Comparative Analysis of Vaccination Coverage in Southeast Region

Análise Comparativa da Cobertura Vacinal Em Região Sudeste
Análisis Comparativo de la Cobertura Vacunal em la Región Sudeste

RESUMO
Objetivo: Comparar a cobertura vacinal entre os estados da Região Sudeste do Brasil no período de 2018 a 2022, com ênfase nas tendências observadas e seus possíveis impactos na saúde pública. **Método:** Estudo epidemiológico descritivo, baseado em dados do DATASUS. Avaliaram-se as coberturas dos principais imunobiológicos infantis obrigatórios. A análise estatística foi realizada por ANOVA de um fator no GraphPad Prism 10.0.0, considerando $p < 0,05$. **Resultados:** A cobertura regional superou a média nacional (69,60%), com Minas Gerais registrando a maior taxa (79,96%) e o Rio de Janeiro, a menor (56,47%). A Febre Amarela teve a menor cobertura (66,40%) e a Tríplice Viral, a maior (85,33%). **Conclusão:** Evidencia-se a necessidade de analisar de forma mais detalhada as determinantes sociais e as problemáticas dos serviços de saúde que influenciam a adesão vacinal, a fim de fomentar estratégias mais específicas e eficazes para alcançar a meta de 95% da OMS.
DESCRITORES: Cobertura de Imunização, Programas de Vacinação, Calendário Nacional de Imunização, Programa Nacional de Imunizações (PNI), Campanhas de Vacinação.

ABSTRACT
Objective: To compare vaccination coverage among the states of the Southeast Region of Brazil from 2018 to 2022, emphasizing observed trends and potential public health impacts. **Method:** Descriptive epidemiological study based on DATASUS data. The coverage of the main mandatory childhood immunobiologicals was assessed. Statistical analysis was performed using one-way ANOVA in GraphPad Prism 10.0.0, considering $p < 0.05$. **Results:** The regional coverage exceeded the national average (69.60%), with Minas Gerais recording the highest rate (79.96%) and Rio de Janeiro the lowest (56.47%). Yellow Fever had the lowest coverage (66.40%), while the MMR vaccine had the highest (85.33%). **Conclusion:** It is essential to conduct a more detailed analysis of social determinants and health service issues that influence vaccine adherence to promote more specific and effective strategies to achieve the WHO's 95% coverage goal.
DESCRIPTORS: Immunization Coverage, Vaccination Programs, National Immunization Schedule, National Immunization Program (PNI), Vaccination Campaigns.

RESUMEN
Objetivo: Comparar la cobertura vacunal entre los estados de la Región Sudeste de Brasil en el período de 2018 a 2022, con énfasis en las tendencias observadas y sus posibles impactos en la salud pública. **Método:** Estudio epidemiológico descriptivo basado en datos de DATASUS. Se evaluó la cobertura de los principales inmunobiológicos infantiles obligatorios. El análisis estadístico se realizó mediante ANOVA de un factor en GraphPad Prism 10.0.0, considerando $p < 0,05$. **Resultados:** La cobertura regional superó el promedio nacional (69,60%), con Minas Gerais registrando la tasa más alta (79,96%) y Río de Janeiro la más baja (56,47%). La Fiebre Amarilla tuvo la menor cobertura (66,40%) y la Triple Viral, la mayor (85,33%). **Conclusión:** Es fundamental realizar un análisis más detallado de los determinantes sociales y los problemas en los servicios de salud que influyen en la adhesión a la vacunación, con el fin de fomentar estrategias más específicas y eficaces para alcanzar la meta de cobertura del 95% establecida por la OMS.
DESCRIPTORES: Cobertura de Inmunización, Programas de Vacunación, Calendario Nacional de Inmunización, Programa Nacional de Inmunizaciones (PNI), Campañas de Vacunación.

DOI: https://doi.org/10.36489/saudecoletiva.2025v15i94p15313-15328

RECEIVED: 03/11/2025 **APPROVED:** 03/20/2025

How to cite this article: Rodrigues BR, Luca VP, Araújo JWS, Barsotti NS. Comparative Analysis of Vaccination Coverage in Southeast Region. Saúde Coletiva (Edição Brasileira) [Internet]. 2025 [acesso ano mês dia];15(94):15313-15328. Disponível em:
DOI: 10.36489/saudecoletiva.2025v15i94p15313-15328

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INTRODUCTION

Vaccination is essential to prevent the spread of pathogens and is one of the most cost-effective public health interventions to reduce morbidity and mortality. [1-5] In 1973, the National Immunization Program (PNI - Programa Nacional de Imunização) was created in order to reduce morbidity and mortality from vaccine-preventable diseases in the country. This is one of the main and most relevant public health interventions in the world, as it completely changed the epidemiological scenario of several diseases in the country. [1,6-8] Brazil was a pioneer in including several vaccines in the Unified Health System (SUS), offering immunobiologicals universally and free of charge.

The vaccines offered by the SUS are provided by the PNI, whose mission is to organize the country's national vaccination policy. In this way, the PNI structures and coordinates immunization actions, monitoring immunobiologicals and their effects on the population, with more than 20 vaccines recommended and specifically targeted for each population (children, adolescents, adults, pregnant women and the elderly). However, national vaccination coverage is on a downward trend. [1,4,7,9,10]

It is essential to understand that immunization is not just an individual issue, but rather a collective protection measure. This means that collective immunity is achieved when the majority of individuals in a given area are protected against the pathogen. As a result, the transmission of the pathogen will decrease, which will provide indirect protection to people who have not been immunized, such as those with weakened immune systems, for example, immunodeficient individuals.[1,3]

According to the World Health Organization (WHO), in order to maintain the eradication, control or elimination of certain diseases, vaccination coverage of at least 95% is recommended. [1,11] The worldwide eradication of several diseases, such as smallpox, was possible thanks to effective vaccination programs. [12]

Advances in research, development, improvement and production of vaccines have been growing exponentially, due to the progress of technology in the world, thus creating products with high safety and efficacy for the population. [13] For vaccines to be distributed, they must be tested, monitored and follow strict protocols by manufacturers and the country's health system. [14] Furthermore, registration only occurs after approval by specific regulatory bodies and detailed clinical studies. In this way, it can be verified that the immunization system is safe and effective. However, the drop in the vaccination rate is a public health issue that has affected many countries, which allows the re-entry of several preventable diseases.

This phenomenon occurs in a multifactorial way, analyzed by the social context of poverty; difficult-to-access location; low education level, fears of adverse reactions, beliefs that the vaccine causes harm; contamination of the political debate with misinformation, growth of the anti-vaccine movement, recent changes in the PNI information systems, in addition to the weakening of the SUS, difficulty of access for the marginalized population, etc. [1-3,9,15]

These are some current situations that corroborate the decrease in vaccination rates worldwide. Despite the impact on reducing cases and deaths from vaccine-preventable diseases, anti-vaccination movements are increasingly questioning the efficacy and safety of immunization by vaccine. [14]

Anti-vaccine groups have existed since the end of the 18th century, when they emerged against smallpox vaccination, due to a lack of information and the population's deep-rooted philosophical and religious beliefs. [8,13]

This movement continues to be even stronger today, due to the great power that the internet has to disseminate ideas and information without scientific proof in a simple and fast way to the entire world.

In a study carried out by the Brazilian Society of Pediatrics (SBP), around 81.29% of the doctors interviewed claimed that many parents fail to vaccinate their children due to the often unfounded media content that they read and hear on communication networks, causing them to lose confidence in immunization programs. [3,13,16]

According to information from the Ministry of Health, the vaccination rate in the population showed a downward trend, reaching less than 59% of vaccinated citizens in 2021. However, the objective established by the WHO is to reach a vaccination coverage rate of 95% in Brazil. [17] Due to the decrease in vaccination, the risk increases for the resurgence of infectious diseases that were even controlled and/or eradicated throughout the territory, such as smallpox, measles, rubella and polio. [3,5,10,13,18,19]

Thus, there is a high rate of children with delayed vaccination in Brazil. Thus, the objective of this study is to present a comparison of vaccination coverage between the states of the Southeast region of Brazil in the period from 2018 to 2022, in order to study the social determinants and the problems of health services contained in these regions that influence low vaccination adherence.

METHOD

A descriptive epidemiological study was conducted, with data extracted from the Department of Information and Informatics of the Unified Health System (DATASUS). DATASUS is an agency of the Secretariat of Strategic and Participatory Management of the Ministry of Health that was developed to promote the computerization of health care for Brazilians. This study analyzed the most significant findings on vaccination coverage in the states of the Southeast Region. The year 2018 was defined as the initial date for the description, and the year 2022 was defined as the final date.

The following immunobiologicals were analyzed: BCG, Rotavirus, Meningococcus C, Pentavalent, Polio, Yellow Fever, Hepatitis A, Triple Viral, and Varicella. The data collected from DATASUS are made available by the TABNET platform, which comes from the National Immunization Program Information System (SI-PNI). Data were evaluated by one-way analysis of variance (ANOVA) using GraphPad Prism software, version 10.0.0, for Windows (GraphPad Software, Boston, Massachusetts, USA). Differences between the means of the four states were analyzed separately, and a p-value < 0.05 was considered statistically significant.

RESULTS

Table 1. Vaccination coverage by year according to region. Data taken from DATASUS in the period 2023. (São Paulo - SP, Brazil, 2024)

Region	2018	2019	2020	2021	2022	Total
North	69,14	72,77	61,48	55,37	62,99	64,14
Northeast	74,04	69,24	62,50	58,17	68,47	66,31
Southeast	**79,06**	72,72	68,90	**62,16**	65,78	**69,60**
South	81,40	81,92	79,16	69,77	74,19	77,17
Midwest	81,87	78,18	73,32	64,55	71,88	73,72
Total	77,13	73,44	68,05	61,52	67,90	69,45

Source: Ministry of Health. DATASUS. Tabnet. Brasília, DF: Ministry of Health, 2024.

Table 1 shows the variation in vaccination coverage in the Southeast region of Brazil between 2018 and 2022. Starting in 2018, with the highest peak in the period analyzed (79.06), it was soon followed by a drop with worse coverage in 2021, reaching 62.16. Overall, the Southeast region had above-average vaccination coverage (69.60). However, compared to other regions of Brazil, the Southeast ranked third during the period analyzed, with the South and Central-West regions obtaining higher vaccination coverage, while the Northeast and North regions had lower vaccination coverage. The states of the Southeast region are classified in decreasing order of vaccination coverage in the period studied: Minas Gerais leads with 79.96, followed by Espírito Santo with 73.23, São Paulo with 70.87, and Rio de Janeiro with the lowest coverage of 56.47.

Furthermore, the highest vaccination coverage rates in the Southeast States were all recorded in 2018, while the lowest, with the exception of Espírito Santo (2022), were observed in 2021.

DOI: https://doi.org/10.36489/saudecoletiva.2025v15i94p15313-15328

Table 2. Vaccination coverage by year according to state in the Southeast region. (São Paulo - SP, Brazil, 2024)

Region	2018	2019	2020	2021	2022	Total
Minas Gerais	**84,74**	77,86	78,29	**68,99**	75,60	76,96
Espírito Santo	**80,98**	75,32	75,47	69,17	**66,12**	73,23
Rio de Janeiro	**72,67**	61,19	49,33	**48,51**	51,39	**56,47**
São Paulo	**78,80**	74,50	71,45	**63,45**	66,63	70,87
Total	79,06	72,72	68,90	**62,16**	65,78	69,60

Source: Ministry of Health. DATASUS. Tabnet. Brasília, DF: Ministry of Health, 2024.

The immunobiological agent that recorded the lowest vaccination coverage in the Southeast region was Yellow Fever (66.40), while the immunobiological agent with the highest vaccination coverage was Triple Viral (85.33). Furthermore, it was highlighted that all states in the Southeast region had the highest vaccination coverage in relation to the triple viral, except for the State of Rio de Janeiro, which obtained a higher vaccination coverage for the BCG vaccine.

Table 3 - Vaccination coverage by state according to immunobiologicals from 2018 to 2022. (São Paulo - SP, Brazil, 2024)

Immunization	Minas Gerais	Espírito Santo	Rio de Janeiro	São Paulo	Total
BCG	89,27	85,06	**78,29**	81,49	82,83
Rotavirus	87,73	84,05	68,01	82,76	81,13
Meningococcus C	87,19	84,56	68,22	82,60	80,98
Pentavalent	84,29	80,03	63,03	80,99	78,25
Poliomyelitis	86,45	83,12	66,76	82,74	80,54
Yellow Fever	82,13	68,21	46,91	66,49	**66,40**
Hepatitis A	86,61	80,53	64,93	79,79	78,54
Triple Viral	**91,43**	**87,38**	77,19	**85,46**	**85,33**
Chickenpox	84,74	75,21	61,10	77,41	75,89

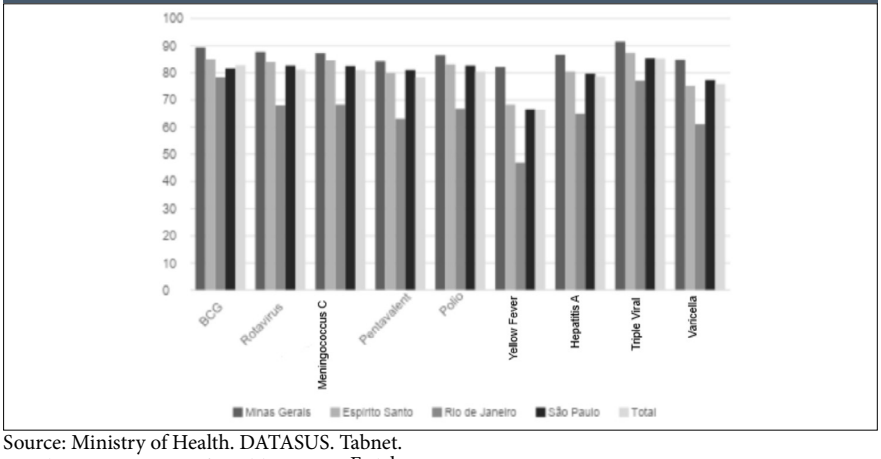
Source: Ministry of Health. DATASUS. Tabnet. Brasília, DF: Ministry of Health, 2024.

Graph 1 analyzes vaccination coverage in the states of the Southeast Region according to immunobiological agents during the period from 2018 to 2022. When examining the graph, two notable points emerge that are worth highlighting. First, we observe that the yellow fever vaccine achieved the lowest coverage among all immunobiological agents analyzed, while the triple viral vaccine stood out with the highest coverage during this period. In addition, the graph notably reveals the state of Rio de Janeiro as the state with the lowest coverage for all immunobiological agents.

In contrast, Minas Gerais emerged as the state with the highest coverage for each immunobiological agent. The evolution of vaccination coverage among the states of the Southeast Region was found throughout the period studied. The state of Rio de Janeiro appears to be a critical point in terms of vaccination coverage, consistently being the state with the lowest coverage between 2018 and 2022. Its line on the graph always remains below the line representing the average or total for the region. The State of Minas Gerais stands out for having the highest vaccination coverage over the years compared to the other States in the region studied.

DOI: https://doi.org/10.36489/saudecoletiva.2025v15i94p15313-15328

Chart 1. Vaccination coverage by state according to immunobiological. (São Paulo - SP, Brazil, 2024)

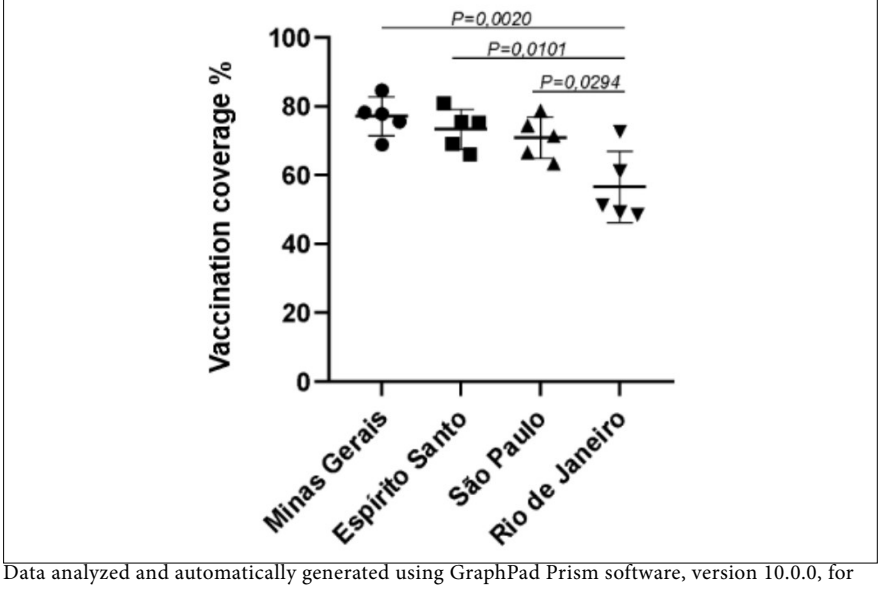


Source: Ministry of Health. DATASUS. Tabnet. Brasília, DF: Ministry of Health, 2024. Graph automatically generated using Microsoft Excel.

In Graph 2, it is possible to observe the statistical result of the comparative analysis between the states of the Southeast. The averages of vaccination coverage were analyzed through pairwise comparisons between the groups. It was observed that, between Minas Gerais and Rio de Janeiro, there was a statistically significant difference ($p = 0.0020$). On the other hand, when comparing Minas Gerais with Espírito Santo and Minas Gerais with São Paulo, no statistically significant differences were observed in either case ($p > 0.05$). The comparison between Espírito Santo and Rio de Janeiro also showed statistically significant differences ($p = 0.0101$).

However, the comparison between Espírito Santo and São Paulo did not show statistical significance ($p > 0.05$). Finally, the comparison between Rio de Janeiro and São Paulo revealed statistically significant differences ($p = 0.0294$).

Graph 2. Statistical comparison of average vaccination coverage rates among states in the Southeast region (2018-2022). (São Paulo - SP, Brazil, 2024)



Data analyzed and automatically generated using GraphPad Prism software, version 10.0.0, for Windows (GraphPad Software, Boston, Massachusetts, USA).

DISCUSSION

In Brazil, the National Immunization Program (PNI) has brought undeniable advances in the country's immunization, introducing several vaccines to help control many diseases circulating in the population. [14]

Vaccination is the main form of primary prevention, in addition to protecting against serious complications and even deaths from various pathologies around the world, such as tuberculosis, hepatitis, measles, smallpox, polio, etc. [3,5,13,15,20] Despite the WHO recommendation of 95% vaccination coverage for disease control and eradication, the PNI faces difficulties in achieving this goal in Brazilian municipalities due to the high rate of children with delayed vaccinations. [4]

This increases the risk of the resurgence of infectious diseases that were controlled and eradicated throughout the territory. [2,3,5,11,15,18,19] An example of this was the resurgence of thousands of measles cases in São Paulo in mid-2019, with the main factor being the vaccine hesitancy of many individuals.

Studies indicate that this situation still persists in Brazil, due to the eradication or control of the disease, side effects, concerns about chemical components, immunity to the disease being greater than that achieved by the vaccine, philosophical and religious beliefs, among others. [3,9,10,13,16] Another important factor that impacted vaccination coverage was the phenomenon of misinformation during the COVID-19 pandemic. [10]

This action occurred due to the failure to recognize fake news in various mass media, such as the internet, television, among others. Thus, many people were limited in their information and induced not to get vaccinated due to the fear that fake news corroborated in the media.

In this way, conspiracy theories regarding vaccines (toxic elements in the content, immaturity of the child's

DOI: https://doi.org/10.36489/saudecoletiva.2025v15i94p15313-15328

immune system to deal with the large number of vaccines, support for natural immunity, lack of studies on the development of the antigen, reduction of vaccine-preventable diseases through improved health and not through vaccination) and the weakening of the State regarding limited information, are examples that allowed the reduction of immunization against the pathogen and, consequently, the hesitation of many other vaccines found in the vaccination schedule by the population, due to the fear caused by the spread of fake news in the media. [8]

To combat vaccine hesitancy, we must have the greatest possible transparency of scientific information about vaccination and the immunization it entails. [4,16,19] In addition to vaccine hesitancy, other reasons for the resurgence of measles were observed, such as recent changes in the PNI information systems (records incompatible with the dose offered, lack of professionals to carry out registration, lack of IT and internet, etc.), in addition to the weakening of the SUS (reduction in funding, limited materials at vaccination centers, overload of health centers, reduction and inadequacy of vaccination campaigns in communities, lack of community health agents (CHA), difficulty in accessing the marginalized population). [1-3,12,15,21]

Vaccination coverage is a measure that assesses the proportion of people in the population who have received the target vaccine. To calculate it, the total number of last doses of the specific vaccine is divided by the estimated number of the target population and multiplied by 100. For children under one year of age, the number of the target population is obtained from the Live Births System (SINASC). [22]

The registration of vaccines administered and vaccination coverage in the Brazilian population is carried out through the PNI Information System (SI-PNI). This allows for a better assessment of possible outbreaks or epidemics, in addition to also helping administrators to control vaccine stocks and schedule their acquisition and distribution. [1,6-8,23] Among the inconsistencies of the SI-PNI is the inadequate quality of the data due to the lack of information. This has a direct impact on the validity, accuracy and reliability of the data, making it difficult to assess the true health situation and compare it with other databases. An example of this is the lack of adequate filling in of the "vaccine batch", which can make it difficult to identify outbreaks or adverse events following vaccination.

A strategy to improve data quality is to invest in training professionals to correctly feed the information system. In addition, IT specialists need to be involved to ensure the correct analysis of the data entered and exported.

On the other hand, the adherence to the SI-PNI at a national level is classified as regular, with its acceptability, in 2017, being > 80% in 4,239 (76%) of 5,570 Brazilian municipalities. However, some municipalities still have low adherence to the SI-PNI in vaccination rooms, which can make it difficult to manage important information. [1,6] The results of this study revealed that the Southeast Region had vaccination coverage above the national average. However, when compared to other regions in Brazil, its ranking was third.

This finding suggests that, despite having a relatively high vaccination coverage, it is important to consider strategies to improve performance and achieve better positions at the national level. When analyzing the Southeast States individually, the State of Rio de Janeiro emerged as a central concern and a critical point with regard to vaccination coverage. Rio de Janeiro consistently had the lowest vaccination coverage between 2018 and 2022, demonstrating the need for attention and specific interventions to improve vaccination coverage in this location. As reported in the PNI Information System, Rio de Janeiro was analyzed as the state with the lowest vaccination coverage compared to the other states in the federation. According to the Rio de Janeiro State Health Council, the BCG vaccine reached coverage of only 76% in 2022, a value below the target established by the WHO (95%). Furthermore, RJ has the second lowest coverage against polio and pentavalent in Brazil.

According to the Subsecretariat of Surveillance and Primary Health Care of SESRJ (Subvaps), the main problems for low vaccination uptake are difficulties in accessing vaccination centers, poor communication with society, reduced number of employees, lack of infrastructure in the system and vaccination records, among others.

To increase vaccination coverage, a given region must have the support of city governments to carry out immunization campaigns in various social areas; hire and train employees for the PHC; promote extramural vaccination campaigns; actively search for unvaccinated people by community health agents; develop projects, such as workshops, lectures and advertisements to publicize, clarify doubts and encourage the population to get vaccinated; extend the hours and days of operation of the PHC; improve the system and IT equipment; establish intersectoral partnerships to help with uptake, such as universities, councils and schools. [24]

On the other hand, Minas Gerais, despite being the state with the largest number of municipalities in the country, stood out as a positive example in relation to vaccination coverage. Throughout the period studied, Minas Gerais maintained a notably higher vaccination rate compared to the other states in the Southeast Region, standing out as a model to be followed in order to achieve better vaccination rates. The main strategies that have been used by the State of Minas Gerais are the creation of Municipal Action Plans, constant monitoring of immunization work process indicators, increased training, active search for updating of

DOI: https://doi.org/10.36489/saudecoletiva.2025v15i94p15313-15328

vaccines for those who missed vaccinations, meetings between epidemiological surveillance and Primary Health Care, among others. [25]

It is extremely important that the population and health professionals clearly understand the relevance of vaccination, as individual immunization is directly related to collective protection, thus preventing the spread of infectious diseases. Therefore, it is recommended that more comprehensive studies be carried out on vaccination coverage throughout Brazil. Through this future research, we will be able to identify the specific and limiting factors associated with non-vaccination in each Region, State and Municipality in order to develop specific strategies to mitigate the decline in vaccination rates in the region.

In addition, when analyzing the phenomenon of fake news in health during the pandemic in 2020, it is necessary to carry out longitudinal studies, such as continuous monitoring of the misinformation ecosystem in the various areas of knowledge. Thus, by obtaining this detailed information, we will be able to promote the design of innovative strategies adapted to each context, in order to significantly increase vaccination adherence throughout the country.

In this way, it will be possible to control or even eradicate several infectious diseases through greater population immunization.

The limitations found in this study were the low reliability of the information taken from the DATASUS database, the need for greater systematization for the searches of scientific articles, including inclusion and exclusion criteria; as well as the evaluation of the methodological quality of the articles included in the summaries and the restriction of articles related to the topic.

CONCLUSION

In this study, we were able to compare vaccination coverage among the states of the Southeast of Brazil between 2018 and 2022. The main results found were: the Southeast region was above average compared to other regions in the country, Minas Gerais was a positive example due to the best vaccination rates and, finally, Rio de Janeiro was the main point of concern due to limited population adherence. The main factors for the low vaccination rate include: lack of qualified professionals to input data into the SI-PNI, increase in fake news on mass communication networks, restricted access and low availability of materials at health centers, among others. To achieve an increase in vaccination coverage, it is necessary to investigate and promote strategies to expand vaccination, such as: improving the monitoring of immunization indicators, paying attention to the difficulties of access to health centers by the population, the level of family income and education of this group. In addition, improvements are needed in health centers: such as increasing the number and training of employees; extending the opening hours of health centers; carrying out campaigns and workshops in various social spheres; partnerships with schools, universities and councils; training teams and the need to intensify vaccination actions. Furthermore, as previously mentioned, due to the scarcity of studies in the area, we recommend future research that can verify in more detail and study the social determinants and problems of health services contained in each region that influence vaccination adherence. We reiterate the importance of reaching the goal established by the WHO of 95% vaccination coverage to prevent the resurgence of several diseases that have already been eradicated and controlled throughout Brazil.

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DOI: https://doi.org/10.36489/saudecoletiva.2025v15i94p15313-15328