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VACCINE COVERAGE AND EPIDEMIOLOGICAL PROFILE OF MEASLES ADMISSIONS IN BRAZIL IN THE PEDIATRIC AGE GROUP BETWEEN 2012 AND 2021

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Abstract: Measles is an extremely contagious acute exanthematous infectious disease, which can lead to complications and death, and is compulsory to report in Brazil. The measles vaccine is part of the National Immunization Program and is available free of charge through the Brazilian health system. The topic demonstrates relevance to public health in Brazil, requiring in-depth analyzes to enable appropriate interventions. The present work aims to analyze the epidemiological profile of hospitalizations for Measles in Brazil, in the pediatric age group from 0 to 19 years old, between 2012 and 2021, relating it to data on vaccination coverage (VC) in the country. A descriptive, cross-sectional, epidemiological and retrospective study was carried out with a quantitative approach, based on secondary data provided by the Department of Informatics of the Unified Health System (DATASUS). Measles hospitalization cases were selected according to Brazilian macro-regions, pediatric age groups, race and sex, between 2012 and 2021, in addition to data regarding vaccination coverage. The study demonstrated that in the period in question, Measles most frequently affected the Northeast region, but proportionally to demographic density, the North was the most affected region. The most affected age group was children under 1 year old. A trend towards higher prevalence in the brown population was demonstrated. CV suffered a gradual decline over the decade of research. An influential relationship was identified between CV and the prevalence of Measles hospitalizations. Therefore, health education for the general population must be continuous and encouraged so that the vaccination rate increases again and Brazil achieves effective immunization of the population.
Keywords: Measles; Public health; Brazil.

INTRODUCTION

Measles is an acute, transmissible and extremely contagious infectious disease, which can lead to complications and death, and has been mandatory notification in Brazil since 1968 (Brasil, 2019, 2022).

It is classified as a highly transmissible viral pathology, characterized by fever, asthenia, rash, cough, rhinorrhea and conjunctivitis (Gans, 2023). Measles has an infection rate of 90% among exposed individuals, and is transmitted through nasopharyngeal secretions through direct contact or through particles that remain in the air for up to two hours. The virus can spread in public places, in crowds and in densely populated areas, such as schools. The incubation period varies from 6 to 21 days, and transmission occurs between 5 days before the rash appears and up to 4 days after (Conceição et al, 2024).

According to Gans et al (2023), obtaining accurate data on its global incidence is challenging due to the variability of surveillance systems and frequent underreporting. Before vaccination was introduced in the 1960s, more than two million people died from measles each year. The introduction of the vaccine drastically reduced both the incidence of the disease and related deaths, in addition to altering its worldwide distribution. Currently, Measles is more common in regions with low vaccination rates, especially where resources are limited. However, outbreaks also occur in more developed areas, often due to a drop-in vaccination uptake, allowing the virus to spread through unvaccinated travelers.

The groups most vulnerable to measles include children who are not yet old enough to be vaccinated, individuals not vaccinated for medical or other reasons, people who have not received the second dose of the vaccine, and a small number of those in whom the vaccine does not induce effective immunity. Additionally, traveling to regions where measles is endemic or contact with infected individuals can significantly increase the risk of contracting the disease (Gans et al, 2023).

In Brazil, the measles vaccine is part of the National Immunization Program and is available free of charge through the Unified Health System (SUS). The recommended schedule includes two doses of the vaccine: the first dose of the MMR vaccine (measles, mumps and rubella) at 12 months of age, and a booster dose of the tetravalent vaccine (including varicella) at 15 months, with a minimum interval of 30 days between doses. Complete protection, estimated at 97%, is only achieved after completing the vaccination schedule. Countries that have eliminated measles face challenges such as maintaining effective surveillance against the importation of the virus and ensuring continuous and homogeneous vaccination coverage above 95% (Medeiros, 2020).

However, a notable re-emergence of diseases, particularly vaccine-preventable ones, in the context of falling vaccination coverage, has been documented in several countries. In 2016, the Region of the Americas was certified with the Interruption of Endemic Circulation of the Measles Virus. However, in 2019, it lost certification due to circulation again in the Americas and Brazil due to the immigration of Venezuelans through the north of the country (Brasil, 2024).

During 2020, approximately 27.2 million children missed their first dose of measles vaccine globally due to the pandemic, resulting in 8.9 million children not being routinely vaccinated. In Brazil, there was an annual drop of 2.7% in MMR vaccination coverage (CV) from 2006 to 2016, with areas of high susceptibility identified in the northeast region. Furthermore, there was a decrease in the application of doses of the MMR vaccine, especially after the adoption of restrictive measures due to COVID-19 between April

and September 2020 (Sato et al, 2023).

Therefore, it is clear that the topic is extremely relevant to public health in Brazil, requiring in-depth analyzes to enable appropriate interventions.

OBJECTIVES

The present work aims to analyze the epidemiological profile of hospitalizations for Measles in Brazil, in the pediatric age group from 0 to 19 years old, in the time frame of 2012 and 2021, relating it to vaccination coverage data in the country.

METHODOLOGY

A descriptive, cross-sectional, epidemiological and retrospective study was carried out with a quantitative approach, based on secondary data provided by the department of Informatics of the Unified Health System (DATASUS). The information was collected in the hospital morbidity section of the SUS, by place of residence, selecting cases of hospitalization for Measles according to Brazilian macro-regions, pediatric age groups (0 to 19 years), race and sex, between the years of 2012 and 2021. Furthermore, in the immunization section of DATASUS, data were collected regarding vaccination coverage in Brazil, according to Brazilian macro-regions.

The collected data were arranged in adapted tables provided by DATASUS, for better visualization and understanding of the study results. The indicators were categorized and compared year by year, allowing the assessment of variations in hospitalizations for Measles and in vaccination coverage to prevent the disease.

RESULTS

Between 2012 and 2021, 2316 hospitalizations for measles were recorded in Brazil, with 2018 accounting for the largest number of cases, with 31.99% (741).

During the decade of research, in the North, 49.65% (1150) of Measles hospitalization cases in Brazil, followed by 30.22% (700) in the Southeast, 15.67% (363) in the Northeast, 3.02% (70) in the South and 1. 42% (33) in the Midwest. In 2019, more hospitalizations were recorded in the Southeast region (552), with an increase of 73.75% percentage points compared to 2018 (28) and a reduction of 54.28% percentage points in 2020 (93) (Table 1).

Regarding hospitalizations for Measles and the age groups affected in the period, patients aged less than one year represented 48.05% (1113) of total hospitalizations, followed by 1 to 4 years with 31.56% (731), 5 to 9 years old with 8.89% (206), 10 to 14 years old with 5.05% (117) and 15 to 19 years old with 6.43% (149). However, in 2012 a greater number of cases were observed in patients aged 1 to 4 years, totaling 54.35% (25) of the year's hospitalizations. The year 2015 demonstrated the highest incidence of hospitalizations in children under one year of age with 69.77% (30), this being the highest proportion between the age group and hospitalizations in the period studied (Table 2).

Between the years 2012 and 2021, there was a predominance of male cases, with exceptions in the years 2012 and 2021, when there was a predominance of female cases, with, respectively, 65.22% (30) and 54.60% (89) of the cases (Table 3).

Year		Hospitalizatio ;					Total
		North	Northeast	Southeast	South	Midwest	
2012	Case	1	17	14	12	2	46
	%	2,17%	36,96%	30,43%	26,09%	4,35%	100,00%
2013	Case	3	48	2	2	6	61
	%	4,92%	78,69%	3,28%	3,28%	9,84%	100,00%
2014	Case	0	67	2	2	0	71
	%	0,00%	94,37%	2,82%	2,82%	0,00%	100,00%
2015	Case	1	36	2	4	0	43
	%	2,33%	83,72%	4,65%	9,30%	0,00%	100,00%
2016	Case	3	24	1	1	0	29
	%	10,34%	82,76%	3,45%	3,45%	0,00%	100,00%
2017	Case	0	46	1	2	1	50
	%	0,00%	92,00%	2,00%	4,00%	2,00%	100,00%
2018	Case	680	20	28	12	1	741
	%	91,77%	2,70%	3,78%	1,62%	0,13%	100,00%
2019	Case	34	89	552	23	14	712
	%	4,78%	12,50%	77,53%	3,23%	1,97%	100,00%
2020	Case	276	15	93	11	5	400
	%	69,00%	3,75%	23,25%	2,75%	1,25%	100,00%
2021	Case	152	1	5	1	4	163
	%	87,12%	0,61%	3,07%	0,61%	1,23%	92,64%
Total	Case	1150	363	700	70	33	2316
	%	100%	100%	100%	100%	100%	100%

Table 1: Measles hospitalizations in the pediatric population up to 19 years old according to Brazilian macro-regions from 2012 to 2021.

Source: Adapted by the authors based on data provided by DATASUS (2024).

Year		Age group (years)					Total
		< 1	**1** to **4**	**5** to **9**	**10** to **14**	**15** to **19**	
2012	Case	4	25	8	7	2	46
	%	8,70%	54,35%	17,39%	15,22%	4,35%	100,00%
2013	Case	25	26	4	4	2	61
	%	40,98%	42,62%	6,56%	6,56%	3,28%	100,00%
2014	Case	39	25	4	2	1	71
	%	54,93%	35,21%	5,63%	2,82%	1,41%	100,00%
2015	Case	30	7	5	0	1	43
	%	69,77%	16,28%	11,63%	0,00%	2,33%	100,00%
2016	Case	5	7	11	4	2	29
	%	17,24%	24,14%	37,93%	13,79%	6,90%	100,00%
2017	Case	15	7	14	9	5	50
	%	30,00%	14,00%	28,00%	18,00%	10,00%	100,00%
2018	Case	308	243	80	53	57	741
	%	41,57%	32,79%	10,80%	7,15%	7,69%	100,00%
2019	Case	382	238	36	15	41	712
	%	53,65%	33,43%	5,06%	2,11%	5,76%	100,00%
2020	Case	209	104	32	18	37	400
	%	52,25%	26,00%	8,00%	4,50%	9,25%	100,00%
2021	Case	96	49	12	5	1	163
	%	58,90%	30,06%	7,36%	3,07%	0,61%	100,00%
Total	Case	1113	731	206	117	149	2316
	%	100%	100%	100%	100%	100%	100%

Table 2: Measles hospitalizations in Brazil according to pediatric age groups from 2012 to 2021.

Source: Adapted by the authors based on data provided by DATASUS.

Year		Sex		Total
		Male	Female	
2012	Case	16	30	46
	%	34,78%	65,22%	100,00%
2013	Case	28	33	61
	%	45,90%	54,10%	100,00%
2014	Case	44	27	71
	%	61,97%	38,03%	100,00%
2015	Case	24	19	43
	%	55,81%	44,19%	100,00%
2016	Case	17	12	29
	%	58,62%	41,38%	100,00%
2017	Case	26	24	50
	%	52,00%	48,00%	100,00%
2018	Case	388	353	741
	%	52,36%	47,64%	100,00%
2019	Case	363	349	712
	%	50,98%	49,02%	100,00%
2020	Case	204	196	400
	%	51,00%	49,00%	100,00%
2021	Case	74	89	163
	%	45,40%	54,60%	100,00%
Total	Case	1184	1132	2316
	%	100%	100%	100%

Table 3: Measles hospitalizations in the pediatric population up to 19 years old according to sex in the period from 2012 to 2021, in Brazil.

Source: Adapted by the authors based on data provided by DATASUS.

Of the 2,316 notifications of measles hospitalization with records of race/skin color, between the years 2012 and 2021, skin with brown color was the most prominent with 50.69% (1174), followed by white with 15.67% (363), black with 1.16% (27), yellow with 0.73% (17) and indigenous with 0. 43% (10). Around 30% (725) of the data collected were without race information. The only period in which brown skin color was not predominant was in 2019, in which there was a higher prevalence in white people (263) compared to brown people (253) with a percentage difference of 1.41% (Table 4).

Relating vaccination coverage data to measles hospitalizations in Brazil, It is possible to see that the South region had the highest average vaccination coverage between 2012 and 2021 (80.96%), followed by the Central-West region (78.82%), Southeast (73.21%), Northeast (67. 99%) and North (67.35%). However, in 2012, 2014 and 2016 the region with the highest vaccination coverage was the Central-West (Table 5).

DISCUSSION

Between 2012 and 2017, the Northeast prevailed as the region with the highest proportion of hospitalizations due to Measles. The pattern in question deviated in the following years, with greater prevalence in the North in 2018, 2020 and 2021 and in the Southeast in 2019 (Table 1).

In 2021, the estimated Brazilian population was divided into 42.02% (89,632,912) in the Southeast, 27.03% (57,667,842) in the Northeast, 14.25% (30,402,587) in the South, 8.86% (18,906,962) in the North and 7.83% (16,707,336) in the Central-West (IBGE, 2023). In contrast, a drastic proportional difference can be seen when comparing demographic percentages with data on hospitalizations for Measles according to regions of Brazil, considering that comparatively, the North, with the highest prevalence of Measles cases, represents a small proportion of the population.

As of 2015, no region reached the target of 95% vaccination coverage (VC). CV, when analyzed according to Brazilian macro-regions in the period (*Table 5*), had its biggest drop in 2021, with a reduction in all regions, being lowest in the North. The North region remained, between 2013 and 2016, with the lowest CV, which started to increase briefly in the period between 2017 and 2019, having an abrupt drop in the years 2020 and 2021. In the period from 2017 to 2019, the Northeast presented the lowest vaccination coverage in the country. Associating these data with those relating to hospitalizations, it is clear that the North had the highest rates of hospitalizations in a period preceded by a reduction in VC.

Analyzing hospitalizations by age group (Table 02), it is highlighted that, during the study period, children under 1 year of age were the most affected in five of the ten years analyzed, suggesting a greater susceptibility to the disease in younger age groups. It is also

Year		Year						Total
		White	Black	Brown	Yellow	Indigenous	No information	
2012	Case	6	1	10	*	1	28	46
	%	13,04%	2,17%	21,74%	*	2,17%	60,87%	100,00%
2013	Case	6	0	37	0	0	18	61
	%	9,84%	0,00%	60,66%	0,00%	0,00%	29,51%	100,00%
2014	Case	4	0	43	1	0	23	71
	%	5,63%	0,00%	60,56%	1,41%	0,00%	32,39%	100,00%
2015	Case	2	0	31	0	0	10	43
	%	4,65%	0,00%	72,09%	0,00%	0,00%	23,26%	100,00%
2016	Case	2	0	13	0	0	14	29
	%	6,90%	0,00%	44,83%	0,00%	0,00%	48,28%	100,00%
2017	Case	3	1	33	0	0	13	50
	%	6,00%	2,00%	66,00%	0,00%	0,00%	26,00%	100,00%
2018	Case	28	11	565	8	7	122	741
	%	3,78%	1,48%	76,25%	1,08%	0,94%	16,46%	100,00%
2019	Case	263	14	253	7	1	174	712
	%	36,94%	1,97%	35,53%	0,98%	0,14%	24,44%	100,00%
2020	Case	44	0	147	1	0	208	400
	%	11,00%	0,00%	36,75%	0,25%	0,00%	52,00%	100,00%
2021	Case	5	0	42	0	1	115	163
	%	3,07%	0,00%	25,77%	0,00%	0,61%	70,55%	100,00%
Total	Case	363	27	1174	17	10	725	2316
	%	100%	100%	100%	100%	100%	100%	100%

Table 4: Measles hospitalizations in the pediatric population up to 19 years old according to race from 2012 to 2021, in Brazil.

Source: Adapted by the authors based on data provided by DATASUS.

Year	Vaccination coverage					Total
	North	Northeast	Southeast	South	Midwest	
2012	100,32	98,38	100,54	97	101,61	99,5
2013	56,88	69,19	73,05	73,5	72,23	70,18
2014	89,09	101,51	98,41	96,72	105,14	98,62
2015	68,79	84,23	91,29	81,11	78,17	84,46
2016	75,28	75,45	86,39	92,16	96,35	83,72
2017	65,03	59,22	62,69	78,1	73,26	64,89
2018	69,43	58,99	66,46	80,31	80,48	67,8
2019	77,61	59,93	65,29	89,14	84,32	70,02
2020	55,57	47,77	52,88	75,31	67,48	56,11
2021	36,69	42,05	50,1	55,81	44,97	46,62
Total	67,35	67,99	73,21	80,96	78,82	72,6

Table 5: Vaccination coverage for Measles in Brazil from 2012 to 2021.

Source: Adapted by the authors based on data provided by DATASUS.

possible to note that the year 2017 presented the highest number of hospitalizations due to measles, with the proportion of children under one year old remaining as the most affected age group. Except for the periods of 2012 and 2013, in which the most affected age group was 1 to 4 years old - reaching 54.35% (25) and 42.82% (26) of hospitalizations, respectively -, there was no other change in the epidemiological pattern of the disease.

The prevalence of hospitalizations for Measles, when related to sex (Table 3), demonstrated a subtle predominance of males, however the incidence tended to vary between both sexes in the period. According to IBGE (2022), in the last census a proportion of 50.97% (27,783,232) male individuals up to 19 years old and 49.03% (26,721,971) female individuals were recorded in the same age group, indicating a slight male predominance in the pediatric population, which could explain the slight greater tendency for hospitalizations due to Measles in this sex.

When analyzing the participation of each race/color in the total number of hospitalizations for Measles, we noticed

the predominance of mixed-race people in relation to other ethnic groups, with 50.69% (1174) of cases in the research period (Table 4). According to the latest IBGE census (2022), brown people represent 45.34% (92,083,286) of Brazil's population. Thus, although mixed race people represent almost half of the country's population, when compared to the prevalence of hospitalizations due to Measles, they proportionally continue to demonstrate the possibility of a greater tendency to be affected by the disease in relation to other races.

It is observed, from the data collected (Table 4), a significant lack of information on race in about 30% of reported Measles cases, making it difficult to accurately analyze health disparities between different racial groups, as well as formulate targeted health policies.

Over the decade from 2012 to 2021, there was noticeable variability in hospitalization rates for Measles in the Brazilian pediatric population, with a greater tendency for the number of cases to increase. Between 2012 and 2014 there was a brief increase in hospitalizations, starting to reduce until 2016, which was followed by a marked increase in 2018, from 50 hospitalizations to 741, remaining stable in the following year and reducing again in 2020 (Table 1). At the same time, vaccination coverage during the research period suffered a gradual decline, going from 99.5% in 2012 to 46.62% in 2021. 2012 and 2014 were the years with the highest vaccination coverage, exceeding the 95th percentile. 2021 had the lowest coverage, followed by 2020, 2017 and 2018 (Table 5). When relating the data, it is identified that the years with lower proportions of hospitalizations were preceded by periods with higher vaccination coverage, while the years with more cases of hospitalization were preceded by periods of low vaccination coverage.

CONCLUSION

Significant advances in public health and vaccination coverage in Brazil meant that in 2016 the country achieved measles elimination certification. However, in recent years, according to the data presented, the drop-in vaccination coverage and the evident failure to adequately control outbreaks are notable.

In general, the present study demonstrated that in the period from 2012 to 2021, in Brazil, Measles most frequently affected the Northeast region, but proportionally to demographic density, the North was the most affected region.

In relation to the other epidemiological variables analyzed, in the period studied, the age group most affected by hospitalizations for Measles was those under 1 year of age in general, in addition to demonstrating a pattern of higher incidence in lower age groups. In terms of sex, it was not possible to demonstrate a relevant predominance of any group in the period in general. Furthermore, the study demonstrated a trend towards higher prevalence in the brown population, despite the DATASUS platform not identifying race in a significant number of cases. However, over the period, no group predominance was noticed in any variable in all years, with variations in the period.

The CV suffered a gradual decline over the decade of research, with some fluctuation, not following a continuous pattern. A relationship was identified between VC and the prevalence of hospitalizations for Measles, in which periods of higher VC preceded years with lower hospitalization rates, while a reduction in VC followed periods with higher hospitalization rates for the disease.

It must be noted that Measles is a disease for which there is no specific treatment, with vaccination being the only effective method to combat its spread and severity. Therefore,

health education for the general population must be continuous and encouraged so that the vaccination rate increases again and Brazil achieves effective immunization of the population.

It is important to highlight that variations in hospitalization patterns can be influenced by several factors, such as vaccination rates, the occurrence of local outbreaks, the seasonality of the disease and other relevant epidemiological aspects. Therefore, this information is of crucial importance to support the formulation of disease prevention and control strategies, such as vaccination campaigns targeted at specific age groups.

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