Physical Disabilities Caused by Leprosy in 100 Million Cohort in Brazil

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Abstract

Background: Leprosy continues to be an important cause of physical disability in endemic countries such as Brazil. Knowledge of determinants of these events may lead to better control measures and provide , as targeted interventions may to mitigate their its impact on affected individuals. This study investigated such determinants factors among the most vulnerable portion of the Brazilian population.

Methods: A large cohort was built from secondary data originated from a national registry of applicants to social benefit programs, spanning covering the period 2001- to 2015, and including over 114 million individuals. Data were linked to the Leprosy leprosy disease notification system utilizing data from 2007 until 2014. Descriptive and bivariate analyses lead to the a multivariate analysis using a multinomial logistic regression model with cluster-robust standard errors. Associations were reported as Odds Ratios with their respective 95% confidence intervals

Results: Among the original cohort members 21,565 new leprosy cases were identified between 2007-2014 were identified among the original cohort members from the study period. Most of the cases (63.1%) had grade zero disability. Grades 1 and 2 represented 21% and 6%, respectively. Factors associated with increasing odds of grades 1 and 2 disability were age over 15 years old (ORs 2,39 and 1,95 respectively), having less schooling (with a clear dose response effect), being a multibacillary patient (ORs 3,5 and 8,22). Protective factors for both grades were being female (ORs 0,81 and 0,61) and living in a high incidence municipality (ORs 0,85 and 0,65).

Conclusions: The findings suggest that the developing of physical disabilities remain a public health problem which incresead the burden of leprosy, mainly for those with severe clinical features and worse socioeconomic condtions. Early diagnosis is paramount to decrease the incidence of leprosy-related disability and our study point to the need for strengthening control actions in non-endemic areas in Brazil, where cases may be missed when presented at early stages in disease. Both actions are needed, to benefit patients and to achieve the WHO goal in reducing physical disabilities among new cases of leprosy.Worse socioeconomic conditions might act as barriers to early diagnosis, which increases the risk of developing physical disabilities. Early diagnosis is paramount to decrease the incidence of leprosy-related disability, and our findings point to the need for strengthening these actions in non-endemic areas, where cases may be missed when presented at early stages in disease progression. In addition, data linkage proved to be useful in generating evidence for improving policy target at leprosy control in Brazil.

Background

Chronic infections with *Mycobacterium leprae* have the potential to cause lasting nerve damage and physical disabilities [1, 2]. Among patients with leprosy, physical disabilities arise as a result of late diagnoses and/or insufficient treatments. The incidence of leprosy-associated disabilities among newly detected cases is, therefore, an important indicator of gaps in population-level leprosy control strategies. Leprosy cases are classified as: Grade 0 disability (G0D) when muscle strength and sensitivity of these segments are preserved; Grade 1 (G1D) when there is decreased muscle strength and/or decreased sensitivity; and Grade 2 (G2D) when there are visible deformities in the hands, feet, and/or eyes [3, 4].

As part of the 2016-2020 Global Leprosy Strategy, the WHO has set a target of reducing the rate of newly diagnosed leprosy patients with G2D to less than 1 per million population [4]. Within Brazil, a country with a high leprosy new case detection rate (13.7/100,000 population in 2018), the National Leprosy Disease Program has similarly prioritized reducing the rate of diagnoses with G2D as a primary goal. From 2012 to 2016, the mean rate of leprosy new case detections with G2D in Brazil was 10.5 per 1 million inhabitants, with an average of 2,042 people diagnosed annually with leprosy-related G2D in this period [5]. In the last decades, Brazil has adopted extensive public health measures to improve the assessment and prevention of leprosy-related physical disabilities [6]. Nevertheless, a systematic review conducted by Vieira et al. (2018) [7], indicates that the proportion of leprosy cases involving disability among children <15 years remains high in Brazil, reflecting active transmission and challenges for case detection.

Although there have been large-scale studies in Brazil studying the social determinants of leprosy incidence and treatment default [8, 9], risk factors for leprosy-associated disability at the time of diagnosis remain scarcely investigated. In Brazil, there are problems related to underdiagnosis and underreporting of new cases of leprosy, which hashave a major impact on the ability to plan control control activities for the disease. In addition, primary health services face difficulties in monitoring patients after completing treatment and monitoring disabilities. Using nationwide linked data from the 100 Million Brazilian Cohort, this study used large-scale data to identify risk factors for having leprosy-related physical disabilities at the time of diagnosis.

Methods

<u>Study Design and Data source</u>

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The 100 Million Brazilian Cohort [10, 11] was built by linking health and administrative records of individuals registered in the *Cadastro Único para Programas Sociais* (CadÚnico), a national registry for social assistance programs in the country. This database was created at the Centro de Integração de Dados e Conhecimentos para Saúde at Oswaldo Cruz Foundation (Cidacs, Salvador, Bahia, Brazil) and is part of the Center's mission to evaluate the impact of social determinants and policies on health. The cohort includes administrative records from over 114 million individuals who applied for social assistance between 2001 and 2015.

As previously described [8, 9, 12, 13] the data from the 100 Million Brazilian Cohort was then linked to leprosy notification records in the national notifiable disease system, *Sistema de Informação de Agravos de Notificação*, SINAN-leprosy.

Settings and Participants

The study population for this investigation included members of the 100 Million Brazilian Cohort followed from January 1st 2007 until December 31st 2014. Cohort members were excluded if they: (i) were diagnosed with leprosy prior to registration in CadÚnico, (ii) belonged to family units with no member aged over 15 years (i.e., children registered separately from their families), (iii) had less than one day of follow-up, (iv) were relapsed leprosy cases or (v) did not have information on grade of disability at diagnosis.

Outcome and exposures

For this study, the primary outcome was the detection of physical disabilities caused by leprosy, classified by grade 0 (G0D), grade 1 (G1D) or grade 2 (G2D).

Exposure variables were related to individual socioeconomic indicators (i.e. sex, age, self-identified race/ethnicity, literacy, schooling, and employment status) and household living conditions (i.e. household density, housing materials, water source, electricity source, sewage disposal, and waste disposal). For children younger than 18 years, education and employment were reported as the education level and employment status of the head of the family (here defined as the oldest member of the family).

Geographic exposures included region of residence, urbanicity (urban or rural), and residence in a 'high-burden cluster'). Risks within clusters of higher incidence were investigated as defined by Penna et al. (2009) [14], based on epidemiological data from 1980 until 2007. These clusters were described as 29 spatial clusters comprising 789 municipalities and were devised to facilitate decision-making for leprosy control in Brazil. Although these were defined more than ten years ago, a recent study [15] analyzed the spatial distribution of leprosy in selected endemic regions of the country comparing the periods 2001-2003 versus 2010-2012 and concluded that there is significant overlap of clusters comparing both time periods.

Clinical exposures included the operational classification of leprosy (i.e. paucibacillary or multibacillary [PB or MB]) and the number of skin lesions.

Statistical Analysis

Descriptive analysis was performed to assess the distribution of the independent variables, followed by bivariate analysis with the outcome (presence of any degree of disability) to assess the strength of association between independent variables and grade of disability at diagnostic. Those with a p-value less than 0.1 were considered eligible for the multivariate model.

For the multivariate analysis, a multinomial logistic regression model with cluster-robust standard errors (i.e., accounting for familial clustering of covariates) to estimate the adjusted odds ratios (OR) was used, with grade zero disability cases used as the reference category.

All analyses were performed using Stata, version 15.0 (Stata Corp LLC, College Station, Texas, USA).

Ethics

This study was performed under the international (Helsinki), Brazilian and UK research regulations and was approved by the Three Ethics Committee of Research: (i) University of Brasília (1.822.125), (ii) Instituto Gonçalo Muniz - Fiocruz (1.612.302) and (iii) London School of Hygiene and Tropical Medicine's Research Committee (10580 – 1).

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Role of Funding Source

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Results

The study population included 21,565 new leprosy cases detected in Brazil between 2007 to 2014 (Figure 1). At the time of diagnosis, 15,095 (63.1%) cases had G0D, while grades 1 and 2 represented 21% (5,026) and 6% (1,444), respectively. In the multivariate model, 16,376 cases were included, as missing values for some variables prevented a number of cases from being included.

Newly detected leprosy cases had a mean age of 37.6 years old, varying by the grade of disability (G0D 34.9; G1D 43.4; G2D 45.7) (Table 1). Overall, 49.6% of the leprosy cases were female, 72.1% was identified as mixed race ("pardo"), 61% had up to 4 years of schooling and 79.3% were literate, and 50.9% were unemployed or unemployed but currently studying. Although 81.8% earned up to 0.5 minimum wage, 11.3% reported no source of income. Most of the leprosy cases lived in urban areas (79.5%) and in the Northeast (40.4%) and the North (23.6%) regions. The greater proportion of the cases lived in municipalities that belonged to the epidemiologically-defined high incidence clusters (63.8%). Also, 69.3% of the cases lived in brick or cement-made dwellings, with publicly provided water, garbage collection and electricity. However, 67% of them reported using a homemade tank as a sewage disposal system. There were more MB cases than PB (59.2% vs 40.8%) at time of diagnosis (Table 1).

In multivariate analysis, the odds of G1D were higher among leprosy cases aged over 15 years (OR 2.39; 95%CI 2.06-2.77), as well as among those with lower levels of education – no education/pre school (OR 1.64; 95%CI 1.40-1.93), ≤10 years of education (OR 1.48; 95%CI 1.28-1.70), and >10 and ≤14 years of education (OR 1.28; 95%CI 1.10-1.48) – , unemployed (OR 1.19; 95%CI 1.06-1.32) and living in rural areas (OR 1.14; 95%CI 1.04-1.26) (Table 2). Cases with multibacillary leprosy (OR 3.50; 95%CI 3.13-3.92) and with lesions (OR 1.12; 95%CI 1.02-1.24) were also more likely to have G1D. Factors that showed to be protective against G1D included being female (OR 0.81; 95%CI 0.75-0.88), increased household density (>1 inhab/romm – OR 0.79; 95%CI 0.71-0.88) and living in a cluster municipality (OR 0.85; 95%CI 0.78-0.93) (Table 2).

For G2D, the model showed similar risk factors to the G1D analysis (Table 2). Both, age above 15 years old (OR 1.95; 95%CI 1.51-2.50), lower levels of education appeared to influence the odds of had G2D, specifically, no education/pre school (OR 1.91; 95%CI 1.44-2.53) and ≤10 years of education (OR 1.64; 95%CI 1.27-2.12). Being a multibacillary leprosy case was also a risk factor (OR 8.22; 95%CI 6.51-10.38) to have G2D. However, being female (OR 0.61; 95%CI 0.53-0.70) and living in a high incidence municipality (OR 0.67; 95%CI 0.58-0.78) decreased the odds of presenting G2D at diagnosis. Protective effects were also observed for living in the North (OR 0.53; 95%CI 0.39-0.72), Northeast (OR 0.53; 95%CI 0.39-0.71) and Central-West regions (OR 0.50; 95%CI 0.36-0.68) (Table 2).

Discussion

This study investigated factors associated with leprosy-related disability in a large Brazilian set of 21,565 new leprosy cases. Our results showed lower odds of have grade 1 or grade 2 physical disabilities associated to women, living in the North, Northeast and Center-West regions or in high-incidence clusters, in urban areas, and increased household crowding. However, new leprosy cases aged over 15 years, with a lower levels of education, unemployed and with multibacillary leprosy had higher chances of presenting grade 1 or grade 2 physical disabilities at diagnosis.

The higher likelihood of leprosy-related disabilities found among those older than 15 years is similar to previous studies. In a hyperendemic area of the Center-West region of Brazil, the estimated risk ratio of grade 2 disability was 5.3 times higher among patients aged ≥ 45 years [16]. In the state of Minas Gerais, a retrospective study showed that age above 15 years was an important risk factor for the development of physical disability in leprosy patients as well [17]. A study of patients from the state of Maranhão showed a progressive increase in the chances of developing physical disability among those older than 15 years, ranging from 3 to 10.4 times higher risk [18]. Considering that the duration of the disease is directly related to age and, given the chronic profile of leprosy effects, increasing age may result in more advanced disabilities [17, 19].

Regarding gender, some studies did not identify an association between gender and level of disability [20–22]. However, other studies reported higher grades of physical disability among male individuals with leprosy [17, 23].

Men are generally more exposed to *M. leprae* and have reduced contact with health care, which may delay diagnosis and increases the risk of developing physical disabilities [24]. For the general population in Brazil, between 2012 and 2016, the detection rate of new cases with physical disability grade 2 was higher in males. This rate was 15.2 and 6.1 cases per 1 million among men and women, respectively [5]. Cultural factors may explain the difference by gender as women may be more likely to seek health assistance than men [18].

Our study also suggests that higher levels of education were negatively associated with the presence of physical disabilities at diagnosis, which is consistent with the literature [16, 17]. Higher education has been shown to be associated with better understanding of the disease and, consequently, better access and utilization of health services. Regular treatment and evaluation, as well as self-care, are aspects that prevent the worsening of leprosy cases [17, 25].

The fact that cases from the Northeast and the North regions were less likely to present G1D and G2D contrasts with the findings from Freitas and colleagues (2016) [15], which showed greater proportions of G2D in municipalities with higher incidence rates of leprosy. They hypothesize that “in these municipalities, at least in the short term, a consequence of increased surveillance actions may be the initial increase in the ‘detected’ cases of the disease. In turn, this increase may lead to increased tracing of people who have had contact with it and greater detection of cases with grade 2 disability, which previously were not identified. This hypothesis may explain the finding that municipalities with a greater proportion of cases presenting with grade 2 disability also had higher average leprosy incidence rates.” However, the areas with higher endemicity do not have a better structure surveillance and care system, as they are systematically poorer. The clusters are located in areas that are more vulnerable.

Therefore, we hypothesize that this fact is likely due to a more sensitive health staff and surveillance system to case detection, therefore more capable of detecting leprosy cases earlier. Assuming that disability is a marker for late diagnosis, it is expected that regions of high endemicity will show a lower chance of patients presenting with grades 1 and 2 disability. G2D, as already mentioned, may indicate late diagnosis and a suboptimal surveillance system. According to Penna et al. (2009) [14], access to primary health care units has improved mainly in rural areas and small towns, improving the diagnosis of leprosy in the first decade of this century. However, as her work emphasizes, “the diagnosis of skin diseases depends on the cultural importance given to skin lesions, as well as health-seeking habits among the population.”

The study by Freitas et al. (2014) [26] looked at risk factors and identified a high new case detection rate in the Central-West and North regions compared to the South, large cities and greater urbanization, median and high illiteracy rate, income inequality (Gini index), domiciles’ agglomeration, worse sanitation condition, and percentage of cases with grade 2-disability.

Although we found similar evidence that individuals living in urban areas were at greater risk of leprosy detection than individuals living in rural areas, we did not find evidence of an association of household density with leprosy risk in the full cohort. It is, however, noteworthy that in subgroup analyses increased household density (more than one resident per two rooms) was associated with an increased leprosy risk in children, a group indicative of active transmission [8].

The association between the proportion of multibacillary leprosy and presentation of G2D has been shown in the past [16, 27, 28]. Studies conducted in some Brazilian cities indicate that at the time of diagnosis, educational level and operational classification are statistically associated with the development of physical disabilities. It is emphasized that multibacillary patients are twice more likely to develop sequelae than paucibacillary individuals [29].

Our study has several strengths: the large sample size and extensive follow up period allowed us to evaluate determinants of disability to an extent that is rarely possible. This study linked data from over 100 million individuals and was able to assess factors associated with physical disability in an unprecedented way. Additionally, using administrative databases linkade we also were able to evaluate a wider range of variables present in CadÚnico. Unlike other studies, we analyzed the most vulnerable fraction of the Brazilian population, for whom biological and poverty-related risk factors for leprosy overlap.

Nevertheless, our study has some limitations. The use of secondary data originated from routine surveillance activities always brings the issue of completeness of information. We did not have complete information on disability evaluation at diagnosis (n=1,557) and at discharge. The latter was poorly collected to an extent that did not allow us to use that timepoint in the analysis. Efforts should be undertaken to stress the importance of performing this evaluation at discharge and record it in the information systems. Other factors associated with disability were not available in our database and therefore, could not be assessed, such as health services characteristics and patients’ perception and knowledge about leprosy.

Conclusion

The findings suggest that the developing of physical disabilities remain a public health problem, which incresead the burden of leprosy, mainly for those with severe clinical features and worse socioeconomic condtions. Early diagnosis is paramount to decrease the incidence of leprosy-related disability and focus should be given to younger patients, which reflect recent and active transmission. Our study pointpoints to the need for strengthening control actions in non-endemic areas in Brazil, where cases may be missed when presented at early stages in disease. It is imperative to train staff in less endemic areas to become sensitive to leprosy, aiming at reducing under detection. Besides early diagnosis and timely treatment, social protection policies and initiatives are key to lead us to effective leprosy control – evidence that has been put forth a century ago[30] and yet remains valid.

Data linkage proved a powerful tool to shed more light on identifying potential causal factors of disabilities among the poorest Brazilian population. However, there is need for further studies on GIF-related socioeconomic and clinical factors at the end of treatment, issues we could not address in our study. Future research should also explore if the findings found in this work will replicatebe similar among relapses or reinfections; considering we focused exclusively on new cases. Finally, it is necessary to state that the main reason for leprosy to be a public health problem lies in the fact that it causes physical disabilities in people of working age. This is the reason why WHO has set the goal of drastically reducing these disabilities among new cases.

Declarations

Ethics approval and consent to participate

This study was performed under the international (Helsinki), Brazilian and UK research regulations and was approved by the Three Ethics Committee of Research: (i) University of Brasília (1.822.125), (ii) Instituto Gonçalo Muniz - Fiocruz (1.612.302) and (iii) London School of Hygiene and Tropical Medicine's Research Committee (10580 – 1).

Consent for publication

Not applicable

Availability of data and materials

The data that support the findings of this study are available from Center of Data and Knowledge Integration for Health (Cidacs – https://cidacs.bahia.fiocruz.br/) but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of Cidacs.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

- MNS participated in the study conceptualization, investigation, formal analysis and visualization, writing of the original draft, interpretation of the results and revision and editing of the final version of the manuscript.
- JSN participated in the study conceptualization, investigation, formal analysis and visualization, writing of the original draft, interpretation of the results and revision and editing of the final version of the manuscript. She also participated in the supervision and funding acquisition.
- JMP participated in the investigation, formal analysis and visualization, interpretation of the results and revision and editing of the final version of the manuscript.
- AAM participated in the investigation, formal analysis and visualization, interpretation of results and revision and editing of the final version of the manuscript.
- MYI participated in the investigation, interpretation of results and revision and editing of the final version of the manuscript.
- CSST participated in formal analysis and visualization, interpretation of the results and revision and editing of the final version of the manuscript.
- MLFP participated in the interpretation of the results and revision and editing of the final version of the manuscript. She also participated in the supervision and funding acquisition.
- LS participated in the interpretation of the results and revision and editing of the final version of the manuscript.
- LCR participated in the study conceptualization, interpretation of the results and revision and editing of the final version of the manuscript. She also participated in the supervision and funding acquisition.
- MLB participated in the study conceptualization, interpretation of the results and revision and editing of the final version of the manuscript. He also participated in the supervision and funding acquisition.
- EBB participated in the study conceptualization, investigation, formal analysis and visualization, interpretation of the results and revision and editing of the final version of the manuscript.
- GOP participated in the study conceptualization, interpretation of the results and revision and editing of the final version of the manuscript. He also participated in the supervision and funding acquisition.

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Tables

Table 1. Characteristics of leprosy cases evaluated for physical disabilities. The 100 Million Brazilian Cohort, 2007-2014.

Variables	Physical Disabilities			Total
	Grade 0 (N=15,095) n(%)	Grade 1 (N=5,026) n(%)	Grade 2 (N=1,444) n(%)	n(%)
Individual characteristics				
Age (Mean [SD])	34.9 (19.2)	43.4 (18.6)	45.7 (19.0)	37.6 (19.5)
Sex				
Male	6,984 (46.3)	2,915 (58.0)	965 (66.8)	10,864 (50.4)
Female	8,111 (53.7)	2,111 (42.0)	479 (33.2)	10,701 (49.6)
Ethnicity				
White	2,645 (17.9)	1,076 (21.8)	330 (23.2)	4,051 (19.2)
Black	1,178 (8.0)	412 (8.4)	132 (9.3)	1,722 (8.1)
Asian	49 (0.3)	19 (0.4)	1 (0.1)	69 (0.3)
Mixed (brown)	10,879 (73.5)	3,406 (69.0)	956 (67.3)	15,241 (72.1)
Indigenous	48 (0.3)	20 (0.4)	1 (0.1)	69 (0.3)
Ignored/Missing				455 (0.02)*
Literacy				
Yes	12,182 (81.5)	3,714 (74.6)	1,028 (71.6)	16,924 (79.3)
No	2,760 (18.5)	1,262 (25.4)	407 (28.4)	4,429 (20.7)
Ignored/Missing				234 (0.01)*
Schooling				
No education/Pre-school	2,266 (17.0)	1,060 (23.3)	362 (26.8)	3,688 (19.2)
Primary School (ages 5 to 10)	5,346 (40.1)	2,034 (44.6)	595 (44.1)	7,975 (41.5)
Junior High School (ages 11 to 14)	3,981 (29.9)	1,101 (24.1)	302 (22.4)	5,384 (28.0)
Senior High School	1,677 (12.6)	350 (7.7)	89 (6.6)	2,116 (11.0)
Higher Education	48 (0.4)	14 (0.3)	2 (0.2)	64 (0.3)
Ignored/Missing				2,566 (0.1)*
Work condition				
Employed	6,801 (50.6)	2,073 (46.1)	562 (44.2)	9,436 (49.1)
Unemployed	3,211 (23.9)	1,309 (29.1)	421 (33.1)	4,941 (25.7)
Unemployed but currently studying	3,434 (25.5)	1,112 (24.8)	288 (22.7)	4,834 (25.2)
Ignored/Missing				2,615 (0.1)*
Per capita income				
No income	1,682 (11.1)	577 (11.5)	173 (12.0)	2,432 (11.3)
0 - 0.25 minimum wage	8,580 (56.8)	2,428 (48.3)	681 (47.2)	11,689 (54.2)
0.25 - 0.5 minimum wage	2,440 (16.2)	835 (16.6)	241 (16.7)	3,516 (16.3)
0.5 - 1 minimum wage	1,910 (12.7)	961 (19.1)	285 (19.7)	3,156 (14.6)
>1 minimum wage	482 (3.2)	225 (4.5)	64 (4.4)	771 (3.6)
Ignored/Missing				1 (0.0)*
Household characteristics				
Region of residence				
North	3,636 (24.1)	1,164 (23.2)	298 (20.6)	5,098 (23.6)
Northeast	6,401 (42.4)	1,822 (36.2)	497 (34.4)	8,720 (40.4)
Southeast	1,966 (13.2)	814 (16.2)	297 (20.6)	3,107 (14.4)
South	346 (2.3)	202 (4.0)	88 (6.1)	636 (3.0)
Central-west	2,716 (18.0)	1,024 (20.4)	264 (18.3)	4,004 (18.6)
Area of residence				
Urban	12,100 (80.2)	3,894 (77.6)	1,128 (78.3)	17,122 (79.5)
Rural	2,984 (19.8)	1,125 (22.4)	312 (21.7)	4,421 (20.5)
Ignored/Missing				22 (0.0)*
Household density				
≤ 0.5 inhab/room	5.014 (33,67)	2.141 (43,22)	619 (43,65)	7.774 (36,56)

0.5 - 0.75 inhab/room	2.802 (18,82)	848 (17,12)	230 (16,22)	3.880 (18,25)
0.75 - 1.00 inhab/room	3.320 (22,30)	970 (19,58)	253 (17,84)	4.543 (21,37)
>1.00 inhab/room	3.754 (25,21)	995 (20,08)	316 (22,28)	5.065 (23,82)
Ignored/Missing				338 (0.01)
Construction material				
Bricks/Cement	10,429 (70.0)	3,347 (67.5)	975 (68.7)	14,751 (69.3)
Wood/Taipa/Others	4,473 (30.0)	1,610 (32.5)	444 (31.3)	6,527 (30.7)
Ignored/Missing				318 (0.01)*
Water supply				
Public network (tap water)	10,171 (68.3)	3,311 (66.8)	978 (68.9)	14,460 (68.0)
Well/Natural source/Others	4,731 (31.7)	1,646 (33.2)	441 (31.1)	6,818 (32.0)
Ignored/Missing				318 (0.01)*
Electricity				
Electricity with counter	13,566 (91.0)	4,468 (90.1)	1,278 (90.1)	19,312 (90.8)
Electricity without counter	1,336 (9.0)	489 (9.9)	141 (9.9)	1,966 (9.2)
Ignored/Missing				318 (0.01)*
Waste disposal system				
Public network/Septic tank	4,823 (32.8)	1,588 (32.6)	506 (36.5)	6,917 (33.0)
Homemade tank/Ditch/Others	9,864 (67.2)	3,285 (67.4)	879 (63.5)	14,028 (67.0)
Ignored/Missing				705 (0.03)*
Garbage disposal				
Public collection system	11,409 (76.6)	3,654 (73.7)	1,070 (75.4)	16,133 (75.8)
Burned/Buried/Outdoor disposal/Others	3,494 (23.4)	1,303 (26.3)	349 (24.6)	5,146 (24.2)
Ignored/Missing				317 (0.01)*
High-burden cluster municipality				
No	5,148 (34.1)	1,987 (39.5)	679 (47.0)	7,814 (36.2)
Yes	9,947 (65.9)	3,039 (60.5)	765 (53.0)	13,751 (63.8)
Clinical characteristics				
WHO operational classification				
Paucibacillary	7,698 (51.0)	968 (19.3)	128 (8.9)	8,794 (40.8)
Multibacillary	7,396 (49.0)	4,058 (80.7)	1,316 (91.1)	12,770 (59.2)
Ignored/Missing				3 (0.0)*
Presence of lesions				
No	9,123 (60.44)	1,862 (37.05)	432 (29.92)	12,419 (51.94)
Yes	5,940 (39.35)	3,135 (62.38)	1,004 (69.53)	11,419 (47.76)
Ignored/Missing	32 (0.21)	29 (0.58)	8 (0.55)	73 (0.31)*

*The percentage of ignored/missing data refers a part of the total.

Table 2. Univariate and adjusted analyses for grade of physical disabilities. The 100 Million Brazilian Cohort, 2007-2014.

	Grade 1		Grade 2	
	OR_{crude}[1] (95%CI) (N=16,376)	OR_{adj}[2,3] (95%CI) (N=16,376)	OR_{crude}[1] (95%CI) (N=16,376)	OR_{adj}[2,3] (95%CI) (N=16,376)
Individual characteristics				
Age				
Up to 15 years old	1.00	1.00	1.00	1.00
> 15 years old	3.41 (3.01-3.87)	2.39 (2.06-2.77)	3.28 (2.63-4.11)	1.95 (1.51-2.50)
Sex				
Male	1.00	1.00	1.00	1.00
Female	0.62 (0.58-0.66)	0.81 (0.75-0.88)	0.48 (0.38-0.48)	0.61 (0.53-0.70)
Schooling				
No education/Pre-school	1.60 (0.86-2.94)	1.64 (1.40-1.93)	3.83 (0.93-15.88)	1.91 (1.44-2.53)
Primary School (ages 5 to 10)	1.30 (0.71-2.38)	1.48 (1.28-1.70)	2.67 (0.65-11.04)	1.64 (1.27-2.12)
High School (ages 11 to 14)	0.95 (0.52-1.74)	1.28 (1.10-1.48)	1.82 (0.44-7.55)	1.31 (1.00-1.72)
Senior High School	0.72 (0.39-1.32)	-	1.27 (0.30-5.34)	-
Higher Education	1.00	1.00	1.00	1.00
Work condition				
Employed	1.00	1.00	1.00	1.00
Unemployed	1.06 (0.98-1.16)	1.19 (1.06-1.32)	1.01 (0.86-1.18)	1.47 (1.23-1.74)
Unemployed but currently studying	1.34 (1.23-1.45)	1.13 (1.03-1.24)	1.59 (1.39-1.81)	1.15 (0.98-1.35)
Household characteristics				
Region of residence				
North	0.55 (0.46-0.66)	0.91 (0.72-1.15)	0.32 (0.25-0.42)	0.53 (0.39-0.72)
Northeast	0.49 (0.41-0.58)	0.81 (0.64-1.01)	0.31 (0.24-0.39)	0.53 (0.39-0.71)
Southeast	0.70 (0.58-0.85)	1.06 (0.84-1.33)	0.58 (0.45-0.76)	0.80 (0.59-1.08)
South	1.00	1.00	1.00	1.00
Central-west	0.65 (0.54-0.78)	0.86 (0.68-1.09)	0.38 (0.29-0.49)	0.50 (0.36-0.68)
Area of residence				
Urban	1.00	1.00	1.00	1.00
Rural	1.17 (1.08-1.27)	1.14 (1.04-1.26)	1.12 (0.98-1.28)	1.05 (0.89-1.24)
Household density				
≤ 0.5 inhab/room	1.00	1.00	1.00	1.00
0.5 - 0.75 inhab/room	0.71 (0.65-0.78)	0.87 (0.78-0.98)	0.66 (0.57-0.78)	0.96 (0.80-1.16)
0.75 - 1.00 inhab/room	0.68 (0.63-0.75)	0.87 (0.78-0.97)	0.62 (0.53-072)	0.85 (0.71-1.03)
>1.00 inhab/room	0.62 (0.57-0.68)	0.79 (0.71-0.88)	0.68 (0.59-0.79)	1.04 (0.87-1.23)
High-burden cluster municipality				

No	1.00	1.00	1.00	1.00
Yes	0.79 (0.74-0.85)	0.85 (0.78-0.93)	0.58 (0.52-0.65)	0.67 (0.58-0.78)
Clinical characteristics				
WHO operational classification				
Paucibacillary	1.00	1.00	1.00	1.00
Multibacillary	4.36 (4.04-4.71)	3.50 (3.13-3.92)	10.7 (8.9-12.87)	8.22 (6.51-10.38)
Presence of lesions				
No	1.00	1.00	1.00	1.00
Yes	2.56 (2.38-2.76)	1.12 (1.02-1.24)	3.44 (3,015-3.93)	1.03 (0.88-1.20)

[1]Univariate logistic regression model accounting for household cluster.

[2]Final model of multinomial logistic regression accounting for household cluster with exclusion of the missing data.

[3]For all the tests and for permanence of the variables in the final model was used the significance level of 5%.

Figures

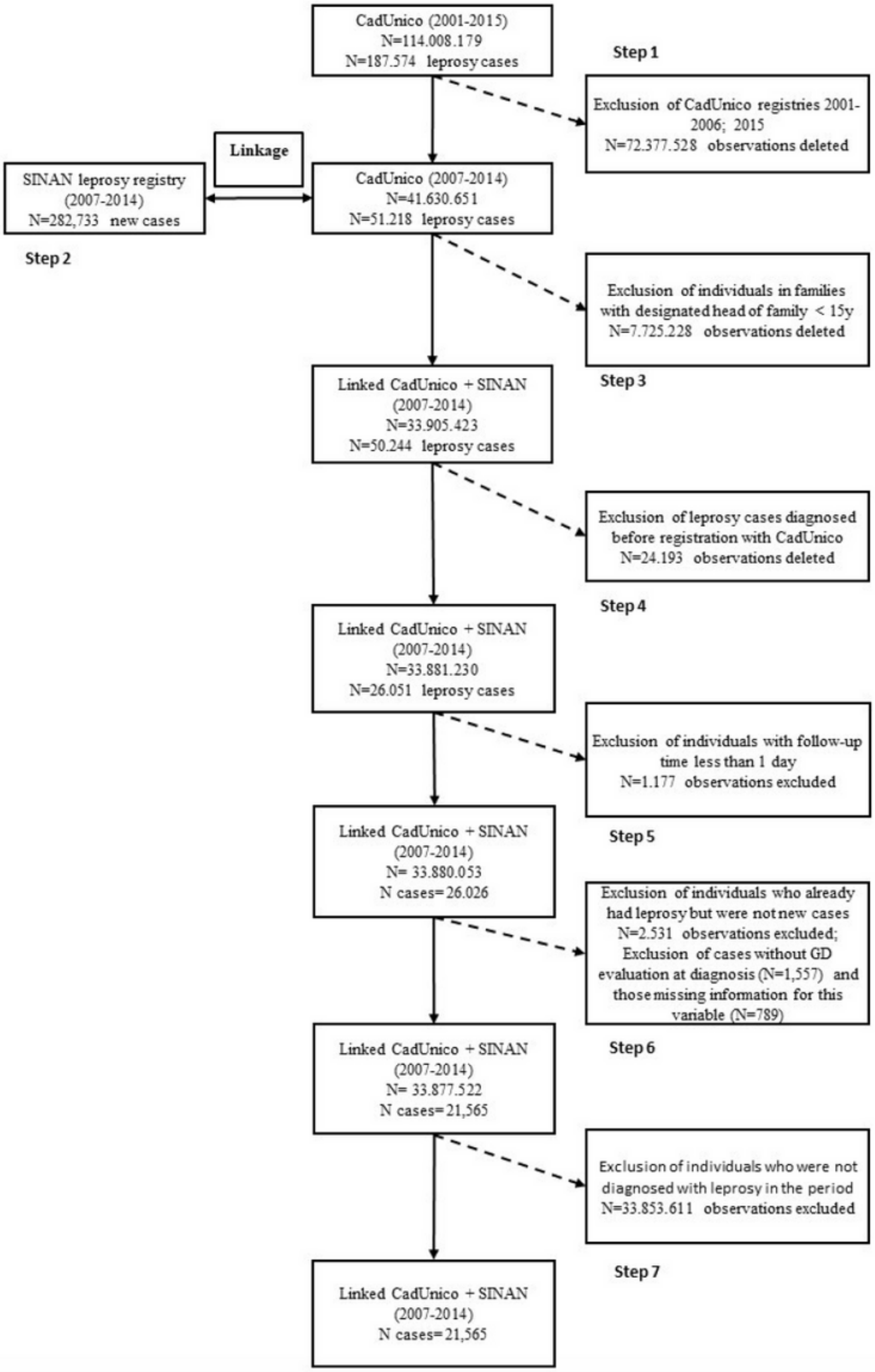

Figure 1

Study population selection flowchart from the 100 Million Brazilian Cohort.