pro b-type natriuretic peptide levels (PR: 2.2; 95% CI = 1.3–3.6) increased the prevalence of non-use of the health service in the last year by people with CD. The results of this study showed that individual determinants are not isolated protagonists of the non-use of health services in the last year by people with CD, which reinforces the need for public policies that consider the contextual determinants of the use of health services by populations affected by the disease.

Author summary

Chagas disease (CD) is a parasitic infection caused by Trypanosoma cruzi (T. cruzi) that predominantly affects poor and vulnerable populations. It is estimated that around six million people are infected with T. cruzi, most of them in endemic areas of Latin American countries. It is recommended that individuals with CD be followed up by health
services through one to two medical consultations per year. Identifying groups of people with CD who are more vulnerable in relation to their health status, whether due to the unavailability of health services or the types of behavior that lead to the non-use of available services, can contribute to reducing morbidity and mortality from the disease. Our study evaluated the prevalence of non-use of health services in the last year by 1,160 people with CD in an endemic area in Brazil and the contextual and individual factors associated with this non-use. The study results showed that almost a quarter of these patients had not had a medical appointment in the last year. “Living in cities with a larger population” and “having a lower severity of the disease” influenced the non-use of the health service in the last year by these patients. These results reinforce the need for public policies that consider the contextual determinants of the use of health services by populations affected by the disease.

Introduction
Chagas disease (CD) is a systemic and chronic parasitic infection caused by *Trypanosoma cruzi* (*T. cruzi*) that predominantly affects poor and vulnerable populations. With globalization and constant migratory flows, CD is present on almost every continent. It is estimated that in the world more than 7,500 deaths from CD occur per year, and that approximately six million people are infected with *T. cruzi*, most of them in endemic areas of Latin American countries [1,2,3]. In the Americas, CD is the parasitic disease with the highest mortality burden and disability-adjusted life years (DALYs) [3]. In Brazil it is estimated that the prevalence of CD is around 0.6%, which corresponds to more than 1.1 million infected individuals [4]. This scenario points to a major challenge for the country’s health system: ensuring access to comprehensive care for over a million people with CD [5].

Although annual rates of incidence and prevalence of CD have fallen as a result of measures to control the disease and improve quality of life, care for patients with CD is still a major challenge for health systems in endemic [6,7] and non-endemic countries [8,9]. It is recommended that individuals with CD be followed-up by health services through one to two medical consultations per year for the early detection of the clinical progression of the disease, treatment, and promotion of healthy lifestyle habits [10,11,12]. It is noteworthy that medical assistance to patients with CD is influenced by the economic and social context of the regions where patients live [13].

In Brazil, individuals with CD should be monitored longitudinally in public Primary Health Care (PHC) services through periodic medical consultations and, when necessary, referred to specialized health services [12]. The use of health services in the country is provided in three ways: public, private, and supplementary, with the public sector being the main provider [14,15]. It is estimated that more than 70% of the Brazilian population depends on the Sistema Único de Saúde (SUS) for access to health care [16].

The use of health services is an important marker for assessing access and equity in health systems [17]. In Brazil, people with chronic non-communicable diseases (NCDs) use health services more than people without NCDs [18]. To date, studies on the non-use of health services by people with CD have not been identified in the national and international literature.

The assumed universality of access to the health system and the well-known social inequality in Brazil offer interesting opportunities for analyzing the contextual and individual determinants of the use of health services [19] by populations with neglected diseases in the country. In this context, identifying groups of people with CD who are most vulnerable
regarding their health status, whether due to the unavailability of health services or the types of behavior that lead to the non-use of available services [17], may contribute to the development and implementation of effective public policies for the comprehensive care of populations with CD. Thus, the aim of this study was to assess the prevalence of non-use of health services in the last year by people with CD in an endemic area in Brazil and the contextual and individual factors associated with this non-use.

Methods

Ethics statement

This study was approved by the National Research Ethics Commission (CONEP: 179,685/2012). All subjects agreed to participate and signed the informed consent form prior to the beginning of the study.

Study design

This is a multilevel study organized based on the Behavioral Model of the Use of Health Services by Andersen & Davidson [17] that considered contextual and individual data. Contextual data refer to the municipal level and were collected from official publicly accessible databases of the Brazilian government. The individual data were collected during the first follow-up of a prospective cohort study with patients with CD called SaMi-Trop (Center for Research on Biomarkers in Neglected Tropical Diseases in São Paulo / Minas Gerais).

The SaMi-Trop cohort is a multicenter study resulting from the cooperation between four Brazilian public universities: University of São Paulo (USP), Federal University of Minas Gerais (UFMG), Federal University of São João del-Rey (UFSJ) and State University of Montes Claros (Unimontes). The SaMi-Trop methodology has been presented in detail in previous publications [20,21].

Research environment

The SaMi-Trop cohort covers an endemic area for CD in the state of Minas Gerais, Brazil. This area consists of 21 municipalities which are located in two remote regions of the state: the northern region of the state and the Jequitinhonha Valley region. Most of these municipalities were small in size, with a high percentage of rural population and high social vulnerability—with the absence or insufficiency of some assets related to urban infrastructure, human capital and income and work, which should, in principle, be available to every citizen, by virtue of State action [22]. In relation to the health sector, most municipalities had 100% coverage of the Family Health Strategy (FHS) which did not offer specialized services [23]. The FHS is the main PHC model in the country and provides health care for the population of a defined territory. The services are provided by a team that includes a doctor, a nurse, a nursing technician or assistant, and community health workers [24]. In Brazil, PHC is the gateway to public health care, being offered in all municipalities. The specialized services in contrast, are regionalized and organized into municipalities with a larger population and better health structure [25].

Study population and recruitment

Patients over 18 years of age who reported having CD, while undergoing electrocardiogram (ECG) exam by a Telehealth program in 2012, were recruited to participate in the cohort. The Telehealth Network of the state of Minas Gerais offers remote support to public PHC services through ECG reports and teleconsulting in several areas of health [26]. The individuals
included in the cohort participated in two assessments to date, with an interval of two years between them. At baseline, which took place from 2013 to 2014, 2,157 individuals participated. In the first follow-up, which took place from 2015 to 2016, 1,709 individuals were assessed. Between stage one and stage two there were 303 losses (people not located or who refused to participate in the follow-up) and 145 deaths. A total of 1,709 individuals were considered eligible to participate in this study, of which 150 were excluded from the analysis because they presented negative serology for the anti-\(T.\) c\(r\)u\(z\)i antibody, and 399 for not presenting an answer for the dependent variable. Thus, 1,160 individuals with CD were included in this study (Fig 1).

**Variables and data sources**

Based on the theoretical model adopted in this study [17], the use of health services in the last year was adopted as an outcome of interest in this study. This variable was built from the question "How long has it been since your last medical consultation related to CD?", and later categorized into "use of health services in the last year" (yes vs. no).

The choice of independent variables (contextual and individual) was also based on the Behavioral Model of the Use of Health Services [17]. According to this model, the use of health services is influenced at the contextual and individual levels, by the following components: predisposing characteristics (existing conditions that predispose individuals to use health services or not, even if these conditions are not directly responsible for use); enabling factors (conditions that facilitate or hinder the use of health services); and need (conditions recognized by individuals or health service providers as health care demanders). These components modulate health behavior (personal health practices that influence an individual’s health status) and an individual’s health outcomes (perceived health status of an individual; health status assessed by a health professional; and satisfaction of the individual in relation to the health care they receive).
The contextual data of the 21 municipalities participating in SaMi-Trop came from official publicly accessible databases of the Brazilian government: Atlas of Human Development in Brazil (Atlas do Desenvolvimento Humano no Brasil—AtlasBr) [22]; Ministry of Health (Ministério da Saúde—MS) [27] and Brazilian Institute of Geography and Statistics—Cities (Instituto Brasileiro de Geografia e Estatística—Cidades—IBGE Cidades) [28]. Data were collected on six variables related to sociodemographic aspects, public health policies, and health indicators. The contextual variables, with the exception of the Municipal Human Development Index (MHDI) variable, are numeric and were dichotomized considering the 25th percentile when it was a negative measure (low values indicated the best situation) or the 75th percentile when it was a positive measure (high values indicated the best situation). The objective of this dichotomization was to separate 25% of the better-off municipalities vs. 75% of the municipalities in the worst situation, since the majority of the municipalities included in this study had low socioeconomic status.

The individual data were collected during the first follow-up of the cohort through interviews and peripheral blood tests. At this stage, patients with CD participating in the cohort were invited to attend a primary care unit in the municipalities on the day and time scheduled for an interview and clinical evaluation, which were carried out by researchers from SaMi-Trop. The interview included socio-demographic data, data on the clinical and therapeutic history of CD, and data on lifestyle, quality of life, and the use of health services (Table 1).

Statistical analysis

A descriptive analysis of the individual variables was subsequently performed, the absolute (n) and relative (%) frequencies were estimated, and the bivariate analysis was performed using Pearson’s chi-square test. Individual variables with a value of \( p \leq 0.20 \) were selected to initially compose the multivariate model, respecting the entry by levels.

After confirming the absence of multicollinearity between contextual and individual variables (correlation < 0.7), Poison Regression analysis with Robust Variance was performed. For the multilevel analysis, the model of fixed effect and random intercept (mixed) was used [32]. A priori, an empty model was considered (only with random intercept and the dependent variable, without the other variables). Subsequently, variables from the first level (contextual variables), followed by variables from the second (individual variables related to individual characteristics) and third level (individual variables related to health behaviors) were included, as proposed by the theoretical model adopted in this study (Table 1). The Prevalence Ratio (PR) and 95% CI were calculated to quantify associations between the outcome and the contextual and individual variables. The model was adjusted at the introduction of each level, keeping in the final model only those with statistical significance (\( p \leq 0.05 \)). Deviance, represented by “-2 loglikelihood”, was used to assess the quality of the fit.

Descriptive and bivariate analyzes were performed using SPSS statistical software version 18.0 (IBM SPSS, IBM Corp., Armonk, United States) and multivariate analysis with STATA version 14.0 (StatCorp, College Station, Texas, 270).

Results

A total of 1,160 people with CD from 21 municipalities in endemic area for disease in the state of Minas Gerais, Brazil participated in this study. Among the participants, 67.8% were female, 58.4% were aged up to 60 years, 60% were literate, 76.8% reported having been diagnosed with CD for more than 10 years, and 77.6% had positive self-perceived health (Table 2).

The prevalence of non-use of health services in the last year related to CD in this population was 23.5% (IC95%: 21.1–25.9), varying from 0% to 37.5% in different municipalities. In the
bivariate analysis (Table 2), the individual variables referring to the "individual characteristics" and "health behaviors" levels selected to compose the multiple model (p ≤ 0.20) were: gender, age, self-declared skin color, literacy, income, functional class, NT-proBNP, severe arterial hypertension, self-perceived health, physical activity, and alcohol use.

According to the adjusted multiple model (Table 3), only one contextual variable influenced the outcome. The prevalence of non-use of health services in the last year was higher among patients with CD living in municipalities with a larger population. At level 2 (individual characteristics), two individual variables remained in the model after adjustment: functional class
Table 2. Descriptive and bivariate analysis of individual characteristics and health behaviors of people with Chagas disease and its association with not using health services in the last year. Minas Gerais, Brazil (n = 1,160).

| Variables                        | Descriptive | Bivariate Use of health services in the last year | p-value * |
|----------------------------------|-------------|--------------------------------------------------|-----------|
| **Individual characteristics**   |             |                                                  |           |
| Gender                           |             |                                                  |           |
| Female                           | 787 (67.8)  | 590 (75.0)                                       | 0.081*    |
| Male                             | 373 (32.2)  | 297 (79.6)                                       |           |
| Age                              |             |                                                  |           |
| 60 years or older                | 482 (41.6)  | 389 (80.7)                                       | 0.004*    |
| Up to 60 years                   | 678 (58.4)  | 498 (73.5)                                       |           |
| Self-reported skin color*        |             |                                                  | 0.034*    |
| Non-white                        | 897 (77.7)  | 673 (75.0)                                       |           |
| White                            | 258 (22.3)  | 210 (81.4)                                       |           |
| Marital status*                  |             |                                                  | 0.453     |
| Single, widowed or divorced      | 399 (34.5)  | 310 (77.7)                                       |           |
| Married or cohabiting            | 758 (65.5)  | 574 (75.7)                                       |           |
| Literacy*                        |             |                                                  | 0.010*    |
| No                               | 462 (40.0)  | 371 (80.3)                                       |           |
| Yes                              | 694 (60.0)  | 512 (73.8)                                       |           |
| **Enabling factors**             |             |                                                  |           |
| Family income*                   |             |                                                  | 0.094*    |
| Up to minimum wage               | 627 (54.2)  | 467 (74.5)                                       |           |
| Above minimum wage               | 530 (45.8)  | 417 (78.7)                                       |           |
| Distance from the Health Unit*   |             |                                                  | 0.870     |
| Over 100 km                      | 54 (5.5)    | 43 (79.6)                                        |           |
| 6 to 99 km                       | 262 (26.6)  | 200 (76.3)                                       |           |
| 0 to 5 km                        | 668 (67.9)  | 512 (76.6)                                       |           |
| **Need**                         |             |                                                  |           |
| Functional class                 |             |                                                  | < 0.001*  |
| With limitations                 | 471 (41.0)  | 390 (82.2)                                       |           |
| Without limitations              | 679 (59.0)  | 488 (71.9)                                       |           |
| NT-proBNP                        |             |                                                  | < 0.001*  |
| Altered                          | 148 (12.8)  | 132 (89.2)                                       |           |
| Normal                           | 965 (83.2)  | 723 (74.9)                                       |           |
| Diabetes mellitus                |             |                                                  | 0.603     |
| Yes                              | 129 (11.1)  | 101 (78.3)                                       |           |
| No                               | 1031 (88.9) | 786 (76.2)                                       |           |
| Systemic arterial hypertension*  |             |                                                  | 0.016*    |
| Yes                              | 771 (66.5)  | 606 (78.6)                                       |           |
| No                               | 389 (33.5)  | 281 (72.2)                                       |           |
| Time since CD diagnosis*         |             |                                                  | 0.409     |
| More than 10 years               | 696 (76.8)  | 548 (78.7)                                       |           |
| 1 to 10 years                    | 199 (22.0)  | 151 (75.9)                                       |           |
| Less than 1 year                 | 11 (1.2)    | 10 (90.9)                                        |           |
| Self-perceived health*           |             |                                                  | 0.003*    |
| Negative                         | 258 (22.4)  | 215 (83.3)                                       |           |
| Positive                         | 895 (77.6)  | 666 (74.4)                                       |           |

(Continued)
and NT-proBNP. This result revealed a higher prevalence of non-use of health services in the last year among patients without functional class limitations and without alterations in NT-proBNP levels. No individual variable referring to level 3 (health behaviors) remained in the model after adjustment.

### Discussion

The results of this study showed that almost a quarter of patients with CD residing in cities in the endemic area in Brazil did not have a medical consultation in the last 12 months related to the disease. The contextual factor "population" (larger population) and individual factors

### Table 2. (Continued)

| Variables                        | Descriptive | Bivariate      | p-value $^*$ |
|----------------------------------|-------------|----------------|--------------|
|                                  |             | Use of health services in the last year |             |
| Individual characteristics       | n (%)       | Yes (%)        | No (%)       |
| Health behaviors                 |             |                |              |
| Personal health practices        |             |                |              |
| Physical activity$^*$             |             |                |              |
| No                               | 279 (24.1)  | 201 (72.0)     | 78 (28.0)    |
| Yes                              | 881 (75.9)  | 686 (77.9)     | 195 (22.1)   |
| Alcohol use$^*$                   |             |                |              |
| Frequent alcohol use             | 22 (1.9)    | 13 (59.1)      | 9 (40.9)     |
| Infrequent alcohol use           | 1137 (98.1)| 874 (76.9)     | 263 (23.1)   |
| Smoking$^*$                      |             |                |              |
| Smoker                           | 61 (5.3)    | 46 (75.4)      | 15 (24.6)    |
| Non-smoker                       | 1099 (94.7)| 841 (76.5)     | 258 (23.5)   |

*Variation of the n = 1,160 because of missing information;

$^*$ Pearson’s chi-squared test;

$^p \leq 0.20$

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### Table 3. Final model of the Multilevel Poisson Regression of the factors associated with the non-use of health services in the last year by people with Chagas disease. Minas Gerais, Brazil (n = 1,160).

| Models                          | Variables                        | PR (IC95%) | p-value |
|---------------------------------|----------------------------------|------------|---------|
| **Level 1 Contextual Characteristics** | Population                     |            |         |
| Smaller population              | 1                                |            |         |
| Larger population               | 1.6 (1.1–2.2)                    | 0.008      |         |
| Deviance (-2log Log likelihood) = 131.860.510 |                       |            |         |
| **Level 2 Contextual Characteristics Individual Characteristics** | Population                     |            |         |
| Smaller population              | 1                                |            |         |
| Larger population               | 1.6 (1.2–2.0)                    | < 0.001    |         |
| Functional class                |                                  |            |         |
| With limitations                | 1                                |            |         |
| Without limitations             | 1.6 (1.2–2.1)                    | 0.001      |         |
| NT-proBNP                       |                                  |            |         |
| Altered                         | 1                                |            |         |
| Not altered                     | 2.2 (1.3–3.6)                    | 0.003      |         |
| Deviance (-2log Log likelihood) = 122.272.774 |                       |            |         |

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related to lower disease severity (functional class without limitations and non-substituted NT-proBNP levels) were associated with a higher prevalence of non-use of the health service in the last year by these patients.

The use of the health service in the last year is recognized as an important marker of access to health care [17]. The European Union has defined the one-year recall period for assessing the use of health services as a way of ensuring comparability between member countries [33]. In Brazil, surveys with national coverage also use the one-year recall period to assess the use of health services in the country [34].

The prevalence of non-use of health services in the last year among patients with CD was similar to the prevalence found for the general Brazilian population (23.8%) and slightly higher than the prevalence found for the general population of the state of Minas Gerais (21.7%) [16]. No previous studies were identified in the national and international literature that pointed out the prevalence of non-use of health services by people with CD or other infectious and parasitic diseases, which made comparisons of this nature impossible.

In Brazil, people with chronic non-communicable diseases (NCDs) used health services twice as often compared to people without NCDs [18]. In this study, most patients with CD who used health services in the last year had overlapping other diseases, such as systemic arterial hypertension (66.5%) and diabetes mellitus (11.1%). Thus, considering the recommendation that people with CD be followed-up by health services through at least one medical consultation per year [11,12], the prevalence of non-use of health services in the last year among CD patients was high.

In the theoretical model adopted in this study [17], the use of health services is influenced by the contextual and individual levels. At the contextual level, the findings of this study pointed out that only the population size of the patient’s municipality of residence affected the non-use of health services in the last year by populations with CD. Living in municipalities with a larger population was consistently associated with a higher prevalence of non-use of health services in the last year by the participants in this study.

Regardless of the FHS coverage, what seems to have favored the non-use of health services by patients with CD in the municipalities with a larger population was the difficulty of access to the health services offered. In Brazil, access to health services through SUS is a social right. The PHC services, which are responsible for offering periodic medical consultations to patients with CD, are public [35]. However, determinants inherent to the structure and organization of health services can generate barriers to access care for patients with CD in different regions of the country [36].

In Brazil, around 23% of the municipalities are medium (25 to 100 thousand inhabitants) and large (more than 100 thousand inhabitants) [37]. Municipalities with a larger population have more complex health systems and greater difficulty in structuring PHC and consolidating a preventive health care model [38]. In larger municipalities, it is also observed that the availability of health services may not be known to everyone, and the degree of information about the services available varies between different population groups [39]. Reports by PHC doctors in a medium-sized municipality endemic for CD pointed out that the disease was a hidden problem for PHC. According to the reports of these doctors, the lack of registration of patients with CD in PHC services was one of the main factors that contributed to the invisibility of the disease in the health system [36].

In smaller municipalities, residents and health workers are more likely to get to know each other and have a closer relationship, which facilitates access to information and the scheduling of consultations and exams [40]. A study that evaluated access to PHC services in small municipalities in Brazil showed that the functioning of these services on all days of the week, opening hours appropriate to the needs of patients, and ease in scheduling appointments were factors...
that enabled the use of health services in these municipalities, promoting more equitable access [41].

Regarding the individual level, the non-use of health services in the last year by patients with CD was influenced exclusively by health needs. Presenting functional class without limitations and levels of NT-proBNP without alterations were associated with a higher prevalence of non-use of health services in the last year by these patients. This finding shows that the use of services in the last year by patients with CD was motivated by the presence of symptoms and severity of the disease. A study carried out with PHC doctors from an endemic region in Brazil also pointed out that the search for medical care by patients with CD also happened only when there was the presence of some complication [36].

The limitation of the functional class is known to be associated with death caused by increased myocardial dysfunction. NT-proBNP levels are accurate discriminators of the diagnosis of heart failure, powerful predictors of death, and assist in the risk stratification of patients with CD [31]. Patients with symptomatic or asymptomatic CD should be followed-up by the health services through annual medical consultations for early detection of the clinical progression of the disease and early implementation of therapy for the treatment of visceral complications. Regular follow-up of these patients in health services can contribute to a reduction in mortality from CD [10] in both endemic and non-endemic regions.

In Brazil, one of the main reasons for seeking care in health services is illness or disease treatment (48.2%) [16], which reveals clinical diagnosis as a condition for frequent use of health services [42]. According to a systematic review of qualitative studies, factors such as the absence of symptoms and the impact on daily activities have negatively influenced the search for medical care by patients with CD in endemic areas [43].

The failure to use health services in the last year by patients with CD motivated by the absence of symptoms and the severity of the disease can also be an indicator of the lack of public health policies for comprehensive care to populations affected by the disease. Failure to perform screening and early diagnosis of the disease may contribute to the patient’s lack of perception of the need to use health services to prevent complications. Thus, there is an urgent need to develop approaches for comprehensive, sustained, efficient, timely, adequate, and accessible medical care, focused on universal coverage and comprehensive care for populations with CD [44].

Individual factors such as gender, age, self-declared skin color, education, and income did not influence the non-use of health services in the last year by patients with CD participating in this study, possibly because this population was relatively homogeneous in terms of sociodemographic profile.

This study has some limitations. There is a certain homogeneity of the population in terms of sociodemographic characteristics. The variable “use of health services in the last year” was analyzed retrospectively, based on the respondent’s memory. And, despite the short period of interest (12 months), the presence of memory bias cannot be ruled out. Contextual data refer to time periods different from individual data due to the unavailability of updated data in the official publicly accessible databases of the Brazilian government at the time of collection. The participation of CD patients in a cohort study may motivate them to seek medical care. However, this is the first study with a multilevel approach that assessed the contextual and individual influence on the non-use of health services by populations affected by CD. The results of this study have important implications for the planning of health care policies aimed at these populations.

This study revealed that the non-use of health services in the last year by patients with CD from endemic area in Brazil was influenced by the population size of the municipality where these patients live and by the absence of symptoms and severity of the disease. According to
these results, individual determinants are not isolated protagonists of the non-use of health services by people with CD. The context in which these people live also determines the non-use of health services, which reinforces the need for public policies that consider the contextual determinants of the use of health services by populations affected by the disease.

Supporting information

S1 STROBE Checklist. Checklist. (DOCX)

S1 Database. Data that underlies this paper. (XLSX)

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References
1. World Health Organization. Chagas disease. Geneva: World Health Organization; 2020. https://www.paho.org/en/topics/chagas-disease
2. World Health Organization. Integrating neglected tropical diseases into global health and development: fourth WHO report on neglected tropical diseases. Geneva: World Health Organization; 2017. https://www.who.int/neglected_diseases/resources/9789241565448/en/
3. World Health Organization. Global Health Estimates 2016: Disease burden by Cause, Age, Sex, by Country and by Region, 2000–2016. Geneva: World Health Organization; 2018.
4. World Health Organization. Chagas disease in Latin America: an epidemiological update based on 2010 estimates. Geneva: World Health Organization; 2015.
5. Dias JC, Coura JR, Yasuda MAS. The present situation, challenges, and perspectives regarding the production and utilization of effective drugs against human Chagas disease. Rev Soc Bras Med Trop. 2014; 47(1): 123–5. https://doi.org/10.1590/0037-8682-0248-2013 PMID: 24603750
6. Marchiol A, Forsyth C, Bernal O, Valencia C, Cucunubá Z, Pachón E, et al. Increasing access to comprehensive care for Chagas disease: development of a patient-centered model in Colombia. Rev Panam Salud Publica. 2017; 41: 153. https://doi.org/10.26633/RPSP.2017.153 PMID: 31384272
7. Alonso-Padilla J, Cortés-Serra N, PINazon MI, Bottazzi ME, Abril M, Barreira F, et al. Strategies to enhance access to diagnosis and treatment for Chagas disease patients in Latin America. Expert Review of Anti-infective Therapy. 2019; 17:145–157. https://doi.org/10.1080/14787210.2019.1577731 PMID: 30712412
8. Iglesias-Rus L, Romay-Barja M, Boquete T, Benito A, Blasco-Hernández T. The role of the first level of health care in the approach to Chagas disease in a non-endemic country. PLoS Negl Trop Dis. 2019; 13(12): e0007937. https://doi.org/10.1371/journal.pntd.0007937 PMID: 31841503
9. Forsyth C, Meymandi S, Moss I, Cone J, Cohen R, Batista C. Proposed multidimensional framework for understanding Chagas disease healthcare barriers in the United States. PLoS Negl Trop Dis. 2019; 13(9): e0007447. https://doi.org/10.1371/journal.pntd.0007447 PMID: 31557155
10. Pérez-Molina JA, Perez AM, Norman FF, Monge-Maillo B, López-Vélez R. Old and new challenges in Chagas disease. Lancet Infect Dis. 2015; 15: 1347–56. https://doi.org/10.1016/S1473-3099(15)00243-1 PMID: 26231478
11. Dias JC, Paim JP, Gontijo ED, Luqueatto A, Shikanai-Yasuda MA, Coura JR, et al. 2nd Brazilian Consensus on Chagas Disease, 2015. Rev Soc Bras Med Trop. 2016; 49(1): 3–60. https://doi.org/10.1590/0037-8682-0505-2016 PMID: 27982292
12. Ministério da Saúde (Brasil). Portaria n.º 57, de 30 de outubro de 2018. Torna pública a decisão de aprovar o Protocolo Clínico e Diretrizes Terapêuticas da doença de Chagas, no âmbito do Sistema Único de Saúde—SUS. Diário Oficial da União 31 out 2018; Seção 1, p. 41.
13. Mendes FSNS, Perez-Molina JA, Anhebben A, Meymandi SK, Sosa-Estani S, Molina I. Critical analysis of Chagas disease treatment in different countries. Mem Inst Oswaldo Cruz. 2021; 116: e210034. https://doi.org/10.1590/0074-02760210034 PMID: 35830002
14. Paim J, Travassos C, Almeida C, Bahia L, Macinko J. The Brazilian health system: history, advances, and challenges. Lancet. 2011; 377(9779): 1778–97. https://doi.org/10.1016/S0140-6736(11)60054-8 PMID: 21561655
15. Atun R, Andrade LOM, Almeida G, Cotlear D, Dmytraczenko T, Frenz P, et al. Health-system reform and universal health coverage in Latin America. Lancet. 2015; 385(9974): 1230–47. https://doi.org/10.1016/S0140-6736(14)61646-9 PMID: 25458725
16. Instituto Brasileiro de Geografia e Estatística. Pesquisa Nacional de Saúde 2019: informações sobre domicílios, acesso e utilização dos serviços de saúde—Brasil, grandes regiões e unidades da federação [Internet]. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística; 2020 [cited 2020 Nov. 25]. https://biblioteca.ibge.gov.br/visualizacao/livros/liv101748.pdf
17. Andersen RM, Davidson PL. Improving access to care in America: Individual and contextual indicators. Changing the US Health Care System: Key Issues in Health Services Policy and Management. 2007.
18. Malta DC, Bernal RTI, Lima MG, Araújo SSC, Silva MMA, Freitas MIF, et al. Doenças crônicas não transmissíveis e a utilização de serviços de saúde: análise da Pesquisa Nacional de Saúde no Brasil. Rev Saude Publica. 2017; 51 Supl 1: 4s.
19. Chiavegatto Filho AD P, Wang YP, Malik AM, Takaoka J, Viana MC, Andrade LH. Determinants of the use of health care services: multilevel analysis in the Metropolitan Region of Sao Paulo. Rev. Saúde Pública. 2015; 49: 15. https://doi.org/10.1590/s0034-8910.2015049005246 PMID: 25741652

20. Cardoso CS, Sabino EC, Oliveira CDL, Oliveira LC, Ferreira AM, Cunha-Neto E, et al. Longitudinal study of patients with chronic Chagas cardiomyopathy in Brazil (SaMi-Trop project): a cohort profile. BMJ Open. 2016; 6: e011181. https://doi.org/10.1136/bmjopen-2016-011181 PMID: 27147390

21. Ferreira AM, Sabino EC, De Oliveira LC, Oliveira CDL, Cardoso CS, Ribeiro ALP, Haikal D.S. Benzindazole use among patients with chronic Chagas' cardiomyopathy in an endemic region of Brazil. PLoS ONE. 2016; 11: 0165950. https://doi.org/10.1371/journal.pone.0165950 PMID: 27855177

22. Programa das Nações Unidas para o Desenvolvimento; Instituto de Pesquisa Econômica e Aplicada, Fundação João Pinheiro [Internet]. Atlas de Desenvolvimento Humano no Brasil [cited 2017 Dez. 18]. http://www.atlasbrasil.org.br/perfil

23. Ministério da Saúde [Internet]. Cadastro Nacional de Estabelecimentos de Saúde [cited 2017 Dez. 18]. http://cnes.datasus.gov.br/

24. Castro MC, Massuda A, Almeida G, Menezes-Filho NA, Andrade MV, de Souza Noronha KV, et al. Brazil's unified health system: the first 30 years and prospects for the future. Lancet. 2019; 394 (10195):345–356. https://doi.org/10.1016/S0140-6736(19)31243-7 PMID: 31303318

25. Santos L. Região de saúde e suas redes de atenção: modelo organizativo-sistêmico do SUS. Ciênc. Saúde Coletiva. 2017; 22(4):1281–1289.

26. Alkmim MB, Figueira RM, Marcolino MS, Cardoso CS, Pena de Abreu M, Cunha LR, et al. Improving patient access to specialized health care: the Telehealth Network of Minas Gerais, Brazil. Bull World Health Organ. 2012; 90(5):373–8. https://doi.org/10.2471/BLT.11.099408 PMID: 22589571

27. Ministério da Saúde [Internet]. Secretaria de Atenção Primária à Saúde, Departamento de Saúde da Família. Sistema de Nota Técnica do Departamento de Saúde da Família [cited 2017 Dez. 18]. Available from: http://sisaps.saude.gov.br/notaecnica/frmListaMunic.php

28. Instituto Brasileiro de Geografia e Estatística [Internet]. Cidades. [cited 2017 Dez. 18]. https://cidades.ibge.gov.br/

29. Chaicko KA. AHA Medical/Scientific Statement: 1994 revisions to classification of functional capacity and objective assessment of patients with diseases of the heart. Circulation. 1995; 92(7):2003–5. PMID: 7671385

30. Maisel A, Mueller C, Adams KJ, Anker SD, Aspromonte N, Cleland JG, et al. State of the art: using natriuretic peptide levels in clinical practice. Eur J Heart Fail. 2008; 10(9):824–39. https://doi.org/10.1016/j.ejheart.2008.07.014 PMID: 18760965

31. Lima-Costa MF, Cesar CC, Peixoto SV, Ribeiro AL. Plasma B-type natriuretic peptide as a predictor of mortality in community-dwelling older adults with Chagas disease: 10-year follow-up of the Bambuí Cohort Study of Aging. Am J Epidemiol. 2010; 172(2):190–6. https://doi.org/10.1093/aje/kwq106 PMID: 20581155

32. Snijders TAB. Multilevel analysis. Springer Berlin Heidelberg 2011; 879–882.

33. Allin S, Masseria C, Sorenson C, Papanicola I, Mossialos E. Measuring inequalities in access to health care: a review of the indices?: European Commission Brussels, Belgium; 2007. http://eprints.lse.ac.uk/29837/

34. Almeida AME, Tolentino SM, Andrade KRC, Galvão TF, Pereira MG. Prevalência de utilização de serviços de saúde no Brasil: revisão sistemática e metanalise. Epidemiol. Serv. Saúde. 2017 Sep; 26(3): 589–604. https://doi.org/10.5123/S1679-49742017000300016 PMID: 28977183

35. Viacava F, Oliveira RAD, Carvalho CC, Laguardia J, Bellido JG. SUS: oferta, acesso e utilização de serviços de saúde nos últimos 30 anos. Ciênc. saúde coletiva. 2018; 23(6): 1751–1762.

36. Damasceno RF, Sabino EC, Ferreira AM, Ribeiro ALP, Moreira HF, Prates TEC, et al. Challenges in the care of patients with Chagas disease in the Brazilian public health system: A qualitative study with primary health care doctors. PLoS Negl Trop Dis. 2020; 14(11): e0008782. https://doi.org/10.1371/journal.pntd.0008782 PMID: 33166066

37. Calvo MCM, Lacerda JT, Colussi CF, Schneider IJC, Rocha TAH. Estratificação de municípios brasileiros para avaliação de desempenho em saúde. Epidemiol. Serv. Saúde. 2016; 25(4): 767–776. https://doi.org/10.5123/S1679-49742016004000010 PMID: 27869970

38. David GC, Shimizu HE, Silva EN. Atenção Primária à Saúde nos municípios brasileiros: eficiência e disparidades. Saúde debate. 2015; 39(spe): 232–245.

39. Goddard M, Smith P. Equity of access to health care services: theory and evidence from the UK. Soc Sci Med. 2001; 53: 1149–62. https://doi.org/10.1016/s0277-9536(00)00415-9 PMID: 11556606
40. Ferreira AM, Sabino EC, Oliveira LC, Oliveira CDL, Cardoso CS, Ribeiro ALP, et al. Impact of the social context on the prognosis of Chagas disease patients: Multilevel analysis of a Brazilian cohort. PLoS Negl Trop Dis. 2020; 14(6): e0008399. https://doi.org/10.1371/journal.pntd.0008399 PMID: 32598390

41. Carvalho BR, Ferreira JBB, Fausto MCR, Forster AC. Avaliação do acesso às unidades de atenção primária em municípios brasileiros de pequeno porte. Cad. Saúde Colet. 2018; 26(4): 462–469.

42. Bibiano AMB, de Lima Silva V. da Silveira Moreira R. Factors associated with the use of health services by elderly men in Brazil: a cross-sectional study. BMC Public Health. 2019; 19(1): 859. https://doi.org/10.1186/s12889-019-7232-0 PMID: 31266478

43. Ventura-Garcia L, Roura M, Pell C, Posada E, Gascón J, Aldasoro E, et al. Socio-Cultural Aspects of CD: A Systematic Review of Qualitative Research. PLoS Negl Trop Dis. 2013; 7(9):e2410. https://doi.org/10.1371/journal.pntd.0002410 PMID: 24069473

44. World Health Organization [Internet]. Chagas Disease in the Americas: A Review of the Current Public Health Situation and a Vision for the Future. Report: Conclusions and Recommendations Washington, D.C. [cited 2020 Ago. 20]. https://www.who.int/publications/i/item/Chagas-Disease-in-the-Americas-conclusions-recommendations-2018.