

Sanitation conditions of indigenous and nonindigenous households in Brazil according the 2000 and 2010 national censuses

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Abstract *This study compares the availability of basic sanitation infrastructure in indigenous and nonindigenous household located in urban and rural areas using data from the 2000 and 2010 Brazilian National Censuses. The analyses were based on descriptive statistics and modelling with multiple logistic regression. While there was an increase in the availability of basic sanitation in Brazilian households over the decade, indigenous households continued to have worse conditions in 2010. Sewage was the sanitation service with the lowest coverage in both censuses, and indigenous households had a lower rate of sewage services than nonindigenous households did. Logistic regression results confirmed the findings of the descriptive analyses, attesting to the fact that sanitation conditions are worse in indigenous households. In some areas, such as the urban North and Southeast and rural areas of the Central-West region, the gap in basic sanitation infrastructure between indigenous and nonindigenous households increased from 2000 to 2010. This study not only indicates the less-adequate sanitation conditions in indigenous households in Brazil but also attests to the persistence of major inequalities associated with race or color in the country.*

Key words *Demographic censuses, Basic sanitation, Indigenous population, Racial or ethnic composition, Health inequalities*

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Introduction

The potential uses of census data in the investigation of health inequalities, especially those related to ethnicity/race, has been increasingly recognized by a growing number of studies¹⁻⁴. An important step towards reducing them is to determine their magnitude and contextualize them through the production of quantitative information of recognized quality and representativeness⁴⁻⁷.

Despite significant improvement in health indicators in recent years, Brazil continues to exhibit profound inequalities in different dimensions. Several segments of Brazilian society continue to face exclusion and vulnerability, which is manifested in inadequate housing conditions, including basic sanitation, and difficulty in accessing and using health and education services⁴⁻⁸.

In accordance with what is being discussed in the global agenda in the context of the United Nations (UN) General Assembly and the Human Rights Council, Brazil adopted the goals of the "Human Right to Water and Sanitation" (HRWS), which are directly related to guidelines for poverty reduction and sustainable development^{9,10}. In addition, the country is a signatory of the "Sustainable Development Goals" (SDGs), which propose 17 goals aimed at eradicating extreme poverty, reducing inequalities and promoting greater social justice, among other factors. Specifically, regarding sanitation, objective six (*ensure access to water and sanitation for all by 2030*) refers to the elimination of inequality in access to safe drinking water without discrimination and to ensuring access to adequate sanitation. These goals follow the Millennium Development Goals (MDGs), which should have been achieved by 2015¹¹.

In the context of the Americas, Brazil is one of the countries with the highest number of indigenous ethnic groups, although it has one of the lowest proportions of indigenous individuals relative to the total population (< 0.5%)¹². The law regulating basic sanitation in Brazil reinforces the state's commitment to providing adequate environmental health conditions to indigenous peoples and other traditional populations, rural populations and residents of small, isolated urban centers and recommends solutions that are compatible with the populations' sociocultural characteristics¹³. Although there is a legal framework that emphasizes and protects sociocultural specificities, the inadequacy of basic sanitation services is pronounced in indigenous lands in

Brazil^{4,14-16}. Within this context, several studies have emphasized the prominence of infectious and parasitic diseases and nutritional deficiencies in the epidemiological profile of indigenous people in Brazil; such diseases are even more pronounced in indigenous peoples than in the non-indigenous population¹⁵⁻²⁶.

Although there has been an increase in knowledge about the demographic and epidemiological aspects of indigenous peoples in recent years, analyses at the national level, particularly in urban contexts, are still scarce^{4,14-16,20,27}. Against this background, the objective of this study is to investigate the possible differences in the presence of basic sanitation infrastructure between indigenous and nonindigenous households in Brazil based on data from the 2000 and 2010 Demographic Censuses.

Methodology

This is a cross-sectional study based on samples from the 2000 and 2010 Demographic Censuses, which are national surveys conducted by the Brazilian Institute of Geography and Statistics (IBGE). Census data were selected for use because they provide detailed information about individuals and households. Households located in municipalities with at least a 3.0% indigenous population, according to data from the 2010 Demographic Census (214 municipalities), were included in the analysis. Data from the same set of municipalities were selected from the 2000 and 2010 Censuses, with the exception of municipalities that did not yet exist in 2000, although not all of the included municipalities met the criterion of a 3.0% indigenous population in 2000.

The strategy used to select the included municipalities aimed to minimize the effect of the territorial dispersion of the indigenous population in Brazil, which, in addition to being proportionally small (approximately 818,000 individuals or 0.4% of the national population)¹⁰, has a high geographical concentration. Thus, the use of a reduced set of municipalities with a larger indigenous population relative to the total population aimed to better compare groups of individuals who may reside in geographic areas with more similar socioeconomic and health characteristics. Several alternative methods for selecting municipalities were considered to concomitantly identify the smallest number of units that concentrated the largest volume of indigenous people. As in the study by Cunha²⁸, the criterion of a

population with at least 3.0% indigenous people was chosen; this criterion identified 214 municipalities (3.8% of the total number of Brazilian municipalities) that included 62.1% of the indigenous people in the country (N = 817,963) in 2010.

The analyses included households classified as “permanent private” in urban and rural areas in the North (N), Northeast (NE), Southeast/South (SE/S) and Central-West (CW) regions. The Southeast and South regions were combined due to the small number of municipalities in these regions with populations that comprised at least 3.0% indigenous people, which would have compromised the statistical analyses. For the ethnic/racial categorization of households, the color/race of the head of household was used as a proxy. Following the classification adopted by the Brazilian Census, the following categories were analyzed: “white” (“branca”), “black” (“preta”), “brown” (“parda”), and “indigenous” (“indígena”). Due to the small number of cases, the categories “yellow” (“amarela”) (3,035 households in 2000 and 10,842 households in 2010) and “not informed” (5,911 households in 2000 and 14 in 2010) were not included.

The following basic sanitation indicators were used as the outcome variables: (a) water supply (for urban areas, access to water through a general water supply network with plumbing in at least one room; for rural areas, having water through a general water supply network, well or spring on the property or within the village); (b) sewage (access to sewage through a general sewage network or septic tank); and (c) garbage collection (garbage collected directly or after placement in a garbage disposal container). The variables used to construct these indicators in the 2000 Census were water supply, origin (V0207); water supply, plumbing (V0208); type of sewage (V0211); and garbage collection (V0212). For the 2010 Census, the following variables were considered: water supply, type (V0208); water supply, plumbing (V0209); sewage, type (V0207); and garbage, destination (V0210).

The statistical analyses used weighting procedures based on the complex sample design of the two censuses under investigation, a process that is justified by the fact that the data captured by these methods, specifically those used in this study, derive from probabilistic sampling. Each unit selected for the sample concomitantly represents other units that are part of the target population, which requires that these units be related to an expansion factor or weight²⁹. After the ap-

plication of the expansion factor, which constitutes the so-called sample weighting procedure, the results become representative of the population universe (i.e., in the case of the Demographic Censuses, all households and/or individuals in the Brazilian territory on the date of each survey). Therefore, the results presented are estimates for all the households in the set of municipalities included in this study, derived from the 2000 and 2010 Demographic Census samples.

The IBM® Statistical Package for the Social Sciences (SPSS)® Statistics 20.0 software was used for descriptive statistical analyses (prevalence) and for multiple logistic regression (MLR) modeling. The odds ratios (ORs) estimated for the association between the explanatory variables (covariates) and the outcome considered a statistical significance level of 5%.

The covariates included in the analyses used to fit the MLR models were as follows: color or race of the head of household (V0408 in 2000; V0606 in 2010), referred below using the abridged terminology “white household”, “black household”, “brown household”, and “indigenous household”; literacy of the head of household (if he/she knows how to read or write a simple note) (V0428 in 2000; V0627 in 2010); and *per capita* household income in number of minimum wages (V6532 in 2010). The *per capita* household income for the year 2000 was given by the ratio between the variables total household income in minimum wages (V7617) and the number of household residents (V7100).

Regarding ethical considerations, according to the current legislation in Brazil (Resolution no. 466/2012 of the National Health Council), there was no need for approval by the Research Ethics Committee because the research was based on publicly available secondary data.

Results

In 2000, 781,633 households (62.0% urban and 38.0% rural) in 210 municipalities were investigated; in 2010, there were 1,064,749 households (66.1% urban and 33.9% rural) in 214 municipalities. The difference in the number of municipalities between the two censuses is because the municipalities Conquista D’Oeste, Nova Nazaré, Rondolândia and Santo Antônio do Leste, all in the state of Mato Grosso, were created after 2000. Regarding households with indigenous heads of household, the study included 26.8% of those identified in 2000 and 45.2% in 2010. The fre-

quency of indigenous households in urban areas in 2000 ranged from 1.0% (SE/S and CW) to 2.3% (NE) of the total number of households; in the rural areas, it ranged from 8.2% (NE) to 21.5% (N). In the 2010 Census, the proportion of indigenous households in urban areas ranged from 0.9% (SE/S) to 4.6% (NE) of the total number of households; in rural areas, it ranged from 16.1% (NE) to 26.5% (N) (Table 1).

In general, in both urban and rural areas, the frequencies of households with basic sanitation infrastructure (water supply, sewage and garbage collection) increased between 2000 and 2010. In the urban areas of the N region, there was an opposite pattern for “white households” (47.6% in 2000 to 39.2% in 2010), “brown households” (37.1% in 2000 to 31.6% in 2010) and “indigenous households” (32.3% in 2000 to 22.5% in 2010) for sewage services. In rural areas, exceptions were found for water supply among “white households” (78.5% in 2000 to 75.9% in 2010) in the SE/S regions and for garbage collection for “white households” (10.3% in 2000 to 10.4% in 2010) in the N region and for “black households” (8.6% in 2000 to 8.0% in 2010) in the CW region. In general, the service that was least present among households in both censuses and in both urban and rural areas was sewage. The exception was in rural areas in the 2010 Census,

where garbage collection was the least prevalent service available for “indigenous households” in the NE and SE/S regions and for “white”, “black”, “brown” and “indigenous households” in the CW region (Table 2).

In the two datasets (2000 and 2010), regardless of color/race and household location (urban/rural), the N region had the lowest prevalence of basic sanitation services, followed by the NE, CW and SE/S regions. In urban areas in the 2010 Census, the order differed, with the N region exhibiting the lowest prevalence, followed by the CW, NE and SE/S regions (Table 2).

Regarding the color/race of the household, in both urban and rural areas in the N region, the indigenous populations had the lowest prevalence of basic sanitation services in both 2000 and in 2010. An exception was found for the year 2000 in urban areas of the N region, where “black households” had the lowest prevalence of sewage services (28.4%) and garbage collection (55.0%). In the NE region, “black and indigenous households” had the lowest prevalence of basic sanitation services in urban and rural areas for both censuses. In both urban and rural areas in the SE/S region, “indigenous households” had the lowest prevalence of basic sanitation services in both censuses. The only exception was in 2010 in rural areas, where “brown” (13.5%) and “black”

Table 1. Absolute and relative distribution (%) of the estimates of the households investigated based on the color/race of the head of household according to the geographic region, household location and census year. Selected municipalities, Brazil 2000 and 2010.

Region	Location	Census year	Total	Households (color/race of head of household)							
				White		Black		Brown		Indigenous	
				%	n	%	n	%	n	%	n
N	Urban	2000	169361	44559	26.3	10078	6.0	111385	65.8	3339	2.0
		2010	267055	59467	22.3	21832	8.2	177579	66.5	8176	3.1
	Rural	2000	112531	18333	16.3	8680	7.7	61368	54.5	24151	21.5
		2010	138277	18830	13.6	10720	7.8	72072	52.1	36654	26.5
NE	Urban	2000	122286	39082	32.0	11094	9.1	69347	56.7	2764	2.3
		2010	172571	47733	27.7	17713	10.3	99109	57.4	8015	4.6
	Rural	2000	86581	22223	25.7	7234	8.4	50018	57.8	7105	8.2
		2010	106795	21283	19.9	8240	7.7	60080	56.3	17191	16.1
SE/S	Urban	2000	58069	41179	70.9	2288	3.9	14006	24.1	596	1.0
		2010	77950	49439	63.4	3711	4.8	24062	30.9	737	0.9
	Rural	2000	51524	35952	69.8	1786	3.5	8481	16.5	5305	10.3
		2010	52805	31837	60.3	1706	3.2	10346	19.6	8917	16.9
CW	Urban	2000	134597	73556	54.6	6471	4.8	53176	39.5	1394	1.0
		2010	186603	89996	48.2	13487	7.2	80971	43.4	2149	1.2
	Rural	2000	46684	17320	37.1	2358	5.1	17802	38.1	9204	19.7
		2010	62693	18889	30.1	3683	5.9	2469	39.0	15653	25.0

Table 2. Households with basic sanitation infrastructure according to geographic location, color/race of the head of household and census year. Selected municipalities, Brazil 2000 and 2010.

Region and household location	Color/race	Water supply ^a		Sewage ^b		Garbage collection ^c		
		2000	2010	2000	2010	2000	2010	
		%	%	%	%	%	%	
N	Urban	White	53.7	66.1	47.6	39.2	71.1	92.2
		Black	37.9	60.8	28.4	31.5	55	89.8
		Brown	45.8	64.2	37.1	31.6	62.2	89.0
		Indigenous	37.6	50.3	32.3	22.5	55.9	79.1
	Rural	White	16.1	26.7	9.0	9.7	10.3	10.4
		Black	5.1	18.2	3.4	6.4	3.7	6.1
		Brown	7.5	18.3	5.0	5.7	5.4	5.8
		Indigenous	2.3	10.2	1.0	1.8	1.1	2.3
NE	Urban	White	68.9	80.6	50.5	57.9	70.8	92.7
		Black	49.2	73.3	32.8	55.9	59.6	90.9
		Brown	56.1	76.3	40.5	52.9	63	91.6
		Indigenous	64.9	78.1	39.2	46.5	59.1	90.9
	Rural	White	18.9	34.9	4.9	10.9	6.6	14.1
		Black	10.7	28.7	2.5	11.5	5.1	16.3
		Brown	15.0	28.6	4.8	11.1	6.9	13.7
		Indigenous	17.3	27.0	3.2	11.8	3.8	8.1
SE/S	Urban	White	90.3	96.2	41.0	52.8	90.2	98.2
		Black	84.1	93.4	46.7	64.2	84.6	96.7
		Brown	86.0	95.2	51.7	64.2	89.1	97.8
		Indigenous	61.8	82.8	40.1	42.2	72.1	76.7
	Rural	White	78.5	75.9	9.8	21.7	13.4	29.2
		Black	48.4	63.5	7.2	15.0	13.0	24.8
		Brown	59.4	69.9	8.6	13.5	14.6	22.6
		Indigenous	22.4	46.4	4.9	21.4	6.2	20.1
CW	Urban	White	78.3	87	24.6	40.9	90.2	97.9
		Black	64.4	86.8	16.5	32.4	80.1	96.4
		Brown	69.7	86	19.7	34.5	84.4	96.9
		Indigenous	59.5	74.4	11.1	27.7	79.2	89.1
	Rural	White	65.5	79.6	6.0	11.1	9.5	10.1
		Black	45.1	66.9	7.2	11.6	8.6	8.0
		Brown	47.6	72.1	4.0	10.5	6.9	10.0
		Indigenous	6.7	25.8	0.8	5.7	1.1	2.7

^a Access to water through a general water supply network with plumbing in at least one room; ^b Access to sewage through a general sewage network or septic tank; ^c Have garbage collected directly or after placement in a garbage disposal container. For the rural areas, in addition to those who met the characteristics cited for the urban area, those with a well or spring on the property or in the village as the water supply source were also included.

(15.0%) households had a lower prevalence of sewage service than “indigenous households” (21.4%). In the CW region in both censuses, “indigenous households” had the lowest prevalence of basic sanitation services without exception, and the discrepancy was especially great in rural areas (Table 2).

For both datasets, in general, the MLR analyses indicated that households whose heads of

household were nonindigenous were more likely than “indigenous households” to have basic sanitation services in their homes. For the MLR models generated with the 2000 Census dataset, of the 72 possible comparisons between “non-indigenous and indigenous households”, 43 (59.7%) ORs were negative for the “indigenous households”; in five (6.9%), “indigenous households” had higher ORs than “nonindigenous

households”, and in 24 (33.4%), the differences were not significant. For the 2010 Census, there was an increase in the number of ORs indicating that indigenous people were in a disadvantaged position relative to nonindigenous people; in 52 (72.2%) comparisons, “nonindigenous households” were more likely than “indigenous households” to have basic sanitation services; in five (6.9%), “indigenous households” had higher ORs than “nonindigenous households”; and in 15 (20.9%), the differences were not significant (Table 3).

Considering household location for the 2000 Census, of the 32 possible comparisons, 16 (44.4%) were negative for “indigenous households” compared to “nonindigenous households” in urban areas, and 27 (75.0%) were negative for “indigenous households” in rural areas. For the 2010 Census, 27 (75.0%) comparisons were negative for “indigenous households” compared to “nonindigenous households” in urban areas, and 25 (69.4%) were negative in rural areas. Therefore, the number of comparisons showing that indigenous people were disadvantaged regarding the presence of basic sanitation services at home relative to the nonindigenous population increased from 2000 to 2010 in urban areas and decreased in rural areas. In addition, the magnitude of these differences increased from 2000 to 2010 in some cases, particularly in the urban N, the urban SE/S and the rural CW, for the three outcomes analyzed. The N region had the largest number of significant ORs indicating that “indigenous households” were in an unfavorable position compared to the “nonindigenous households” regarding the presence of basic sanitation services, followed by the CW, SE/S and NE regions. The most precarious service (the one with the highest number of negative ORs for both censuses) among “indigenous households” when compared to “nonindigenous households” was water supply, followed by garbage collection and sewage (Table 3).

Discussion

In general, the results of this study indicate that the prevalence of households with basic sanitation services was higher in 2010, despite the persistence of negative trends for indigenous people. In addition, according to the MLR models, a greater number of ORs was observed from 2000 to 2010 that place indigenous people in a less favorable position than nonindigenous people re-

garding the presence of basic sanitation services. Therefore, for the set of selected municipalities (which have high concentrations of indigenous people), this study points to an even more negative pattern for indigenous people when comparing the results of the 2000 and 2010 Censuses, indicating a worsening of inequalities related to basic sanitation infrastructure in households at even higher magnitudes than those found in other studies⁴.

The findings of this study are in line with those presented in official IBGE publications that indicate important advances in the supply of basic sanitation services in Brazil in the last decade (2000-2010). However, the comprehensiveness and universality of these services is still far from being achieved³⁰ as legally defined¹³, especially in rural areas and for households with indigenous heads of household¹². It is worth noting that the observed inequalities in access to basic sanitation services show how much progress needs to be made to achieve the goals of agreements such as the HRWS⁹ and the SDGs¹¹.

Considering the methodological strategy used to select municipalities for this study, which required that the proportion of indigenous people was equal to or greater than 3.0%, it is believed that the comparisons were conducted among less geographically dispersed households throughout the vast Brazilian territory, thus providing a greater degree of comparability among the research units.

With the exception of a few publications^{4,15,16}, studies on basic sanitation conditions among indigenous people in Brazil and their relationship with health and disease processes are still scarce. Many of the studies refer to specific locations based on small samples and/or descriptions of situations that aim mainly at proposing sanitation infrastructure alternatives in specific indigenous areas¹²⁻¹⁴. As observed in the present study, such studies often point to the precariousness of basic sanitation services in indigenous households^{4,14-16}. Taken together, the available studies tend to reveal a morbidity/mortality pattern for the indigenous population in Brazil that is characterized by a high proportion of early deaths, concentrated among children under five, largely due to exposure to infectious and parasitic diseases¹⁷⁻²⁶.

Until 2010, the National Health Foundation (FUNASA) was the government agency responsible for the implementation of sanitation infrastructure for households located in rural areas, including households located on indigenous

Table 3. Odds ratios (ORs) adjusted according to the investigated outcomes. Selected municipalities, Brazil, 2000 and 2010.

Geographical location	Color/race	Water supply ^a (OR, 95% CI)		Sewage ^b (OR, 95% CI)		Garbage collection ^c (OR, 95% CI)		
		2000	2010	2000	2010	2000	2010	
N	Urban	White	1.47 (1.16-1.86)	1.58 (1.36-1.82)	1.34 (1.03-1.75)	1.68 (1.41-2.00)	1.45 (1.14-1.84)	2.20 (1.82-2.66)
		Black	1.05 (0.80-1.36)	1.42 (1.21-1.67)	0.83 (0.62-1.12)	1.44 (1.19-1.74)	0.99 (0.76-1.30)	2.06 (1.67-2.55)
		Brown	1.28 (1.02-1.61)	1.61 (1.40-1.85)	1.07 (0.83-1.40)	1.40 (1.18-1.66)	1.16 (0.92-1.47)	1.80 (1.51-2.14)
		Indigenous	1.00	1.00	1.00	1.00	1.00	1.00
	Rural	White	3.88 (2.94-5.12)	2.14 (1.87-2.45)	4.41 (2.85-6.82)	3.98 (3.06-5.19)	4.90 (3.20-7.50)	2.76 (2.15-3.54)
		Black	1.47 (1.00-2.16)	1.52 (1.28-1.82)	2.30 (1.34-3.92)	3.03 (2.23-4.11)	2.39 (1.42-4.01)	2.00 (1.47-2.73)
		Brown	2.03 (1.56-2.66)	1.53 (1.37-1.71)	3.16 (2.07-4.82)	2.66 (2.09-3.38)	3.24 (2.14-4.90)	1.83 (1.48-2.28)
		Indigenous	1.00	1.00	1.00	1.00	1.00	1.00
NE	Urban	White	1.97 (1.40-2.78)	1.03 (0.87-1.24)	2.04 (1.17-3.57)	1.33 (1.15-1.53)	1.81 (1.22-2.68)	0.99 (0.78-1.25)
		Black	1.25 (0.86-1.82)	0.74 (0.61-0.90)	1.64 (0.90-2.96)	1.41 (1.20-1.66)	1.06 (0.69-1.63)	0.95 (0.73-1.23)
		Brown	1.46 (1.03-2.05)	0.87 (0.73-1.02)	1.84 (1.05-3.21)	1.22 (1.07-1.40)	1.28 (0.87-1.90)	1.02 (0.82-1.26)
		Indigenous	1.00	1.00	1.00	1.00	1.00	1.00
	Rural	White	17.93 (13.69-23.50)	1.28 (1.13-1.44)	6.35 (2.90-13.92)	0.82 (0.69-0.98)	7.43 (3.92-14.07)	1.58 (1.31-1.89)
		Black	9.09 (6.42-12.86)	1.02 (0.86-1.21)	8.52 (3.67-19.81)	0.93 (0.73-1.18)	7.32 (3.57-15.00)	2.06 (1.63-2.59)
		Brown	9.26 (7.08-12.10)	1.02 (0.92-1.14)	4.48 (2.06-9.74)	0.90 (0.78-1.04)	5.56 (2.94-10.51)	1.69 (1.44-1.98)
		Indigenous	1.00	1.00	1.00	1.00	1.00	1.00
SE/S	Urban	White	0.96 (0.74-1.24)	4.31 (2.73-6.81)	1.22 (0.96-1.56)	1.17 (0.78-1.76)	1.32 (1.03-1.70)	10.72 (6.73-17.06)
		Black	0.51 (0.39-0.68)	2.80 (1.61-4.88)	0.76 (0.58-0.99)	2.36 (1.53-3.66)	1.05 (0.80-1.36)	8.44 (4.51-15.79)
		Brown	0.64 (0.50-0.82)	3.74 (2.35-5.96)	0.99 (0.78-1.26)	2.21 (1.47-3.33)	1.12 (0.88-1.43)	11.26 (6.96-18.22)
		Indigenous	1.00	1.00	1.00	1.00	1.00	1.00
	Rural	White	0.84 (0.69-1.01)	2.76 (2.46-3.10)	1.07 (0.67-1.71)	0.72 (0.63-0.83)	1.29 (0.85-1.96)	1.11 (0.97-1.27)
		Black	0.52 (0.40-0.69)	1.83 (1.43-2.34)	0.72 (0.40-1.28)	0.56 (0.41-0.78)	1.28 (0.78-2.12)	1.11 (0.82-1.49)
		Brown	0.73 (0.61-0.87)	2.34 (2.04-2.68)	1.29 (0.82-2.02)	0.47 (0.39-0.57)	1.63 (1.10-2.41)	0.93 (0.78-1.10)
		Indigenous	1.00	1.00	1.00	1.00	1.00	1.00
CW	Urban	White	3.74 (2.30-6.06)	2.15 (1.60-2.89)	0.67 (0.39-1.16)	1.44 (1.07-1.94)	2.33 (1.43-3.80)	4.15 (2.75-6.26)
		Black	3.09 (1.75-5.46)	2.20 (1.59-3.04)	1.20 (0.67-2.17)	1.15 (0.84-1.58)	1.91 (1.07-3.39)	3.01 (1.90-4.77)
		Brown	3.25 (1.98-5.33)	2.03 (1.51-2.73)	1.41 (0.81-2.43)	1.24 (0.92-1.67)	2.70 (1.63-4.47)	3.29 (2.20-4.93)
		Indigenous	1.00	1.00	1.00	1.00	1.00	1.00
	Rural	White	8.25 (6.89-9.88)	8.58 (7.40-9.96)	1.45 (1.02-2.08)	1.73 (1.36-2.21)	1.70 (1.22-2.36)	3.33 (2.42-4.57)
		Black	2.87 (2.13-3.87)	5.26 (4.20-6.58)	1.42 (0.78-2.59)	2.01 (1.44-2.82)	2.16 (1.32-3.53)	2.80 (1.86-4.22)
		Brown	4.32 (3.53-5.30)	6.13 (5.36-7.02)	1.58 (1.07-2.33)	1.71 (1.36-2.15)	2.30 (1.62-3.28)	3.45 (2.54-4.69)
		Indigenous	1.00	1.00	1.00	1.00	1.00	1.00

^a Access to water through a general water supply network with plumbing in at least one room; ^b Access to sewage through a general sewage network or septic tank; ^c Have garbage collected directly or after placement in a garbage disposal container. For the rural areas, in addition to those who met the criteria cited for urban areas, those who had a well or spring on the property or in the village as a water supply source were also included.

lands. According to this agency, in 2009, 63.0% of the indigenous population and 35.0% of the villages had a water supply at the household or collective level³¹. In the present study, the highest proportion of households in rural areas with access to water supply in rural areas, whether through a general water supply network or a well/spring, was observed in the SE/S region (46.4%), followed by the NE, CW and N regions (27.0%,

25.8% and 10.2%, respectively). Therefore, based on the census data described here, coverage values are lower than those reported by the government agency³¹. Law no. 12,314/2010 authorized the creation of the Special Secretariat for Indigenous Health (SESAI) within the Ministry of Health (MS), which, among other activities, is responsible for actions regarding basic sanitation and indigenous healthcare³². As the data source

es used in this study refer to the years 2000 and 2010, it was decided not to discuss the information about the basic sanitation services disclosed under the aegis of SESAI.

Pena and Heller¹⁵ argue that, regarding the implementation of public policies, Brazil does not have techno professional personnel that are sufficiently prepared for the intercultural work needed to implement a basic sanitation infrastructure in indigenous and rural areas in Brazil on the necessary scale. In this scenario, resources are spent on projects that do not fit the reality of indigenous communities, which generates waste and inefficient services. In addition, it is widely recognized that basic sanitation services (water supply, sewage and garbage collection) are inter-related, and thus the partial implementation of a certain service compromises the efficiency of the others^{33,34}.

Analyses based on data from the First National Survey of Health and Nutrition of Indigenous Peoples^{35,36} indicate precarious access to basic sanitation services among “indigenous households” in all regions of Brazil. The results, although not categorized according to household location (urban or rural) because of the statistical design, showed important regional differences in services such as garbage collection by a public cleaning service. In the NE and SE/S regions, the proportions of households with access to such services were 38.4% and 23.2%, respectively. In the CW region, there were no households with access to such services, and in the N region, only 1.1% of the households had their garbage collected^{14,35}. In general, the findings of the National Survey are similar to those observed in the analyses detailed here for households in rural areas according to 2010 Census data.

Increased access to drinking water and sanitation was one of the MDGs related to ensuring environmental sustainability. When launched in 2000, the measurable criterion of the goal was to reduce the proportion of the population without permanent and sustainable access to drinking water and sanitation by half by 2015. The 2014 Brazil Monitoring Report states that Brazil had already fully met this goal in 2012, when the proportion of people without access to water and sanitation was already below half that observed in 1990³⁷. A new demographic census will be undertaken in 2021, which will provide better information for supporting and problematizing the monitoring of SDGs, specifically the sixth goal. The results presented here, even considering specific municipalities, clearly show the marked inequalities

in access to basic sanitation infrastructure for households with “indigenous” and “black” heads of household relative to the general population, especially those located in the N and CW regions.

Basic sanitation actions are indicated as cost-effective interventions aimed at preventing a wide range of infectious and parasitic diseases^{33,34,38}. In Brazil, a longitudinal study involving residents of the urban area of Salvador (BA) showed that the implementation of a sanitation program was accompanied by a 22.0% reduction in the prevalence of diarrhea, which was attributed to the increase in the coverage of the sewage network³⁹.

Regarding the high frequency of diarrhea among indigenous children in Brazil, Escobar et al.¹⁸ reported that considering a wide range of morbidity-related demographic, socioeconomic and health variables, issues related to precarious sanitation play a prominent role. Based on data from the First National Survey of the Health and Nutrition of Indigenous Peoples, the prevalence of diarrhea in indigenous children was twice as low in those who resided in households that had access to sewage through a general sewage network or septic tank and had access to drinking water through the municipal water supply network than in those who had access to sewage and water through another route^{35,36}.

In contrast to many rural areas of the country, which are the target of specific sanitary interventions and, in some cases, are impacted by logistical difficulties in the implementation of infrastructure works, more equal access to basic sanitation services would be expected in urban areas. However, the results of this study showed that, even after controlling for socioeconomic variables, households whose heads of household were indigenous still showed a disadvantage between 2000 and 2010 when compared to households headed by members of other color/race categories. In this sense, the multivariate analyses detailed here point to the importance of color/race, especially among households located in the N and CW regions, in access to basic sanitation services.

A limitation of the present study is the fact that the census data do not allow the evaluation of the quality or continuity of services and do not allow other sanitation alternatives to be captured, information that would be meaningful for specific contexts, such as for indigenous populations in rural areas. In addition, the assignment of color/race to households based on the head of household should be considered with caution since the ethnic/racial composition of each unit

may be different⁴⁰. For example, due to the criterion adopted in some cases for certain localities, a significant number of “indigenous households” may have not been included in the analyses (e.g., households with indigenous members whose heads of household were not indigenous).

Although basic sanitation actions are known to have positive impacts on various health outcomes^{15,16,33,34,38,39}, it is necessary to consider this relationship more deeply in specific situations, considering the socioeconomic and cultural characteristics of the served population and the interaction effect of sanitation interventions with other health promotion measures. The success of structural measures depends greatly on the adherence of the population involved and the appropriateness of measures for cultural particularities and local contexts to ensure that the sanitation infrastructure actually contributes to health promotion^{15,16,22}.

The information that emerged from this study points to diversified and complex scenarios of inequalities regarding the presence of basic sanitation infrastructure according to color/race in Brazil. Even after adjustments for socioeconomic variables, indigenous households continued to present worse conditions than other households, especially those with “white” and “brown” heads of households, even in urban areas. This confirms the social vulnerability that indigenous populations face in various regions of the country. Considering the known existence of unfavorable living conditions for indigenous peoples and other ethnic minorities in Brazil^{4,5,7}, the implementation of equitable and nondiscriminatory public basic sanitation policies in a more effective way is important for reducing ethnic-racial disparities, which have direct implications on the health profiles of individuals.

Collaborations

Authors RV Santos and GM Cunha contributed substantially to the design, analysis, interpretation of data and critical review of the content. TR Fávoro contributed to the writing, analysis, interpretation of data and critical review of the content. L Raupp was responsible for the design, analysis, interpretation of data, writing and critical review of the content. All of the listed authors read and approved the final version presented here.

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