

Incidence Of Immunopreventable Diseases in Children Under Five Years of Age: Analysis of Vaccine Coverage and Homogeneity in The Midwest of Brazil

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Summary

Vaccination is one of the most effective and most controlled interventions in the occurrence of infectious diseases, and it is essential to analyze vaccination coverage and homogeneity between municipalities. The National Immunization Program (PNI), together with the Epidemiological Surveillance System in Brazil, seek to generate an impact on the control, elimination and even eradication of preventable diseases, immunizing the general population, especially children. This study aims to analyze vaccination coverage and homogeneity in the Midwest of Brazil and to relate to the incidence of immunopreventable diseases in children under five years of age. This is an ecological study, based on data from the Information System of the National Immunization Program (SI-PNI), for the period 2018-2022, analyzing the indicators of vaccination coverage, homogeneity and the incidence of immunopreventable diseases in children under five years of age.

Keywords: National Immunization Program; Vaccination; Vaccination Coverage; Vaccine Preventable Diseases;

1. MAIN VACCINE LANDMARKS

It is essential to know the evolution of health science, errors and successes, which over the years resume the eager to contribute to progress and discoveries. The influence on innovation and vaccine improvements occurred through existing epidemics that affected the population mainly at the economic level in several sectors. In the 18th century there *was an epidemic* called cow box. However, humans were also affected by

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human smallpox, which caused damage and even death (MALAGUTTI, 2011).

Malagutti (2011) points out that in England where *the cow box epidemic occurred*, the English physician Edward Jenner (1749-1823) found that women milking cows had scars on their hands and did not acquire cow pox (*vaccinia*). Jenner then instilled in a child the material removed from a woman's injury causing him to present the lesion equally, however, with mild symptoms. Subsequently, he again instilled the material from another lesion and the boy was not affected.

Historically, this was an important milestone in the development of smallpox vaccine, however, the merit for the development of the technique was Louis Pasteur in 1885 with the development of the rabies vaccine (TOLEDO, 2015).

In Brazil in 1904, the federal capital Rio de Janeiro recorded almost 7,000 cases of smallpox and the director of public health led by physician Oswaldo Cruz, presented to the National Congress a bill establishing the mandatory vaccination throughout the country, containing strict clauses in addition to authorizing health agents to invade homes to vaccinate residents (HOCHMAN, 2011).

The denial of the mandatory vaccination brought together in an unarticulated anti-vaccinates, military, population that understood as home invasion and many against the president, consecrating the episode known as "Vaccine Revolt" paralyzing the city of Rio de Janeiro in November 1904, with firm warning to the rebels through arrests and deportations (HOCHMAN, 2011).

Yellow fever in the 1920s and 1930s reached an important zone and in 1940 the priority was the control and eradication of malaria in accordance with international health in the 1950s. Although evident importance in the control and eradication of various infectious diseases, vaccines are often associated with criticism and questioning about adverse events (MILLER, *et.al.* 2015).

The result in the Smallpox Eradication Campaign (CEV), instituted by the National Immunization Program (PNI) of the Ministry of Health, was a milestone in public health in 1973. The PNI is one of the best immunization programs in the world in the international technological and scientific spheres (BARROS *et al.*, 2012).

Brazil through vaccination has eradicated several diseases of worldwide reach, such as smallpox, measles and polio. However, since 2013 the rates of vaccination coverage of measles, polio and other diseases have been suffering a year-on-year drop in all regions of the country, which ends up threatening the health of Brazilians with the return of previously eradicated diseases (SANSON; CREMONESE, 2019).

Still according to Sanson; Cremonese (2018) Brazil obtained the International Certification for the Eradication of Poliomyelitis (Infantile Paralysis) in 1994, with strategies initiated in 1980 that allowed the expansion of the population's vaccination coverage. In 2000, Brazil initiated a Measles Elimination Plan and in 2016 the Pan American Health Organization (PAHO) delivered the Measles Elimination Certificate to the country, however, in 2019 it lost due to numerous reported cases of the disease, after a year of sustained transmission.

In 2020, a study published by the Oswaldo Cruz Foundation showed a significant drop in immunization in Brazil, especially in children. The knowledge of professionals and managers in the face of campaigns and vaccination itself is of the utmost importance so that factors such as the fall in immunization can be reduced

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or even eliminated, ensuring the success and success in achieving vaccination coverage (ALVES et al, 2020).

2. VACCINES AND IMMUNOPREVENTABLE DISEASES

Vaccines act in the prevention, control and eradication of immunopreventable diseases, as well as in reducing morbidity and mortality from some diseases. The administration of immunobiological gives active (vaccine-activated) or passive (sera-activated) immunization to the individual (BRASIL, 2013). In order to make this method accurate and safe, the conducts in the face of immunization need caution, adhering to correct procedures before, during and after the administration of vaccines (BRASIL, 2014).

With the advent of modern biotechnology, there have been several advances in the discovery of new antigens, adjuvants, conductors or concession structure specific to the diffusion of genetic management systems, and research and advances in immunobiologicals, whether first, second or third generation, has changed in different ways (BRAZ et al., 2016).

The effects of vaccination on public health are undeniable. No intervention, with the exception of essential basic sanitation, has had a categorical effect over the years in reducing mortality in relation to population growth in the world (COSTA, 2016).

They portray immunopreventable diseases that, despite having distinct epidemiological characteristics, have in vaccination their primary means of control. Free and universal access has been suffering an important effect on immunopreventable diseases, characterizing as a priority strategy child health, health promotion and as a goal, the decline in morbidity and mortality that affects this public (BRASIL, 2018).

The Ministry of Health continuously carries out means for the control of diseases such as Haemophilus influenza type b, rubella eliminating congenital rubella syndrome, poliomyelitis, neonatal tetanus and hepatitis B control (BRASIL, 2013). Studies on vaccination coverage in childhood have pointed to a decrease in the vaccination rate in the population of different socioeconomic levels (TERTULIANO, STEIN, 2011).

An epidemiological investigation in the country conducted in the space between 2001 and 2016 found that 662 children under one year sick from tetanus, diffrhyphite and pertussis. According to the national immunization schedule, through the pentavalent vaccine, these diseases can be prevented, added with the hepatitis B vaccine (SOUSA, 2018).

The intense migratory movement perceived at the borders with Brazil contributed to the spread of the measles virus. The states with the highest number of confirmed cases were Roraima (369 cases) and Amazonas (9,809 cases), with records of isolated cases related to the importation of the virus from Venezuela, where genotypes of European lineage were also identified totaling 11 federated units affected, recording a total of 10,326 confirmed cases and 12 deaths. In addition, it has aroused concern due to the cases of measles and polio in Venezuela, highlighting the endemic outbreak of Yellow Fever expanding from the Midwest to the east of Brazil (BRASIL, 2018).

The WHO in 2021 pointed out three countries that reported diphtheria: 01 reported case in Brazil, Haiti (12 reported cases, 02 deaths) and 13 cases in the Dominican Republic, including 10 deaths. The case of diphtheria in Brazil was confirmed by culture, incomplete vaccination schedule and no travel history. The

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investigation of the cases is paramount and in this case there was no confirmation of new cases. In 2019, a (01) case of diphtheria (CDC, 2021) was also confirmed.

The evaluation of the clinical picture, isolation and identification of the diphtheria bacillus in the collection of biological samples (swab nasopharynx and/or oropharynx) and/or skin lesions is established for the diagnosis of diphthysis. Individuals with a complete vaccination schedule may present mild sore throat or be asymptomatic as such, differential, etiological and early diagnosis is necessary for epidemiological surveillance in the performance of vaccination, prevention and active contact search actions (CDC, 2021). In some countries, diphtheria is endemic as in Asia, the Middle East, Eastern Europe, the South Pacific and some outbreaks reported since 2016 in South Africa, Indonesia, Venezuela, Vietnam and Haiti (PAHO, 2021). The diphtheria and a disease of immediate compulsory notification, that is, in the national sphere the suspicious case has to be reported to the competent agencies within 24 hours from the suspicion of the case to enable the registration in SINAN, the investigation of cases and the adoption of timely prevention and control measures (BRASIL, 2019a).

Poliomyelitis is an infectious disease most commonly known as infantile paralysis caused by poliovirus (serotypes 1, 2, 3), transmitted fecal-oral and airway, and can reach children and adults. However, it affects unvaccinated children more frequently, with a likelihood of developing lower-limbs paralysis and respiratory problems. These sequelae occur due to neural degeneration, demyelization and degeneration due to the neurotrophic of the virus. (Silveira *et al.*, 2019; Alves *et al.*, 2021).

In the world for 70 years, strategies were initiated to eradicate the disease and among them, highlighting the mass immunization and the beginning of epidemiological surveillance programs soon, there was a decrease in the circulation of the virus and with this the elimination of the disease in some countries, such as Brazil, which in 1994 received the PAHO Certificate, after the country was responsible between 1968 and 1989 to more than 26,000 cases of polio (Alves *et al.*, 2021).

In order to keep the country polio-free and as monitoring strategies, the Polio Eradication Plan developed by the Ministry of Health aims to integrate epidemiological surveillance in addition to vaccination and environmental surveillance that integrates cases of Acute Flaccid Paralysis (PFA), corresponding to clinical manifestations from inferior neural lesions (medulla), interrupting the motor response and causing hypotonic, areflexia and muscular atrophy (TRAJANO *et al.*, 2020; ALVES *et al.*, 2021).

Couto *et al.*, (2021) state that, knowing the impacts caused by polio and the commitment to ensure its eradication, reiterates the need and action of active surveillance with constant monitoring of vaccination coverage and notifications of PFA cases, in addition to the established strategic evaluations, being possible to know the profile and its epidemiological characteristics in the face of the risks of reintroduction of the virus.

According to Costa *et al.*, (2011), the disease known as yellow fever remains a serious public health problem that runs through the history of Brazil, due to the impossibility of eradicating its wild cycle that are the non-human primates the natural reservoir of the disease. Yellow fever is an acute infectious disease caused by the *Flaviviridae virus*, transmitted by mosquitoes of the genus *Haemogogus* and *Sabethes* (wild form) and *Aedes* (urban form).

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This characteristic of the wild cycle contributes so that every year several individuals are affected by the disease at different times in Brazil. In 2008 and 2009, yellow fever became more evident causing a reemerging disease in the country (COSTA *et al.*, 2011).

Studies conducted by Figueiredo, Fonseca (2017) attest that yellow fever epidemics are related to various climate changes such as increased temperature and humidity leading to the rapid spread of the female mosquito and consequently the reproduction of the cycle in monkeys and then, reaching humans in oviposition. Social changes contribute and man's direct actions in deforestation, displacement to forest areas, in addition to environmental imbalance, increase the ability to contact the mosquito. After the bite of the mosquito infected with the virus, there is a spread in cells, lymph nodes and the whole body. The hardest hit organs are the liver, kidneys, spleen, heart and brain. In severe cases, hepatic necrosis occurs. The yellow fever vaccine is very effective in preventing the disease. According to who a single dose of the vaccine is enough to ensure immunity and protection in endemic areas, especially for travelers. For international tourists in Brazil, vaccination against yellow fever is mandatory and in 2018 the WHO inserted some regions as areas of risk for the disease and recommended vaccination of travelers to these locations as well, being Espírito Santo, Rio de Janeiro and São Paulo (HAMER, 2018).

Measles is an acute viral infectious pathology, of high transmissibility and primarily affecting children in the world. Its etiological agent is a virus that belongs to the *family Paramyxoviridae* and its clinical manifestations are defined by dry cough, fever, runny nose, conjunctivitis, malaise, and exanthema and koplik spots. In severe cases they may progress to blindness, dehydration, encephalitis, pneumonia and death (PAHO, 2019).

In Brazil in the 1960s and 1970s, measles was the main cause of infant mortality and this scenario began to be faced with vaccination campaigns and the beginning of mandatory immediate compulsory notification, assisting health authorities in controlling the pandemic. In 2016 the country received the certificate of elimination of the virus from the WHO and the Americas a statement from the International Committee because they were free of measles. However, with the decrease in vaccination coverage in several countries including Brazil, the virus resurfaced in places where it would be eradicated (FIOCRUZ, 2019; PAHO, 2019). The viral genotype D8 was isolated, the same circulating in Venezuela, causing a possible cause of the reintroduction of the virus before Venezuelan immigrants in the country. In 2019, 57,619 suspected cases were reported and of these 13,489 confirmed cases were 15 deaths (BRASIL, 2019b).

For decades measles has caused numerous complications and deaths especially among children. The availability of immunizers globally contributes to the reduction of death cases and health care through adequate vaccination coverage (CÉSARE *et al.*, 2020).

2.1 National Immunization Program (PNI)

In 1975, two years after the establishment of the National Immunization Program (PNI), its technical standards were standardized as PNI strategies to cope with immunopreventable diseases such as routine vaccination, periodic campaigns, D-day vaccination, established actions and creation of surveillance system (BRASIL, 2013).

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The PNI is the responsibility of the General Coordination of the National Immunization Program (CGPNI), the Department of Surveillance of Communicable Diseases (DEVIT) and the Health Surveillance Secretariat (SVS) of the Ministry of Health (BRASIL, 2013).

Forty-four types of immunobiologicals are offered: 27 vaccines; 13 sera heterologous (animal immunoglobulins); and 4 homologous sera (human immunoglobulins) by the PNI, organized in specific calendars according to vital cycles and have special immunobiologicals indicated to individuals in special clinical conditions (BRASIL, 2017).

Vaccines can be applied simultaneously in order not to miss the opportunity to vaccinate the child at the time the person responsible attends for such procedure, according to the PNI and the Brazilian Immunization Society (SBIIm) where according to each age group are available the following vaccines are made available: at birth, the bacillus Calmette and Guérin-BCG vaccine and against Hepatitis B; at 2 months I- 1st dose of Pentavalent that offers protection against diphtheria, tetanus, pertussis and hepatitis B; II- 1st dose of Poliomyelitis Inactivated Vaccine (VIP), for the prevention of poliomyelitis, III- 1st dose of Oral Human Rotavirus Vaccine (VORH) in the prevention of severe diarrhea and IV- 1st dose of Pneumococcal Vaccine 10 (valent) that protects against *Streptococcus Pneumoniae*. At 4 months I- 2nd dose of the same immunobiologicals administered at 2 months and six months I- 3rd dose of Pentavalent and II- the 3rd dose of VIP. At 12 months you should receive the 1st dose of the Triple Viral vaccine (CRS) that protects against measles, mumps, rubella and the boosters of pneumococcal 10 valent and meningococcal vaccines C. At 15 months, I- to Tetra viral (or the combination of the 2nd dose Triple Viral + chickenpox), II- single dose of hepatitis A vaccine, III- 1st strengthening of PTD and IV- 1st reinforcement of VOP (BRASIL, 2019c).

Understanding the importance and potential it that vaccination provides, it is essential that vaccination coverage be evaluated at 2 months, 4 months, 12 months and 15 months, in order to identify the lost moment of vaccination and possibly perform an active search of absentees avoiding loss in the age group (BRASIL, 2019).

In Brazil, since the 1990s, the performance of vaccination coverage is positive, configured by the success of the PNI and acceptance of the population to vaccination. However, it is evident the consolidation of the anti-vaccine movement, which contributes to the fall of vaccination coverage, favoring the reintroduction of immunopreventable diseases (SATO, 2018). Even though it is limited in the country, this movement deprecates the importance of immunization, propagating unfavorable messages about this theme (TEIXEIRA; ROCHA, 2010).

The licensing and commercialization of immunobiologicals are rigorously tested, monitored by manufacturers and this occurs by specific organs and clinical studies are carried out prior to use in the general population. Priority and attention are focused on the child's public and some vaccines successfully reach coverage in several countries, thus acceptable advances in the control and eradication of diseases, and they act in the prevention and protection against childhood diseases (PEIXOTO *et al.*, 2017).

Mizuta *et al.* (2018) address that the program understands that the vaccine is the means by which one can prevent several diseases capable of ravage an entire country, so it works strongly with the entire

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immunization system, and a relevant issue in public health policy, is to evaluate the economic efficiency of immunobiologicals in terms of costs and benefits.

In view of the efforts, Brazil has been finding flaws in relation to immunization, where since 2015 the PNI offers several free immunobiologicals and some factors are scored in these failures, among them: multidoses in the vaccination schedule, lack of raw material, vaccine refusal, lack of knowledge about the viral circulation of the disease and its risks and especially barriers on schedules/location of vaccination points, in addition to social, cultural, emotional and political factors corroborating the reduction of vaccination coverage and consequently the increased reintroduction of this immunopreventable disease and morbidity and mortality rates (Oliveira *et al.*, 2010).

2.2 Vaccination coverage x homogeneity

Municipalities should contribute significantly to the municipal vaccination plan, some purposes of intensification of vaccination campaigns, vaccine inventory management, organization and adequate packaging of immunobiologicals (NUNES *et al.*, 2018). It is also up to the municipality to manage the vaccination process in its units, to monitor records of data and applications of vaccines, respecting the principles established in the laws and planning of the Federal and State Government (BRASIL, 2014).

It is perceived that through vaccination the government has achieved success by immunizing thousands of children, young and old as well as those who need immunization of diseases that can be prevented. This prevention is carried out through municipalities that, with their immunization team in line with the vaccination schedule, fight for homogeneous coverage of continuous vaccination in campaigns as a way to prevent and control diseases (BRASIL, 2017).

One of these actions established are the goals for vaccination coverage defined by the Ministry of Health, being: 100% Yellow Fever, dT (Double Adult), dTpa (Double Adult Acellular), 95% Hepatitis A, Hepatitis B, Tetra viral, Triple Viral, Triple Bacterial, Meningococcal C, Pneumococcal 10 Valente, Poliomyelitis, Pentavalent, 90% BCG and VORH, 80% for HPV and Influenza (BRASIL, 2014).

In order to meet the PNI's goal of reaching all children with the basic schedule, in addition to maintaining high rates of vaccination coverage, it is important to monitor homogeneity, that is, the proportion of administrative units that reach the proposed vaccination goals (BRASIL, 2015).

Oliveira *et al.*, (2010), also address fundamental factors that interfere in childhood vaccination coverage as: children who do not have a vaccine booklet, multi-dose vaccines, coverage inequality, and space between dose intervals, family factors and access to health services. Evidence indicates that the low socioeconomic conditions of families generate low vaccination coverage and with this greater vulnerability in getting sick (NUNES *et al.*, 2018).

The Pan American Health Organization (PAHO) recommends rapid monitoring of vaccine coverage (MRC) with the objective of supervising vaccination actions employed in several countries in the Americas, being an immensely useful method to define vaccination actions, redefine or improve vaccination coverage and homogeneity (BRASIL, 2017).

In order to obtain better results, it is essential to install monitoring systems in health surveillance, which contain epidemiological databases that provide subsidies for decisions regarding the use of a vaccine,

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therefore, should be sensitive and agile in verifying any change in locality notifications (LUHM; CARDOSO; WALDMAN, 2011).

2.3 Vaccination coverage in Brazil

It is signed in the Statute of the Child and Adolescent (ECA) - Law No. 8,069/90 that regulates the article in the Federal Constitution of 1988 No. 227, the mandatory vaccination of minors, aiming to establish the rights and full protection to this population. The ECA, in the sole paragraph of Art. 14, provides that "vaccination of children in cases recommended by health authorities is mandatory" (IGREJA *et al.*, 2020). In addition to vaccines being provided and encouraged by the Ministry of Health, there are children not properly immunized. This is due to several factors, including: superstitions, myths, prejudiced and erroneous information, and most importantly, the cultural and socioeconomic level of caregivers and/or guardians. However, those responsible are indispensable executors in the process of childhood vaccination coverage and should be sensitized and informed about the understanding of this health practice. The health team should commit to providing access to the correct information about vaccines, obtaining the understanding that vaccination is one of the most favorable and important measures to maintain the well-being of the child (SOARES *et al.*, 2020).

Decisions about immunization in childhood are not simple for some officials, where they are often resistant and dubious about the safety of vaccines. On the other hand, many have a positive assessment of the benefits that immunization provides for children, but painful procedures or possible side effects generate conflicts (SOARES *et al.*, 2020).

Several authors corroborate that nursing is responsible for the relevant guidelines on vaccination, as well as possible reactions and contraindications. According to the PNI, this knowledge provides health and quality of life according to the Guidelines of the SUS, where in this context there is fundamental relevance involved in all stages of the process (SILVA; CUNHA, 2018).

Table one. Vaccines included in the National Vaccination Calendar (2019)

CHILD	TEEN AND ADULT
BCG (at birth)	Hepatitis B
Hepatitis B (at birth)	dT (Diphtheria, Tetanus)
Pentavalent (DTP/Hib/HepB)	Black vomit
VIP (Polio Inactivated Vaccine)	Triple Viral (Measles, Mumps, Rubella)
VOP (Oral Polio Vaccine)	Meningococcal ACWY conjugated vaccine
VORH (Oral Human Rotavirus Vaccine)	dTpa (Diphtheria, Acellular Tetanus)
Pneumococcal Vaccine 10 Valiant	pregnant
Yellow Fever Vaccine	HPV (Human Papillomavirus)
Meningococcal conjugated vaccine type C	
Hepatitis A	OLD

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Triple Viral (Measles, Mumps, Rubella)	Influenza
DTP (Bacterial Triple)	Pneumococcus
Tetra viral (Measles, Mumps, Rubella, Chickenpox)	
Influenza (in annual campaigns) HPV (Human Papillomavirus)	

Source: CGPNI/DEVIT/SVS/MS (2019)

3rd Conclusion,

According to what has been presented and discussed, the relevance of immunization as a preventive measure in coping with preventable diseases is evident, actions that are essential with regard to the sanitary measures adopted without control, elimination and even eradication of immunopreventable diseases, especially those that affect children. Thus, it is verified, once again, the importance of public health policies aimed at promoting vaccination coverage in the national context, seeking to minimize deleterious actions caused by an increasingly diverse quantity of pathogens harmful to the health of human populations, especially children.

However, vaccination is still a sanitary procedure that requires public policies to provide information to the population, given the enormous misinformation that occurs in various social contexts, not only in Brazil, but also in some parts of the world. This misinformation has become more evident in the last two years, when, due to the negligence and denialism of some rulers, many lives have been lost – which could have been avoided if public health authorities around the world had increased awareness of the importance of vaccination in coping with and controlling a set of preventable diseases, especially in relation to children.

References

F.B.S. Alves. R.J.A. Sousa. V.C. Avelino. N.V. No, No, No, No. Martins. Epidemiology of acute flaccid paralysis in Brazil. Health and Biosciences, v.2, n.1, pg. 131-142. Apr. 2021. DOI: <https://doi.org/10.47456/hb.v2i1.33849>. Available in: <https://periodicos.ufes.br/healthandbiosciences>. Access: 20 Oct. 2021.

A.G.M. Baby. M.C. S. Saints. R.P.T. Bertolini. V.B.P. Netto. M.S. Andrade. Loss of vaccination opportunity: aspects related to the performance of primary care in Recife, Pernambuco, 2012. Epidemiology and Health Services. Brasilia, DF. Oct, 2015. Available in: <http://dx.doi.org/10.5123/S1679-49742015000400012>. Access on 8 Dec 2020.

BRAZIL. MINISTRY OF HEALTH. Department of health surveillance department epidemiological surveillance general coordination of the national immunization program. Rapid Monitoring Protocol for Vaccination Coverage (MRC) in children aged 6 months to < 15 years of age after the multivaccination campaign. Brasilia: Ministry of Health, 2017.

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BRAZIL. MINISTRY OF HEALTH. Health Surveillance Secretariat. Department of Epidemiological Surveillance. National Immunization Program (PNI): 40 years. Brasilia: Ministry of Health, 2013. Available from: http://bvsmms.saude.gov.br/bvs/publicacoes/program_nacional_immunizations_pni_40.pdf. Access on: 25 Mar. 2020.

BRAZIL. MINISTRY OF HEALTH. Health Surveillance Secretariat. Department of Communicable Diseases Surveillance. Manual of Standards and Procedures for Vaccination. Brasilia, Ministry of Health, 2014.

BRAZIL. MINISTRY OF HEALTH. Health Surveillance Secretariat. Department of Communicable Diseases Surveillance. PNI National Immunization Program. Vaccination coverage in Brazil Period: 2010 - 2014. Brasilia: Ministry of Health, 2015.

BRAZIL. Ministry of Health. General Coordination of the National Immunization program-CGPNI. **Information note No. 125/2018-CGPNI/DEVIT/SVS/MS.** Brasilia: Ministry of Health, 2018.

BRAZIL. Department of Health Surveillance, General Coordination of Epidemiology Development in Services. **Diphtheria. Health Surveillance Guide: single volume.** Brasília: Ministry of Health, 2019a, chapter 2, p.85-97.

BRAZIL. Ministry of Health. Health Surveillance Secretariat. **Measles situation in Brazil: 2019b.** Inform, Brasília, n. 40, p. 1-8, May 2019.

BRAZIL. Ministry of Health. Health Surveillance Secretariat, 16 years old. Department of Communicable Diseases Surveillance. General Coordination of the National Immunization Program. **Normative instruction on the national vaccination schedule.** Brasilia, March 22, 2019c. Available at: <https://www.gov.br/saude/pt-br/media/pdf/2021/>.

BRAZIL. Ministry of Health. **Measles situation in Brazil - 2018 - 2019.** Report, n. 37, 2019b. Available at: <http://www.saude.gov.br/images/pdf/2019/marco/19/Informe-Sarampo-n37-19mar19aed.pdf>. Access: 30 May. 2020.

BRAZ, R.M; DOMINGUES, C.M. A. S; TEIXEIRA, A, M, S; LUNA, E. J. A. Classification of risk of transmission of immunopreventable diseases from indicators of vaccination coverage in Brazilian municipalities. **Epidemiology and Health Services (Online)**, v.25, n.4, p. 745-754, 2016. Available from: Doi: 10.5123/S1679-49742016000400008. Accessed: 15 Apr. 2020.

CÉSARE, N.; MOTA, T.F.; LOPES, F.F.; LIMA, A.C.M.; LUZARDO, R.; QUINTANILHA, L. F.;

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ANDRADE, B.B.; QUEIROZ, A.T.L.; FUKUTANI, K. F. Longitudinal profiling of the vaccination coverage in Brazil reveals a recent change in the patterns hallmarked by differential reduction across regions. **International Journal of Infectious Diseases**, 2020. DOI: 10.1016/j.ijid.2020.06.092. Available in: <https://pubmed.ncbi.nlm.nih.gov/32619762/>. Access on: 03 Mar. 2021.

Centers of Disease Control and Prevention (CDC). The Pink Book. **Epidemiology and Prevention of Vaccine-Preventable Diseases. Diphtheria**. Cap.7. August, 2021.

Available in: <https://www.cdc.gov/vaccines/pubs/pinkbook/dip.html>. Accessed: 15 Dec 2021.

COSTA, Z.G.A; ELKHOURY, A.N.M; ROMANO, A.P.M; FLANNERY, B. Historical evolution of epidemiological surveillance and yellow fever control in Brazil. **Rev. Pan-Amaz. Health**. v. 2, p. 11-26, 2011. Available in: <http://scielo.iec.gov.br/pdf/rpas/v2n1/v2n1a02.pdf>. Access: 01 Feb. 2022.

FIGUEIREDO, L.T. FONSECA, B.A. Yellow fever. **Treatise on Infectious Diseases**. Scientific Editor: Focaccia R. Veronesi. 4th ed. São Paulo: Atheneu; 2017.

CHURCH, P.N.; MOIA, M.Y.S.; KINGS, D.L.A.; FERREIRA, A.R.S.; CARDOSO, G.N.G.; OLIVEIRA, R.S. Mothers' perception of childhood vaccination in a family health strategy in Tucuruí-PA. **Brazilian Journal of Developed**. v. 6, n. 3, p. 9731-9745, Mar. 2020. DOI: <https://doi.org/10.34117/bjdv6n3-012>.

HOCHMAN, G. Vaccination, smallpox and an immunization culture in Brazil. **Sciences & Collective Health**, v. 16, n. 2, p. 375-386, 2011. Available in: <https://doi.org/10.1590/S1413-81232011000200002>. Accessed: 04 Apr. 2020.

POPESCU, C.P.; PERRET,C; MCBRIDE, A; CHECKLEY, A; RYAN,J; CETRON, M; SCHLAGENHAUF, P. **Fatal yellow fever in travelers to Brazil,2018**.

DOI: 10.15585/mmwr.mm6711e1. Available in: <https://pubmed.ncbi.nlm.nih.gov/29565840/>. Accessed: 04 Feb. 2022.

LUHML, K. R.; CARDOSO, M. R. A.; WALDMAN, E. A. Vaccination coverage in children under two years of age from computerized registration of immunization in Curitiba, PR. **Caderno de Saúde Coletiva**, v.45, n.1, p 90-98, 2011. Available in: <http://dx.doi.org/10.1590/S0034-89102010005000054>. Accessed: 27 Nov. 2019.

MALAGUTTI, W. Immunization, Immunology and Vaccines. **Rubio Magazine**. Ed. 1st. v. page 212-214, year. 2011.

MILLER, E. R; MORO, P.L; CANO, M; SHIMABUKURO, T. **Deaths following vaccination: What does**

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the evidence show? *Vaccine*. v. 33, n.29, p. 3288-3292, 2015. Available from: doi: 10.1016 / jvaccine.2015.05.023. Accessed: 05 Feb. 2020.

NOBREGA, A. A; TEIXEIRA, A.M. S; LANZIERI, T.M. Evaluation of the Immunization Program (SI-API) information system. **Collective Health Notebook**, v 49, 2015. Available in: <http://dx.doi.org/10.1590/S0034-8910.2015049005925>. Access: 01 Dec. 2019.

NUNES, D.M; MENEZES, F, C; IGANSI, C.N; ARAÚJO, W. N; SEGATTO, T.C. V; COSTA, K, C, C; WADA, M, Y. Survey of vaccine coverage of triple bacterial and triple viral and factors associated with non-vaccination in Santa Maria, Federal District: 2012. **Pan-Amazonia Health Magazine** (Online), v. 9, n. 1, p. 9-17, 2018. Available in: <http://dx.doi.org/10.5123/s2176-62232018000100002>. Accessed: 04 Apr. 2020.

OLIVEIRA, V. G.; PEDROSA, K. K. A.; MONTEIRO, A. I.; SANTOS, A. D.B. Vaccination: the practice of nursing and the knowledge of mothers and/or caregivers. **Revista Rede Enfermagem**, v.11, p. 133-141, 2010.

PAHO. **Information sheet - Measles. 2019.** Available in: <https://www.paho.org/pt/topicos/sarampo>. Access: 30 Jun. 2020.

PAHO. **Epidemiological Alert: Diphtheria-25 June 2021.** Available in: <https://www.paho.org/en/documents/epidemiological-alert-diphtheria-25-june-2021>. Accessed: 20 Jan.2022.

PEIXOTO, M.C.; TORRES, M.T.; PASSOS, N.C.R.; ALMEIDA, T.S.C. **Vaccination profile of the infant population in a municipality in the recôncavo of Bahia.** *Texture*, v. 10, n. 19, p. 172-179, Dec. 2017. Available in <https://textura.famam.com.br/textura/article/view/55>. Accessed 24 Nov. 2020.

SANSON, E, M; CREMONESE, L. Media influences on the drop in vaccination rates in Brazil. **Ulbra Academic Weeks Review**. v.5, n2, 2019. Available in: <https://www.ulbracds.com.br/index.php/rsa/article/view/1995>. Accessed Jan. 20. 2020.

SATO, A.P.S. What is the importance of vaccine hesitation in the fall of vaccination coverage in Brazil? **Revista de Saúde Pública** (Online), v.52, n.96, p. 1-9, 2018. Available in: <http://www.rsp.fsp.usp.br/artigo/>. Access: 10 Jan 2020.

SILVA, I.C.; CUNHA, C. The importance of nurses in the vaccination room in a basic health unit. Empathy - **Revista de Saúde Integral**, v.1, n 1, p. 157-169, 2018.

SILVEIRA, B.; BENTES, A.A; ANDRADE, M.C.V; CARVALHO, A.L; DINIZ, L.M.O; ROMANELLI,

Incidence Of Immunopreventable Diseases in Children Under Five Years of Age: Analysis of Vaccine Coverage and Homogeneity in The Midwest of Brazil

R.M.C. Polio update. **Revista Medicina Minas Gerais**, 2019. DOI: 10.5935/2238-3182.20190084. Available in: <http://www.rmmg.org/artigo/detalhes/2628>. Accessed: 10 Dec.2022.

SOARES, J. S.; SILVA, E. S. F.; SOUSA, W. R.M.; ARAÚJO, L. R.S.; BARBOSA, T. DE J. A.; Mothers' knowledge about vaccines given to children under one year of age. **Electronic Magazine Acervo Saúde**. 43, p. 1-10, 27 Aug. 2020. DOI: <https://doi.org/10.25248/reas.e2874.2020>. Accessed: 10 Aug.2021.

SOUSA, B. S. Q. **Epidemiology of cases of deaths from immunopreventable** diseases: diffrhphthesis, tetanus and pertussis in children under 1 year of age in Brazil between 2001 and 2016. Monograph (Nursing) - Faculty of Health Sciences, University Center of Brasília, Brasília, 2018.

TEIXEIRA, A.M. S, ROCHA, C.M. V. Surveillance of vaccination coverage: a methodology for detection and intervention in risk situations. **Epidemiology and Health Services** (Online), v.19, n.3, p. 217-266, 2010. Available from: http://scielo.iec.gov.br/scielo.php?Script=sci_arttext&PID=S1679-49742010000300004. Access on: 08 Mar. 2020.

TERTULIANO, G.C; STEIN, A. T. Delayed vaccination and its determinants: a locality study assisted by the Family Health Strategy. **Sciences & Public Health**, v. 16, n. 2, p. 523-530, 2011.

TOLEDO, A.C.C. History of Medicine: History of smallpox. **Revista Médica de Minas Gerais**, v.15, n.1, p.58-65, 2015. Available in: <https://doi.org/10.1016/j.vaccine.2015.05.023>. Access on: 05 Mar. 2020.

Trajan, I.L. O.; NICHILATTI, L. P.; FERREIRA, R.M. P.; LINHARES, M.A.; CUZCANO, C.A.S.; JUNIOR, D. V.M.; FONSECA, R. N.M. Epidemiology of Acute Flaccid Paralysis in Brazil from 2014 to 2018. **Brazilian Journal of Health. Revista de Curitiba**. v. 3, nº 4. 2020. DOI: 10.34119/bjhrv3n4-189. Available in: <https://www.brazilianjournals.com/index.php/BJHR/article/view/14074/16658>. Accessed: 06 Feb, 2021.