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Original Article

Leprosy in Elderly Patients in an Endemic State of Northern Brazil: A Geo-epidemiological Study

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Leprosy remains a major public health concern in northern Brazil, especially in the elderly with severe forms of the disease. This study aimed to describe the distribution of leprosy in elderly patients in an endemic state in northern Brazil. Leprosy cases in the elderly in the state of Pará during a 10 year period, i.e., 2005-2009 and 2010-2014 were analyzed. There were 6,382 registered cases and 5,327 new cases, with a higher proportion of the cases comprising men (2005-2009 = 67.8%; 2010-2014 = 68.7%) and patients aged 60-69 years (2005-2009 = 63.6%; 2010-2014 = 61.4%). A dimorphic clinical form, multibacillary operational classification, lack of physical disability, and entering the health service as a new case owing to spontaneous demand were prevalent in both sexes. Detection rates in the elderly had a homogeneous distribution, with a hyper-endemic pattern (> 40.0 per 100,000 inhabitants) throughout the time period and a tendency decline ($R^2 = 0.9014$) until the year 2024. Leprosy in the elderly manifested differently over time in the territories of Pará, with high numbers of new cases that might have contributed to maintaining the chain of transmission of the disease.

Keywords : Leprosy, Elderly, Geo-epidemiology, Brazil

Introduction

Leprosy is a contagious, chronic infection with slow evolution and a wide spectrum of clinical manifestations and characteristic signs and symptoms involving the skin and peripheral nerves (Lockwood and Saunderson 2012).

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Leprosy is classified as a neglected tropical disease and has significant correlations with poverty, stigma, disadvantage, and discrimination (World Health Organization 2017).

Worldwide, developed countries consider leprosy as an eliminated public health problem; however, the disease persists in highly endemic countries (i.e., India, Brazil, and Indonesia). These countries accounted for 79.6% of new cases in 2018, and Brazil was responsible for 93% of new cases (28,660) in Latin America (World Health Organization 2019). This represents an important region in the maintenance of disease transmission and may be influenced by the heterogeneity of social and economic health conditions observed in the northern part of the country (Kerr-Pontes et al 2004).

The evolution of the Brazilian epidemiological profile requires a health surveillance model that incorporates both temporal and spatial analyses, recognizing the associations between socio-economic, historical, geographic, population, and territorial factors in health-disease processes (Penna et al 2009, Richardus et al 2016). Geoepidemiology creates this collaborative link between the temporal and spatial dynamics of diseases (Bakker et al 2009).

Ageing imposes an increased burden on individuals with leprosy, as morphological and physiological changes reduce homeostatic balance and functionality while performing daily tasks (Cornman et al 2016). Elderly people with leprosy often manifest severe forms of the disease actively contributing to the transmission of the disease as well as atypical clinical manifestations in addition to an increased risk of developing disabilities and various associated diseases (Oliveira et al 2019). This study aimed to describe the distribution of leprosy in the elderly population in an endemic state, Pará, in the northern region of Brazil during a 10-year period spanning 2005–2014.

Material and Methods

The study was performed in accordance with resolutions 466/12 and 510/2016 of the Brazilian National Health Council for Research involving human beings and was approved by the Research Ethics Committee of the University of the State of Pará (CEP/UEPA) under opinion No. 1,456,689 / 2016. A commitment to use the data was signed, guaranteeing confidentiality and privacy of the information.

An ecological study was carried out on leprosy cases reported in people aged 60 years or older (considered "elderly" according to the Brazilian elderly statute (Oliveira et al 2019)) to analyze the magnitude and severity of leprosy in a time period from 2005 to 2014, divided into two 5-year periods (2005–2009 and 2010–2014). The area analyzed consisted of the Integration Regions (IRs) of Pará. It encompasses an area of 1,247,955,381 km^2 of the Brazilian Amazon and is the second-largest federal state in territorial extension, with a population of 7,581,051 inhabitants, a demographic density of 6.07 inhabitants/km^2, and latitude of 3° 57 0 south and longitude of 53° 5 24" west. The area is divided into 144 municipalities aggregated by 12 IRs: Metropolitana (05 municipalities), Guamá (18 municipalities), Rio Caeté (15 municipalities), Araguaia (15 municipalities), Carajás (12 municipalities), Tocantis (11 municipalities), Baixo Amazonas (13 municipalities), Lago Tucuruí (07 municipalities), Rio Capim (16 municipalities), Xingu (10 municipalities), Marajó (16 municipalities) and Tapajós (12 municipalities).

Databases were purchased were from secondary sources. Clinical and epidemiological data including the clinical form of leprosy (indeterminate, tuberculoid, dimorphic, Virchowian, or unclassified), operational classification (paucibacillary and multibacillary; MB), and degree of physical disability (0, 1, 2, or not evaluated) were acquired on the basis of the Notifiable Diseases Information System of the State Secretariat of Public Health of Pará (SINAN/SESPA). Demographic data (from 2000 and 2010 censuses, in addition to population estimates) and continuous cartographic data (scales 1:250,000) were obtained from the Brazilian Institute of Geography and Statistics (IBGE) and used to construct the study area algebraically. Demographic data of the IRs of the state of Pará were obtained from the Information System of the Amazon Foundation of Support to Studies and Research in Pará (FAPESPA).

Debugging was performed using TabWin 3.6 software. Variables were tabulated and filtered, removing incomplete data, redundancies, and inconsistencies. Data with duplicate names and/or characteristics and typing errors in SINAN were excluded. Laboratory work was performed at the Epidemiology and Geoprocessing Laboratory of the Amazon (EpiGeo) at UEPA. Georeferencing of data was performed using the LAT/LONG projection system with DATUM SIRGAS 2000 to index geographic coordinates, create the geographic database (BDGeo), and integrate epidemiological and demographic databases using ArcGIS 10.5 software.

In the descriptive analyses, monitoring indicators were built according to the annual prevalence rates of leprosy (number of cases in the course of treatment in that location and year, divided by the total population in the same location and year, multiplied by 10,000) and annual detection rates for new cases (new resident cases diagnosed in that location and year, divided by the total population in the same location and year, multiplied by 100,000), calculated during the periods of 2005-2009 and 2010-2014. The denominator was the total population and the elderly population in the 12 integration regions from 2005 to 2014 (Tables 1 and 2). To assess these indicators, the parameters of the Brazilian Ministry of Health (Brazil, 2020) were considered. The prevalence of a point with cases undergoing treatment on December 31 of the year of assessment was adopted.

An analysis of leprosy trends was projected for the following 10 years using the annual detection rate of new cases in the general and elderly population per 100,000 inhabitants by 2024. To obtain these values, polynomial regression models for the time period were used with second-order modeling and curve-fitting models. Monitoring indicators presented were produced using the Microsoft Excel® 2013 software.

Spatial distributions were obtained from data aggregated by area, with the indicators classified by color in five categories which varied according to their parameter patterns: low (dark green), medium (light green), high (yellow), very high (orange), and hyper-endemic (red). Analysis was performed in accordance with the international cartographic standards for choropleth maps (Nardi et al 2013).

Results

In the 12 IRs of Pará during the period 2005-2014, 6,382 cases of leprosy were registered, of which 5,327 were new cases. During 2005-2009, there were 3,214 records of the disease (2,708 new cases), and during 2010-2014, there were 3,168 (2,619 new cases) (Table 3).

In relation to the new cases of leprosy in the elderly, occurrence was more frequent in men (2005–2009 = 67.8%; 2010–2014 = 68.7%), with proportions reaching twice as that of women (2005–2009 = 32.2%; 2010–2014 = 31.3%). The age group of 60–69 years had a greater distribution (2005–2009 = 63.6%; 2010–2014 = 61.4%) (Table 4).

Table 1 : Distribution of the total population by sexes in the 12 Integration Regions of the state of Pará, Brazil, 2005-2014

	Integration Regions of the state of Pará, Brazil												
	Pará	Araguaia	Baixo Amazonas	Carajás	Metro-politana	Guamá	Lago Tucuruí	Marajó	Rio Caeté	Rio Capim	Tapajós	Tocan-tins	Xingu
2005	**7,087,681**	**418,031**	**657,916**	**499,795**	**1,973,028**	**576,338**	**325,617**	**446,035**	**446,452**	**558,865**	**209,270**	**669,993**	**306,341**
Men	3,510,378	219,321	334,733	255,856	942,250	292,609	157,462	231,460	229,387	287,908	110,657	344,411	160,556
Women	3,577,303	198,710	323,183	243,939	1,030,778	283,729	168,155	214,575	217065	270957	98,613	325,582	145,785
2006	**7,228,687**	**431,866**	**665,623**	**517,100**	**1,997,750**	**587,234**	**334,456**	**457,030**	**453,612**	**571,998**	**210,375**	**688,329**	**313,314**
Men	3,648,433	226516	338,478	264,646	954,263	298,096	172,519	237,187	232,963	294,638	110,974	353,982	164,171
Women	3,580,254	205350	327,145	252,454	1,043,487	289,138	161,937	219,843	220,649	277,360	99,401	334,347	149,143
2007	**7,367,310**	**445,464**	**673,198**	**534,118**	**2,022,053**	**597,947**	**343,147**	**467,842**	**460,655**	**584,903**	**211,460**	**706,355**	**320,168**
Men	3,718,202	233,589	342,111	273,300	965,991	303,476	176,805	242,792	236,492	301,252	111,293	363,369	167,732
Women	3,649,108	211,875	331,087	260,818	1,056,062	294,471	166,342	225,050	224,163	283,651	100,167	342,986	152,436
2008	**7,504,065**	**458,882**	**680,674**	**550,904**	**2,046,031**	**608,511**	**351,722**	**478,509**	**467,598**	**597,636**	**212,531**	**724,138**	**326,929**
Men	3,786,729	240,555	345,692	281,826	977,377	308,746	181,028	248,316	239,944	307,786	111,601	372,615	171,243
Women	3,717,336	218,327	334,982	269,078	1,068,654	299,765	170,694	230,193	227,654	289,850	100,930	351,523	155,686
2009	**7,637,004**	**471,925**	**687,940**	**567,222**	**2,069,338**	**618,784**	**360,059**	**488,876**	**474,350**	**610,012**	**213,572**	**741,424**	**333,502**
Men	3,853,019	247,331	349,136	290,110	988,274	313,852	185,129	253,663	243,289	314,112	111,93	381,574	174,646
Women	3,783,985	224,594	338,804	277,112	1,081,064	304,932	174,930	235,213	231,061	295,900	101,669	359,850	158,856
2010	**7,762,953**	**484,280**	**694,825**	**582,681**	**2,091,421**	**628,516**	**367,954**	**498,697**	**480,748**	**621,741**	**214,558**	**757,802**	**339,730**
Men	3,915,560	253,755	352,370	297,951	998,460	318,666	189,005	258,720	246,436	320,100	112,167	390,059	177,871
Women	3,847,393	230,525	342,455	284,730	1,092,961	309,850	178,949	239,977	234,312	301,641	102,391	367,743	161,859
2011	**7,862,943**	**494,088**	**700,291**	**594,955**	**2,108,951**	**636,242**	**374,222**	**506,495**	**485,827**	**631,051**	**215,340**	**770,806**	**344,675**
Men	3,963,990	258,675	355,005	304,158	1,006,006	322,408	191,997	262,709	248,845	324,638	112,407	396,673	180,469
Women	3,898,953	235,413	345,286	290,797	1,102,945	313,834	182,225	243,786	236,982	306,413	102,933	374,133	164,206
2012	**7,960,134**	**503,625**	**705,602**	**606,885**	**2,125,993**	**643,750**	**384,081**	**514,073**	**490,763**	**636,337**	**216,101**	**783,445**	**349,479**
Men	4,010,819	263,490	357,492	310,200	1,013,224	326,009	196,863	266,581	251,160	327,098	112,637	403,076	182,989
Women	3,949,315	240,135	348,110	296,685	1,112,769	317,741	187,218	247,492	239,603	309,239	103,464	380,369	166,490
2013	**8,054,419**	**512,873**	**710,755**	**618,457**	**2,142,524**	**651,037**	**390,113**	**521,428**	**495,552**	**644,996**	**216,840**	**795,703**	**354,141**
Men	4,056,010	268,135	359,903	316,064	1,020,085	329,489	199,717	270,324	253,390	331,315	112,864	409,274	185,450
Women	3,998,409	244,738	350,852	302,393	1,122,439	321,548	190,396	251,104	242,162	313,681	103,976	386,429	168,691
2014	**8,149,418**	**522,194**	**715,946**	**630,117**	**2,159,179**	**658,378**	**396,191**	**528,837**	**500,377**	**653,720**	**217,583**	**808,058**	**358,838**
Men	4,101,424	272,815	362,312	321,976	1,026,909	332,974	202,613	274,095	255,648	335,559	113,088	415,510	187,925
Women	4,047,994	249,379	353,634	308,141	1,132,270	325,404	193,578	254,742	244,729	318,161	104,495	392,548	170,913

Table 2 : Distribution of the elderly population by sexes in the 12 Integration Regions of the state of Pará, Brazil, 2005-2014

		Integration Regions of the state of Pará, Brazil											
	Pará	Araguaia	Baixo Amazonas	Carajás	Metro-politana	Guamá	Lago Tucuruí	Marajó	Rio Caeté	Rio Capim	Tapajós	Tocan-tins	Xingu
2005	**439,336**	**22,119**	**44,453**	**24,952**	**137,921**	**42,633**	**16,483**	**24,867**	**31,865**	**29,626**	**9,838**	**38,649**	**15,930**
Men	215,150	12,896	22,348	13,882	56,890	20,924	9,437	12,726	16,184	15,883	5,550	19,412	9,018
Women	224,186	9,223	22,105	11,070	81,031	21,709	7,046	12,141	15,681	13,743	4,288	19,237	6,912
2006	**456,878**	**23,288**	**45,562**	**26,171**	**144,065**	**44,104**	**17,320**	**25,626**	**32,705**	**30,937**	**10,265**	**40,140**	**16695**
Men	223,730	13,554	22,944	14,531	59,440	21,644	9,873	13,135	16,612	16,579	5,811	20,167	9,440
Women	233,148	9,734	22,618	11,640	84,625	22,460	7,447	12,491	16,093	14,358	4,454	19,973	7,255
2007	**475,450**	**24,504**	**46,761**	**27,445**	**150,527**	**45,680**	**18,195**	**26,449**	**33,631**	**32,326**	**10,710**	**41,731**	**17,491**
Men	232,837	14,244	23,577	15,209	62,124	22,422	10,331	13,577	17,092	17,314	6,081	20,979	9,887
Women	242,613	10,260	23,184	12,236	88,403	23,258	7,864	12,872	16,539	15,012	4,629	20,752	7,604
2008	**495,346**	**25,784**	**48,172**	**28,799**	**157,545**	**47,430**	**19,119**	**27,376**	**34,700**	**33,810**	**11,192**	**43,475**	**18,342**
Men	242,253	14,968	24,312	15,930	64,984	23,266	10,815	14,062	17,632	18,099	6,370	21,852	10,361
Women	253,093	10,816	23,860	12,869	92,561	24,164	8,304	13,314	17,068	15,711	4,822	21,623	7,981
2009	**518,083**	**27,153**	**49,775**	**30,264**	**165,251**	**49,372**	**20,126**	**28,431**	**35,889**	**35,430**	**11,727**	**45,399**	**19,266**
Men	253,288	15,734	25,121	16,704	68,065	24,196	11,340	14,605	18,221	18,946	6,691	22,797	10,868
Women	264,795	11,419	24,654	13,560	97,186	25,176	8,786	13,826	17,668	16,484	5,036	22,602	8,398
2010	**542,135**	**28,613**	**51,553**	**31,824**	**173.525**	**51,465**	**21,199**	**29,568**	**37,206**	**37,165**	**12,300**	**47,465**	**20,252**
Men	264,684	16,549	26,014	17,527	71,367	25,183	11,896	15,185	18,870	19,845	7,025	23,811	11,412
Women	277,451	12,064	25,539	14,297	102,158	26,282	9,303	14,383	18,336	17,320	5,275	23,654	8,840
2011	**561,326**	**29,756**	**52,972**	**33,146**	**180,840**	**52,860**	**22,168**	**30,274**	**38,056**	**38,517**	**12,800**	**48,944**	**20,993**
Men	273,598	17,115	26,686	18,158	74,417	25,833	12,360	15,576	19,279	20,478	7,275	24,603	11,818
Women	287,728	12,641	26,286	14,988	106,423	27,027	9,808	14,698	18,777	18,039	5,525	24,341	9,175
2012	**582,114**	**30,968**	**54,546**	**34.556**	**188,687**	**54,412**	**23,430**	**31,066**	**39,023**	**39,733**	**13,336**	**50,570**	**21,787**
Men	283,156	17,719	27,427	18,829	77,636	26,545	12,999	15,998	19,738	21,020	7,538	25,459	12,248
Women	298,958	13,249	27,119	15,727	111,051	27,867	10,431	15,068	19,285	18,713	5,798	25,111	9,539
2013	**604,373**	**32,257**	**56,260**	**36,042**	**197,018**	**56,098**	**24,521**	**31,942**	**40,085**	**41,280**	**13,907**	**52,323**	**22,640**
Men	293,318	18,360	28,231	19,541	81,013	27,313	13,520	16,459	20,237	21,748	7,822	26,365	12,709
Women	311,055	13,897	28,029	16,501	116,005	28,785	11,001	15,483	19,848	19,532	6,085	25,958	9,931
2014	**627,930**	**33,621**	**58,103**	**37,611**	**205,775**	**57,902**	**25,667**	**32,885**	**41,221**	**42,910**	**14,511**	**54,185**	**23,539**
Men	304,029	19,034	29,085	20,291	84,547	28,134	14,069	16,949	20,769	22,515	8,123	27,317	13,196
Women	323,901	14,587	29,018	17,320	121,228	29,768	11,598	15,936	20,452	20,395	6,388	26,868	10,343

Table 3 : Registered prevalence and new cases of leprosy in the elderly in the 12 Integration Regions of the state of Pará, Brazil, 2005–2014

Integration Regions	Registered prevalence				Number of new cases			
	Number		Rate per 10,000 population		Number		Rate per 100,000 population	
	2005 a 2009 (*n*=3,214) n (%)	2010 a 2014 (*n*=3,168) n (%)	2005 a 2009	2010 a 2014	2005 a 2009 (*n*=2,708) n (%)	2010 a 2014 (*n*=2,619) n (%)	2005 a 2009	2010 a 2014
Araguaia	365 (11.3)	337 (10.7)	29.87	18.50	301 (11.1)	278 (10.6)	336.7	224.1
Baixo Amazonas	147 (4.6)	179 (5.7)	6.73	5.56	113 (4.1)	138 (5.3)	35.67	39.84
Carajás	473 (14.7)	381 (12.0)	18.90	11.72	409 (15.1)	309 (11.8)	371.6	228.4
Metropolitana	540 (16.8)	574 (18.1)	9.17	7.27	463 (17.0)	471 (18.0)	76.8	64.0
Guamá	176 (5.5)	206 (6.5)	4.99	4.01	143 (5.3)	158 (6.0)	81.2	39.72
Lago de Tucuruí	292 (9.1)	238 (7.5)	36.46	26.91	245 (9.1)	197 (7.6)	339.4	212.1
Marajó	106 (3.3)	153 (4.8)	4.88	8.22	88 (3.3)	115 (4.4)	81.5	101.0
Rio Caeté	122 (3.8)	105 (3.3)	6.57	5.67	105 (3.9)	85 (3.3)	74.6	53.7
Rio Capim	336 (10.5)	327 (10.3)	19.58	15.29	281 (10.4)	286 (10.9)	226.0	169.3
Tapajós	128 (4.0)	146 (4.6)	19.66	21.19	111 (4.1)	122 (4.6)	233.0	223.2
Tocantins	329 (10.2)	303 (9.6)	20.53	14.04	284 (10.5)	274 (10.4)	164.5	122.8
Xingu	200 (6.2)	219 (6.9)	24.81	16.63	165 (6.1)	186 (7.1)	250.6	206.9

Table 4 : Distribution of new cases and annual leprosy detection rate in the elderly by sexes and age groups in the 12 Integration Regions of the state of Pará, Brazil, 2005–2014

	New cases		Detection rate per 100,000 population	
	2005-2009 (n=2,708) n (%)	2010-2014 (n = 2,619) n (%)	2005-2009	2010-2014
Sexes				
Men	1,835 (67.8)	1,798 (68.7)	81.73	64.04
Women	873 (32.2)	821 (31.3)	38.88	29.24
Age groups (years)				
60-69	1,721 (63.6)	1,608 (61.4)	76.65	57.27
70-79	779 (28.7)	788 (30.1)	34.69	28.06
≥ 80	208 (7.7)	223 (8.5)	9.26	7.94

Table 5 : Distribution of new leprosy cases in the elderly by sex according to the clinical form, operational classification, and degree of disability in the 12 Integration Regions of the state of Pará, Brazil, 2005–2014

	New cases			
	Men		Women	
	2005-2009 (n = 1,835) n (%)	2010-2014 (n = 1,798) n (%)	2005-2009 (n = 873) n (%)	2010-2014 (n = 821) n (%)
Clinical form				
Indeterminate	179 (9.7)	157 (8.7)	148 (16.9)	101 (12.3)
Tuberculoid	218 (11.9)	167 (9.3)	206 (23.6)	140 (17.1)
Dimorphic	855 (46.6)	956 (53.2)	314 (36.0)	424 (51.6)
Virchowian	405 (22.1)	404 (22.5)	111 (12.7)	109 (13.3)
Unclassified	178 (9.7)	114 (6.3)	94 (10.8)	47 (5.7)
Operational Classification				
Paucibacillary	392 (21.4)	290 (16.1)	374 (42.9)	246 (29.9)
Multibacillary	1,440 (78.5)	1,508 (83.9)	497 (56.9)	575 (70.1)
Unknown	3 (0.1)	-	2 (0.2)	-
Degree of disability				
0	931 (50.7)	867 (48.2)	538 (61.6)	460 (56.0)
1	484 (26.4)	564 (31.4)	188 (21.5)	226 (27.5)
2	187 (10.2)	201 (11.2)	58 (6.7)	67 (8.2)
Not avaluated	233 (12.7)	166 (9.2)	89 (10.2)	68 (8.3)

The dimorphic clinical form of leprosy was frequent among both men (2005–2009 = 46.6%; 2010–2014 = 53.2%) and women (2005–2009 = 36.0%; 2010–2014=51.6%) throughout the entire study period. The MB operational classification prevailed in both sexes: men (2005–2009=78.5%; 2010–2014=83.9%) and women (2005–2009 = 56.9%; 2010–2014 = 70.1%). In terms of physical disability, a score of 0 was the most common in both men (2005–2009=50.7%; 2010–2014= 48.2%) and women (2005–2009=61.6%; 2010–2014=56.0%) in the 10 years analyzed (Table 5).

The mode of entry for care in public health services for new cases predominated among the reported cases of leprosy in elderly patients across the state. From 2005–2009, 11/12 regions presented relative values above 80.0%, with emphasis on Tapajós (86.7%; 111/128 new cases), Carajás (86.4%; 409/473 new cases), Tocantis (86.3%; 284/329 new cases), and Rio Caeté (86.1%; 105/122 new cases). From 2010–2014, there was a decline in the number of regions with such high percentages; however, Tocantis reached a value of 90.5% (274/303 new cases), which was higher due to spontaneous demand throughout the series. During the first time period studied, it was observed that 10/12 IRs presented this type of demand to the Health Service, particularly Tocantis (68.6%; 195/329 new cases), Lago Tucuruí (66.6%; 163/292 new cases), and

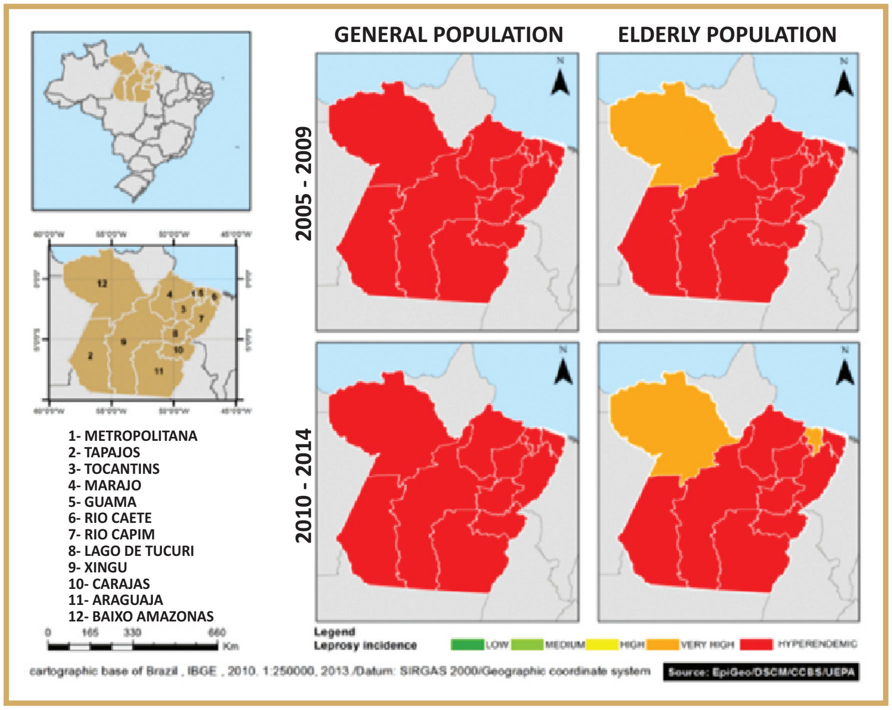

Fig. 1 : Spatial distribution of new cases in the general and elderly population in the Integration Regions of the state of Pará, Brazil, 2005–2014

Araguaia (65.1%; 196/365 new cases). In the second time period, there were similar results, with 9/12 IRs still having the same spontaneous demand as new cases, mainly Araguaia (66.9%; 186/337 new cases), Carajás (62.1%; 192/381 new cases), and Lago Tucuruí (61.9%; 122/238 new cases).

Analysis of the spatial distribution of the rates of detection of new cases of leprosy among the general and elderly population demonstrated a homogeneous distribution of the disease related to a hyper-endemic pattern throughout the entire study period in both population subgroups (Figure 1). From 2005-2009, 11 IRs presented parameters considered hyper-endemic, except for Baixo Amazonas, which had a very high incidence (35.67%). In the 2010–2014 period, 10 IRs remained hyper-endemic; however, 2 IRs presented parameters considered to be very high: Baixo Amazonas, which continued in this parameter (39.84%) and Guamá, which passed this standard (39.72%) from the second time period.

The annual detection rates of new cases of leprosy in the general population showed progressive declines during the historical series, but with two fluctuations between 2007-2008 and 2011-2012, in addition to inflexibility in 2010. Concerning the elderly population, it was evidenced that the detection rates also followed the decrease of the general population over the years, with slight punctual variations in the years 2008 and 2012, however with the maintenance of high detection rates in hyperen-

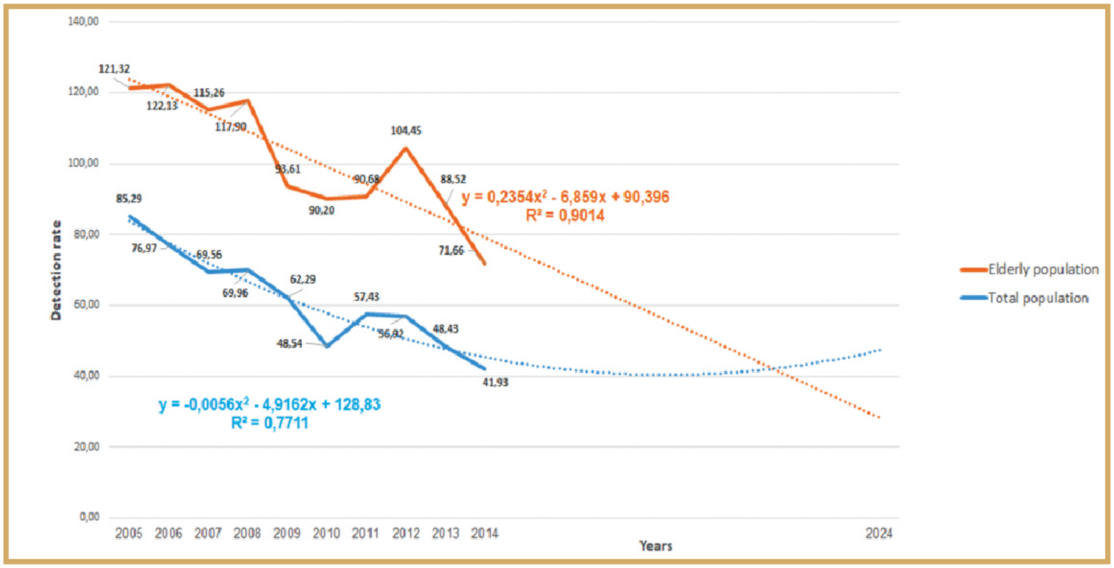

Fig. 2 : Historical series of leprosy detection rate in the general and elderly population with a polynomial trend until 2024, in the state of Pará, Brazil, 2005-2014

demic parameters. The trend in detection rates in the elderly population showed a decline until 2024 ($R^2 = 0.9014$) (Fig. 2).

Discussion

Leprosy has shown a decline in monitoring indicators in recent years due to the introduction of multidrug therapy. However, the detection of new cases in several countries, including Brazil, remains significant (World Health Organization, 2019). The northern region of Brazil shows the maintenance of clusters with high endemicity, probably due to social, economic, and geographical vulnerability (Penna et al 2009). This study reveals the geo-epidemiological context of this disease in elderly patients during a 10 years time period in the endemic state of Pará in northern Brazil.

In addition to being a neglected disease, leprosy shows evidence of distinct distributions between sexes in old age (Brazil 2018). Other epidemiological studies have demonstrated this higher occurrence in men (Fine et al 1997; Irgens et al 1990). This may be related to the behavioural context and distinction of values and attitudes toward the health-disease process and assistance (Dijkstra et al 2017), and due to difficulties in accessing health services, both because of leprosy-related disabilities (Richardus et al 1999) and frequent functional decline in old age (Maia et al 2006). There may also be greater biological susceptibility to the disease in men (Fine et al 2001).

The highest occurrence of leprosy in the 60–69 years group was similar to that reported in other studies investigating leprosy in elderly people (Oliveira et al 2019; Souza et al 2020). These findings may be related to this age group constituting a higher proportion of the population, according to data for Pará in the 10 years analyzed (Brazilian Institute of Geography and Statistics, 2020). Further, there could be better preservation of functional capacity in this age group (Nogueira et al 2017), allowing better access to health services. Notably, Brazil has a family health strategy (FHS) that aims to reorganize primary care in the country through expansion, qualification, and consolidation of health actions and services by multi-professional teams.

The higher frequency of new cases of the MB form of leprosy in elderly patients in the state corroborates the findings by Nobre et al (2017) who reported an increase in new MB cases with advancing age at a national level (ranging from 15% among children to 74% among the elderly). Widely discussed factors that influence this include public understanding of the disease, accessibility to health actions and services, and technical training of health professionals (World Health Organization, 2016). However, in the case of elderly people with leprosy, limitations in access to health services can be affected by low coverage as well as physiological declines imposed by age and frequently associated diseases (Cruz et al 2020).

This growing distribution of MB cases in elderly patients differs from that predicted by the World Health Organization, which highlights the occurrence of high numbers of new MB cases in populations from regions with low leprosy endemicity (World Health Organization, 2016). Brazil is considered a country with a high burden of the disease is owing to the high number of cases in a global context; hence, it is ranked second globally (World Health Organization, 2019). This may be influenced by other epidemiological factors that condition these clinical forms in the elderly.

A lack of physical disability was frequent throughout the entire study period, similar to findings by Nogueira et al (2017) when assessing the functional capacity of elderly people with leprosy. This may be related to early diagnosis resulting from a greater coverage of the FHS from one time period to another in the study. However, some IRs still showed concerning percentages of low coverage (Brazil 2019). However, it is worth highlighting the need for continued training of FHS professionals. In addition to leprosy mimicking clinical manifestations of other diseases, an advanced age imposes several physiological changes in cognition, mood, mobility, and communication, which may interfere with the sensitivity of the standardized tests (Oliveira et al 2019).

Analysis of the spatial distribution of detection rates showed patterns considered hyper-endemic throughout the entire study period in both the general and elderly population subgroups. This is in accordance with reported characteristics of the northern region of Brazil, where Pará is one of the states that contribute most to the transmission of the disease and has one of the highest detection rates (Brazil 2020). These patterns suggest that in Pará, leprosy remains a major public health problem. Even after more than three decades of multidrug therapy, leprosy transmissibility is still high, indicating that regional conditions may contribute to the epidemiological context, favoring hidden endemic factors of disease (Ferreira et al 2020).

Such conditions in the northern region of Brazil may be related to poor living conditions, precarious socioeconomic development, inequalities in access to health services, and low compliance with public policies (Penna et al 2009). This occurs less frequently in the territories because they are geographic spaces of permanent interaction, defining patterns of social groups that live there (Bakker et al 2009). Conversely, Pará has evidence of social production of leprosy related to economic development projects, large migratory flows, accelerated urbanization, and inadequate living conditions (Menezes et al 2010).

During the 2005–2009 periods, Pará had one of the lowest population coverages of FHS teams in Brazil (Brazil 2019). This may have contributed to a higher risk of transmission, possibly due to inadequate early diagnosis, treatment, and follow-up. Baixo Amazonas showed very high rates, below the standard of other regions in the study, suggesting the existence of geographic contexts with different vulnerabilities to the social production of leprosy and new organizations in their territories. During this period, Baixo Amazonas had the second-lowest FHS coverage in the state (Pará 2010).

Regardless of FHS coverage, the area ineffectively performed early diagnosis and disease control. In the period of 2010–2014, there was a progressive improvement in population coverage of FHS in almost all regions of the state, with emphasis on Baixo Amazonas (Brazil, 2019). However, this increase did not significantly affect their detection rates, which continued to be very high. This IR is considered one of the oldest occupation areas in the state, with major mining projects that reflect changes in the population pattern, demographic growth, marked urbanization, and rural populations located on the banks of rivers, side roads, and highways (Menezes et al 2010; Pará 2010). The improvement in Guamá's monitoring indicators, on the other hand, may be related to the activities of primary health care in the population, with emphasis on FHS coverage above the state average (Pará 2015).

The northern region has many territories in which a large proportion of its population still resides in rural areas, making access to health services difficult and generating differences in health coverage and underreporting of cases registered with SINAN (Freitas et al 2014). Indeed, Magalhães and Rojas (2007) observed high rates of detection of leprosy in Pará when studying spatial distribution.

Detection rates in the elderly throughout this study period did not decrease as observed in the general population, suggesting maintenance of the epidemiological chain in the state's IRs, with parameters of hyper-endemicity above the recommendations of the Brazilian Ministry of Health and similar to endemic scenarios in the mid-west and north-east of the country (Brazil 2020, Ferreira et al 2020, Rocha et al 2020). This pattern in the elderly is generally observed in countries where the endemic has stabilized with relatively low prevalence (Irgens et al 1990, Larre et al 2012).

This unique manifestation of leprosy in the elderly may be associated with re-infection owing to an increased life expectancy, late clinical manifestations for the extended incubation period of the bacillus, greater immunological susceptibility, associated diseases, nutritional aspects, and more recently, the transition demographic (Rocha et al 2020). However, we highlighted other evidence that may be associated with leprosy cases in elderly patients. For example, proposals for epidemiological transition, particularly in Latin America and Brazil, but in scenarios different from the traditional ones postulated by Omran (2005) amid sequenced phases.

We defend the prolonged polarized model of epidemiological transition, as it highlights a high concomitant incidence of disease at all stages of the transition, the resurgence of infectious diseases that had already been controlled, countries with mixed morbidities and different levels of transition in the same country, both in varying geographic areas and between social groups (Frenk et al 1991). This reflects changes in the frequency, magnitude, and distribution of health conditions (expressing a double burden of illness, disability, and death) as well as systematic social responses to these conditions (expressed in the way the health system would organize itself to offer its services) (Frenk et al 1989, Araújo 2012).

Leprosy has both persistence and recrudescence in Brazil, represented by its emergence in greater intensity amid a non-unidirectional nature. This could explain the distribution of the disease in several Brazilian regions, where its behavior shows important differences in terms of geographic and social polarization leading to different patterns of morbidity indicators between population subgroups (Frenk et al 1991, Schramm et al 2004, Araújo 2012). Fine (2006) stressed that leprosy is not an eradicable disease with current methods, even with favorable projections of monitoring indicators. It will continue to be endemic for many decades in countries such as Brazil.

Conclusion

The findings of the study on leprosy in the elderly population in the state of Pará showed a homogeneous spatial distribution in the integration regions, with a hyperendemic pattern over the ten years analyzed. Its detection rates follow the decline of the general population, but with much higher hyperendemic parameters, mainly of the multibacillary forms**.**

This context suggests the conditioning of the disease by the demographic and epidemiological transition, characterized by a rapidly growing elderly contingent, with morphological changes, reductions in homeostatic balance, multiple associated diseases and a decline in their functional capacity, imposing the need for differentiated disease control in old age. Greater access to health services through primary care, early diagnosis, reinforced contact surveillance in families with elder people, reinforced national healthcare policy for men and comprehensive geriatric assessment deserve attention. Such measures may contribute to the interruption of the chain of transmission of the disease in a territory with great inequities and a hidden historical endemic.

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