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Mapping priority areas for measles surveillance: stratifying reintroduction and transmission risk in Rio de Janeiro, Brazil

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ABSTRACT

Objective. To stratify areas at risk of measles transmission in the state of Rio de Janeiro, using the risk assessment tool developed by the World Health Organization and Centers for Disease Control and Prevention, with adaptations to the regional context.

Methods. This ecological study used municipalities of Rio de Janeiro state as the units of analysis. The overall risk of measles transmission was evaluated based on the scores of indicators grouped into four categories: vaccination, threat assessment, quality of health care services, and living conditions. After summing and normalizing the scores for each category, weights were assigned to obtain the risk index. The 20%, 60%, and 90% centiles were used to establish cut-off points, classifying municipalities as low risk, medium risk, high risk, and very high risk. To evaluate the performance of the measles transmission risk index, a spatial overlay was performed with the cases reported in the epidemic period 2018–2020.

Results. A progressive increase in incidence rates of measles cases was observed across municipalities, corresponding to escalating transmission risk in different strata. About 97% of measles cases occurred in municipalities classified as high or very high risk, primarily located in the state's metropolitan region.

Conclusion. Given the potential risk of measles transmission during the post-elimination period, our findings reinforce the importance of developing and implementing tools to identify priority areas for surveillance. The spatial overlay indicated the method's effectiveness in identifying vulnerabilities associated with transmission other than low vaccine coverage, such as precarious living conditions and poor quality of health care services.

Keywords: Measles; risk assessment; incidence; epidemiological monitoring; Brazil.

Despite the significant reduction in measles morbidity and mortality worldwide in the past decades, the recent resurgence of the disease at a global level underscores the need for sustainable investments in health care systems. These efforts are essential to achieve regional elimination goals for measles (1, 2).

In Brazil, recent epidemics associated with difficulties in achieving vaccination coverage goals have reignited concerns about the risk of a resurgence of measles (3, 4). In 2016, the elimination of the virus in the Region of the Americas was recognized by the World Health Organization's (WHO's) International Expert Committee on Monitoring and Verification of the Elimination of Measles, Rubella, and Congenital Rubella Syndrome (5). However, since 2018, several countries in the Americas have reported measles epidemics. In Brazil, outbreaks were recorded

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in nine states, resulting in uninterrupted virus circulation for 12 months and the loss of the region's certification of measles virus elimination (3–5).

Although successive declines in vaccination coverage are a main factor in the resurgence of measles, a range of socioeconomic and environmental factors contribute to the worsening of the situation. Income inequality, insufficient primary health care coverage, intense urbanization, and high household density all contribute to increased vulnerability to measles transmission. These conditions must be carefully considered when developing effective disease control policies (3, 5).

In a coordinated effort to achieve regional measles elimination, WHO and the Centers for Disease Control and Prevention (CDC) developed a collaborative tool (6). This tool is designed to monitor, guide, and sustain measles elimination efforts across the six WHO regions. By stratifying risk at subnational levels, the tool helps countries identify priority areas for measles surveillance, thus facilitating targeted actions for sustainable disease control (6–8).

Although stratification strategies are an inherent practice in surveillance services, global agencies and scientific studies have worked to develop new techniques and tools that can be incorporated into routine services with emphasis on various diseases, such as arboviruses (9, 10), malaria (11), and measles (5, 6, 12).

In general, risk stratification methods aim to map areas most susceptible to the occurrence of a disease, on the assumption that these events are distributed heterogeneously in the territory, based on their determinants (12). The heterogeneous distribution of determinants in a territory presupposes the incorporation of surveillance strategies that allow the classification of these geographic areas according to different risk levels. Therefore, specific scenarios can be considered for which control actions can be tailored, ensuring greater effectiveness of results and rational use of resources (9).

Despite the global resurgence of measles and the importance of identifying areas with a higher likelihood of introduction and spread of the disease, few studies have been done on the applicability of methods for stratifying areas at risk of transmission, as recommended by WHO (12).

Thus the objective of this study was to stratify areas at risk of measles reintroduction and transmission in the state of Rio de Janeiro, using the WHO/CDC risk assessment tool (6), with adaptations to the regional context. Given the real risk of measles resurgence and sustained transmission in Brazil, this study is both timely and necessary, and offers the potential to implement risk analysis as a strategic tool for measles surveillance.

METHODS

Design and study area

This ecological study was conducted in the state of Rio de Janeiro using municipalities as the unit of analysis. The state is the third most populous in Brazil and is located in the south-eastern region of the country. It had an estimated population of 16 005 174 inhabitants in 2022 (13), distributed over an area of 43 750 423 km². The state has 92 municipalities organized into nine health regions (14). About 73% of the state's gross domestic product is concentrated in two metropolitan regions (Metropolitan I and II), with the capital Rio de Janeiro alone accounting for 46% of this total (15).

Rio de Janeiro state was selected due to the significant measles epidemic that occurred in 2019–2020. Furthermore, as one of the country's leading tourist destinations, the state may be a hub for the introduction and spread of etiological agents, a risk further exacerbated by its high population density and pronounced social inequalities (16).

Global programmatic risk assessment tool

The risk matrix is an important management tool used to identify the type a specific event and degree of threat it poses to a population (17). It must be flexible and adaptable to the context in which it is used, where demographic, programmatic, and health condition data are combined for the risk analysis (18). To combine efforts to eliminate measles and encourage the efficient use of resources, the measles risk assessment tool was developed by WHO and CDC to assess measles risk at a subnational level. The tool is based on the stratification of transmission risk areas and aims to guide countries in mapping priority locations, where programmatic weaknesses require intensified surveillance and control actions (6).

In broad terms, the method classifies areas based on a score assigned to a set of indicators known to be associated with the risk of measles transmission, grouped into four main categories: surveillance quality; immunization program performance; population immunity; and threat assessment. The threat assessment category includes indicators that give a measure of the potential for importation and transmission of the measles virus within a population. The population immunity category includes indicators that aim to characterize the degree of measles immunity within the population. In the surveillance quality category, indicators are used to express, to some extent, the performance of case surveillance for rapid detection of the virus. In the program performance category, specific aspects of routine immunization programs are evaluated, as well as trends in measles vaccine coverage for the first and second doses (6).

For each of these categories, a weight defined by expert consensus (6) was assigned. Thus, for each unit of analysis (area), an overall score is obtained from the weighted average of the four dimensions, where the cut-off criteria for risk categories (low, medium, high, and very high) are defined at the 50th, 75th, and 90th centiles of the distribution. Areas identified as high or very high risk by the tool can, for example, be prioritized for reinforced surveillance actions, implementation of supplementary immunization measures to achieve higher vaccine coverage, and planning responses for measles outbreaks (6).

Stratification of measles transmission risk areas

Based on the understanding of the biological, socioeconomic, and programmatic determinants of measles transmission listed in the WHO/CDC risk stratification tool and described in other publications, a matrix of municipal indicators for the state of Rio de Janeiro was proposed. In this matrix, the calculation methods, associated hypotheses, data source/information system, and respective bibliographic references were described. Initially, 29 indicators that relate to factors recognized as associated with the direct or indirect risk of measles transmission were proposed. Next, a search was conducted in publicly accessible databases, information systems, and government websites to collect data on municipal indicators and create a single database.

For the indicators for which data were available, a descriptive analysis was performed, including the calculation of measures of central tendency and dispersion, which aimed to identify those indicators with the highest variability within each category. Of the 29 indicators initially listed, 12 were retained in the matrix and classified according to the categories suggested in the WHO/CDC tool (6), with some adaptations: vaccination coverage, threat assessment, quality of health services, and living conditions.

Data on epidemiology, live births, and immunization were obtained from the DATASUS website (19), while socioeconomic and population estimates were obtained from the Instituto Brasileiro de Geografia e Estatística (IBGE). Table 1 shows the 12 indicators by category, calculation method, associated hypotheses, data source, and relevant references.

Framework of risk categories, indicators, and scoring

A scoring criterion was applied to the indicators for each of the four categories using the WHO/CDC measles risk assessment tool (6) as a reference. For those indicators that did not have a reference in the WHO/CDC tool, the scoring was based on measures of central tendency and dispersion. For each of the four categories, the risk of measles transmission was evaluated by summing the scores obtained for each of its indicators. The cut-off points for the indicators in the threat assessment and vaccination categories were based on the WHO/CDC measles risk assessment tool (6), while the indicators in the quality of health services and living conditions categories had cut-off points based on the 20th, 60th, and 90th centiles of the distribution. The maximum score that a municipality could receive in the vaccination category was 8 points. In the threat assessment, quality of health services, and living conditions categories, the maximum scores were, respectively, 13, 4, and 8 points (Table 2).

To make the categories comparable, normalization was performed based on the minimum and maximum values according to the formula: $(X_i - X_{Min})/(X_{Max} - X_{Min})$, where: X_i is the sum of the indicators in each category; X_{Min} is the minimum observed value of the category distribution; and X_{Max} is the maximum value of the indicator in the dimension. Once the categories were normalized, the measles transmission risk index was

TABLE 1. Indicators for the risk of measles transmission used at the municipal level, Rio de Janeiro, 2023

Indicator	Description	Hypothesis	Data source (year)	References
Vaccination				
Measles vaccination coverage	Number of doses of MMR and MMRV vaccines per resident population in all age groups	The higher the vaccination coverage, the lower the risk of transmission	SI-PNI (2017–2020)	(6)
Threat assessment				
Transmission	≥ 1 case of measles reported in children younger than 5 years	Occurrence of measles cases in children reflects a higher risk of disease spread	SINAN (2018–2020)	(6)
	≥ 1 case of measles reported in individuals aged 5 to 14 years	Occurrence of measles cases in children reflects a higher risk of disease spread	SINAN (2018–2020)	
Risk of case importation	Cases of measles reported in neighboring municipalities during the period	Occurrence of cases in neighboring municipalities represents a greater threat of disease resurgence	SINAN (2018–2020)	
Population density	Number of inhabitants per square kilometer	Densely populated areas have a higher risk of transmission	IBGE (2010)	(18)
Quality of health services				
Infant mortality	Number of deaths of children younger than 1 year of age, per 1000 live births, in the year under consideration	The higher the infant mortality rate, the greater the susceptibility to transmission.	SIM/SINASC (2018–2020)	(20)
Access to prenatal care	Percentage of live births that had at least seven prenatal care visits during pregnancy	The higher the number of visits, the greater the access to health care services	SINASC (2017)	(21)
Living conditions				
Maternal education	Percentage of resident mothers without complete elementary education and with at least one child younger than 15 years	The higher the percentage of mothers without complete elementary education, the greater the vulnerability to measles transmission	IBGE (2010)	(22)
Poverty	Percentage of extremely poor individuals (per capita household income up to 1/4 of the minimum wage)	The higher the poverty rate, the greater the vulnerability	IBGE (2010)	(3)
Socioeconomic vulnerability	Percentage of individuals aged 15 to 24 years who are neither in school nor employed	The higher the percentage, the greater the social vulnerability	IBGE (2010)	(23)
Housing vulnerability	Percentage of individuals living in households with inadequate water supply and sanitation	The higher the percentage, the greater the social vulnerability	IBGE (2010)	(24,25)
	Percentage of people living in areas with inadequate garbage collection			

IBGE, Instituto Brasileiro de Geografia e Estatística; SIM, Sistema de Informação de Mortalidade; SINASC, Sistema de Informação de Nascidos Vivos; SINAN, Sistema de Informação de Agravos de Notificação; SI-PNI, Sistema de Informação do Programa Nacional de Imunização.
Source: Prepared by the authors.

TABLE 2. Cut-off points and scores of the indicators by category

Indicator	Justification	Cut-off point (score)
Vaccination		
Measles vaccination coverage, %	A crucial indicator for assessing immunization, identifying low vaccination coverage, and evaluating the effectiveness of vaccination strategies	≥ 95 (+0) 90–94 (+2) 85–89 (+4) 80–84 (+6) < 80 (+8)
Threat assessment		
≥ one case of measles in children younger than 5 years	Indicates additional transmission risk	No (+0) Yes (+4)
≥ one case of measles reported in the age group 5–14 years	Indicates additional transmission risk	No (+0) Yes (+3)
≥ one case of measles reported in a neighboring municipality	Transmission in border municipalities increases the risk of importation	No (+0) Yes (+2)
Population density (inhabitants/km²)	Higher risk of transmission or spread in densely populated areas	0–50 (+0) 51–100 (+1) 101–300 (+2) 301–1000 (+3) > 1000 (+4)
Quality of health services		
Infant mortality rate, deaths per 1000 live births	A high infant mortality rate may indicate a weakened health care system, with potential deficiencies in prevention, diagnosis, and treatment	≥ 12 (+1) > 20 (+2)
Percentage of live births that had at least seven prenatal care visits during pregnancy	This number indicates better access to health care services. During prenatal care visits, pregnant women receive information about the importance of measles immunization	≥ 90 (+0) < 90 (+1) < 50 (+2)
Living conditions		
Percentage of resident mothers without complete elementary education and with at least one child younger than 15 years	May indicate a potential lack of access to health information, including the importance of measles immunization. The lower the educational attainment, the higher the vulnerability	> 16 (+1)
Percentage of extremely poor individuals, per capita household income up to 1/4 of the minimum wage	Indicates precarious socioeconomic conditions and social vulnerability	1.5–3.6 (+1) > 3.6 (+4)
Percentage of individuals aged 15 to 24 years who are neither in school nor employed in households vulnerable to poverty[a]	Indicates socioeconomic vulnerability. This can result in financial difficulties, limitations in access to basic services, and increased exposure to social and health risks.	> 33 (+1) < 33 (+0)
Percentage of individuals living in households with inadequate water supply and sanitation	Indicates housing vulnerability	> 3.2 (+1)
Percentage of people residing in areas with inadequate garbage collection	Indicates housing vulnerability	> 8.5 (+1)

[a] Households vulnerable to poverty have per capita household income of up to 1/2 of the minimum wage.
Source: Adapted by the authors from Lam et al., 2017 (6).

obtained through a weighted average by category, with the following weights assigned: vaccination (40%), threat assessment (30%), quality of health services (15%), and living conditions (15%).

In the vaccination category, which received the highest weight, the WHO/CDC measles risk assessment tool (6) was used as a reference. In this category, the aim was to characterize population immunity and overall susceptibility to measles through the measles vaccination coverage indicator. Indirectly, this category also reflects the performance of immunization programs.

The other categories had their weights redistributed based on their relationship with measles, considering the context of the state of Rio de Janeiro. The threat assessment category in the tool proposed by WHO/CDC (6) originally received a weight of 24%. In the present analysis, threat assessment received a weight of 30% due to its importance in virus transmission related to the movement of sick individuals. We combined indicators that potentially express a higher risk of importation and transmission of the measles virus in the area unit under analysis, such as demographic density and recorded cases in a neighboring municipality.

The surveillance quality category in the WHO/CDC tool had a weight of 20%. In our analysis, surveillance quality was replaced by quality of health services to which we assigned a weight of 15%. This category combined indicators that serve as markers of access to and quality of health services provided to the population, such as infant mortality and access to prenatal care. Consequently, municipalities with higher rates of infant mortality and reduced coverage of prenatal services tend to have lower overall coverage and quality of health care services, presenting a higher risk for the introduction and transmission of the measles virus.

The program performance category was weighted at 16% in the WHO/CDC tool. We replaced this category with the living conditions category, which we weighted at 15%.

Such changes in categories were incorporated into the study based on the understanding that measles determinants are not restricted solely to the quality of surveillance services and vaccination coverage, although these are crucial factors for interrupting transmission. In this case, living conditions and the quality of health services are fundamental aspects to ensure access to the resources necessary for maintaining the health of this population (Table 3).

Once the value of the measles transmission risk index was obtained for each municipality, the 20th, 60th, and 90th centiles were used to establish cut-off points and classify them as low risk, medium risk, high risk, or very high risk (5). The classification result of the municipalities was visualized through a choropleth map. To evaluate the performance of the measles transmission risk index, a spatial overlay was performed with the cases reported during the subsequent epidemic period (2018–2020), provided by the Notifiable Diseases Information System (SINAN, Brazilian acronym). The spatial analyses were conducted using QGIS software, version 3.3.4, and the statistical analyses were performed using R software version 4.3.2.

Ethics

We used secondary data obtained from publicly available databases, aggregated in the form of indicators expressed at the municipality level, with no possibility of subject identification and no involvement of human subjects. The study was approved by the Research Ethics Committee of the Instituto de Estudos em Saúde Coletiva of the Universidade Federal do Rio de Janeiro, under protocol number CAAE 76661723.3.0000.5286.

RESULTS

The spatial analysis of the measles transmission risk index showed a higher concentration of municipalities with a very high risk in the Metropolitan region of the State of Rio de Janeiro, while the Serrana, north, and southern parts of the Médio Paraíba regions had a concentration of municipalities with a high risk.

When analyzing the spatial overlap of the risk index with the reported measles cases in the subsequent epidemic period, a progressive increase in incidence rates was seen as the transition was made from municipalities categorized as low risk to those classified as very high risk of transmission. The incidence rates by risk index categories varied considerably, ranging from 0.5 to 16.0 cases per 100 000 inhabitants (Figure 1 and Table 4).

In the subsequent epidemic period (2018–2020), 97.3% of cases occurred in residents of municipalities classified as high or very high risk. Both risk classes are predominantly composed of municipalities located in the Metropolitan region. The high-risk class had the greatest number of cases due to the presence of the municipality of Rio de Janeiro, which had the most notifications during the period, followed by municipalities in the Serrana region, Baía de Ilha Grande, and the Northern region of the state.

The visual analysis of the spatial overlap of the risk index with the frequency of reported cases during the recent epidemic transmission period (2018–2020) in the state corroborates the findings. There was a concentration of cases in municipalities classified as high and very high risk, specifically in municipalities in the Metropolitan region (including Rio de Janeiro, Mesquita, São João do Meriti, Belford Roxo, Duque de Caxias, Magé, Japeri, Queimados, Nova Iguaçu, Niteroi, and São Gonçalo), as well as in the Serrana region, particularly in the municipalities of Petropolis and Nova Friburgo. Additionally, the municipality of Paraty, in the Médio Paraíba region, also stood out with a classification of very high risk and a relatively high frequency of cases (Figure 1).

DISCUSSION

Our findings indicate a relative spatial agreement between areas of high and very high risk of measles transmission and the occurrence of cases reported in the subsequent epidemic period (2018–2020). This demonstrates a good performance of the risk index in identifying vulnerabilities for measles transmission other than low vaccination coverage, such as precarious living conditions, low quality of health services, and the threat of importation of cases.

Given that the base tool is a general guideline recommended for countries in the six WHO regions, it is essential to adapt it according to the availability of data and the organization of local health care systems to reflect regional characteristics and ensure the instrument's effectiveness (12).

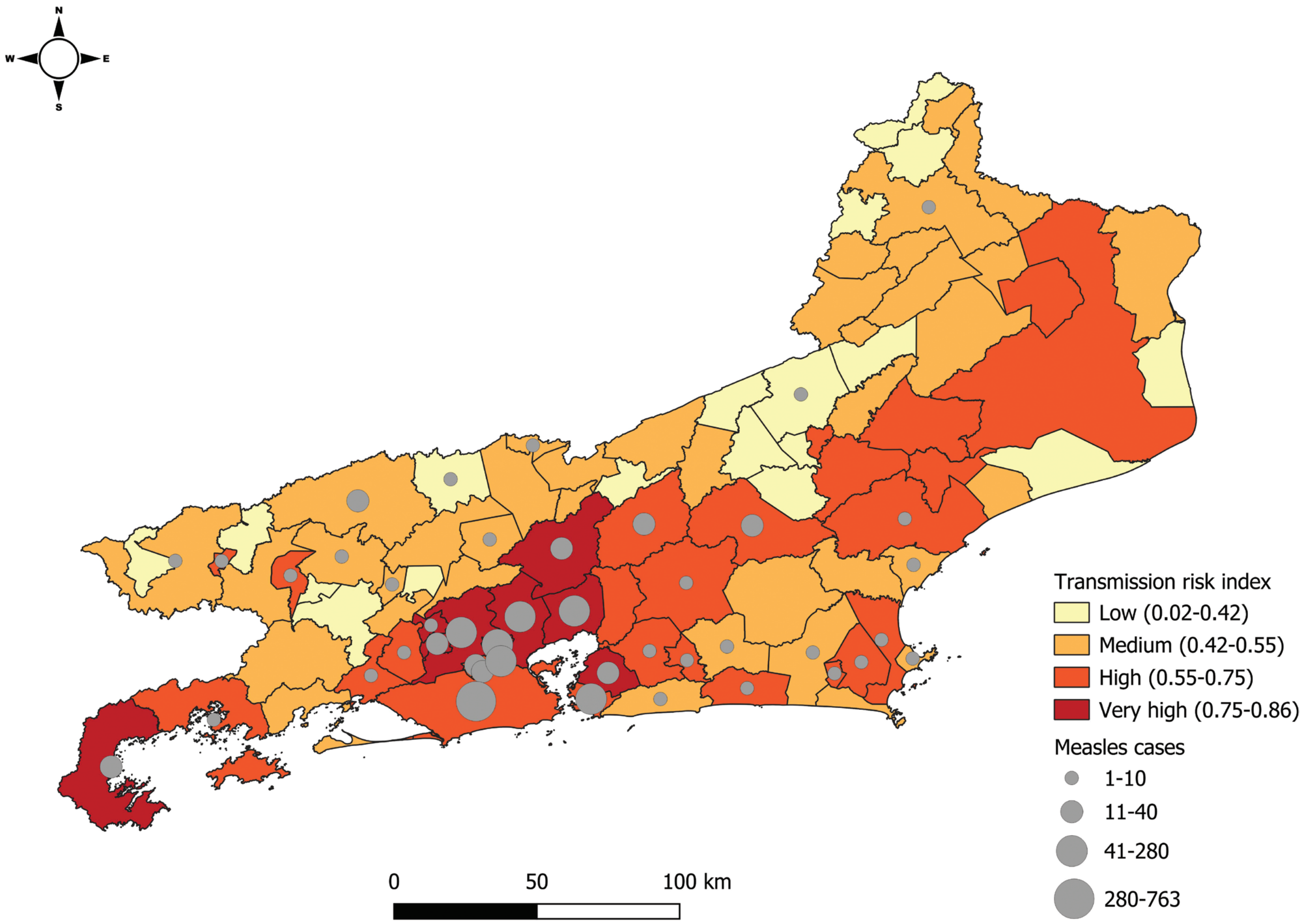
In Brazil, the only known application of the WHO/CDC tool to date was in 2017 with data from 184 municipalities in the state of Ceará, in north-eastern Brazil (5). In that study, the authors made adaptations by introducing the organizational structure category for public health response, which included indicators of coverage by the Family Health Strategy and by

TABLE 3. Weighting of categories used for the calculation of measles transmission risk areas in the state of Rio de Janeiro, Brazil

Category	Weight, %	Rationale
Vaccination	40	The vaccination category received the highest proportion of risk points and presents the set of indicators used to characterize population immunity and, consequently, overall susceptibility to measles. Additionally, this category is relevant for evaluating the performance of the immunization program and assessing aspects of immunization service delivery.
Threat assessment	30	Indicators in the threat category include factors that have been identified as likely contributors to the potential importation and transmission of the measles virus within a population.
Quality of health services	15	The indicators in this category assess access to health care services, whether they are provided continuously and coordinated over time, in addition to evaluating the outcomes achieved in health promotion and disease treatment/control. When barriers to access exist, such as geographical difficulty, financial constraints, or lack of health information, the population becomes more vulnerable to disease. Lack of access to health care services hinders proper vaccination, early diagnosis, and adequate treatment of measles, thus increasing the risk of disease spread and negatively affecting population health.
Living conditions	15	The indicators in this category assess unfavorable living conditions, such as lack of basic sanitation, overcrowding, and poverty, which can increase the risk of measles transmission and the severity of outbreaks.

Source: Adapted by the authors from Lam et al., 2017 (6).

FIGURE 1. Spatial overlay of the measles transmission risk index and absolute frequency of measles cases during the epidemic period (2018–2020) in municipalities in the state of Rio de Janeiro, Brazil



Source: Prepared by the authors based on the study results.

TABLE 4. Frequency of measles cases and measles incidence, by risk classification in the state of Rio de Janeiro, Brazil, 2018–2020

Risk classification	Population, n	Absolute case frequency, n	Relative case frequency, %	Incidence, per 100 000 inhabitants
Very high risk	4 668 875	747	41.9	16.0
High risk	10 375 436	988	55.4	9.5
Medium risk	1 637 243	46	2.6	2.8
Low risk	634 013	3	0.2	0.5

Source: Prepared by the authors based on the study results.

community health workers. Additionally, three categories were created: (i) impact, which gathered information on indicators of malnutrition and infant mortality; (ii) quality of immunization programs and epidemiological surveillance, which gathered information on indicators of vaccine coverage by doses, dropout rate, and notification rate of exanthematous diseases; and (iii) municipal characteristics, which gathered information on indicators of tourism, violence, urbanization, vulnerability, Human Development Index, and municipal resources spent on health. Thus, both the proposition and the criteria for selecting indicators that compose the risk index were adapted to characterize the state context (5). The study further demonstrated that 94.7% of the cases during the 2013–2015 epidemic period in Ceará state occurred in municipalities classified as high or very high risk, a proportion slightly lower than the 97.3% observed in our study (5).

In the Region of the Americas, another experience in analyzing the risk of measles transmission was a study in Chile, where the authors developed a risk matrix to assess the ongoing risk of outbreaks of measles and rubella associated with the importation of cases. However, the authors did not validate the method through spatial overlap of cases and incidence rates (18). On the other hand, a study in Namibia evaluated the WHO risk assessment tool using data from a measles outbreak that occurred in 2009 (26). In this study, the authors compared districts classified as high risk based on 2006–2008 data with the incidence of the disease during the 2009 outbreak. The authors concluded that districts classified as high or very high risk based on 2006–2008 data generally experienced higher measles incidence during the outbreak in 2009. This pattern was also observed in several districts categorized as medium or low risk (26).

Recently, a systematic review of scientific publications on experiences in applying methods of stratification of measles transmission risk areas worldwide concluded that, despite the relevance of the topic, such experiences are still not well disseminated (12). This limitation restricts our ability to compare our findings with those of other studies conducted in countries that have successfully achieved measles elimination. Therefore, our study represents a new reference in the state of Rio de Janeiro, whose findings can support disease surveillance, either by identifying the priority municipalities at the regional level or by providing opportunities to discriminate, at the local level, the categories and indicators that contribute to the municipality's higher risk classification. Furthermore, this analysis can support managers to develop actions aimed at addressing aspects of measles transmission other than immunization.

In our study, some indicators initially intended to be used in the four categories were not included in the final matrix due to the unavailability of data at the municipal level, such as those related to the flow of national and international tourists and intermunicipal mobility. This highlights the need for investment in the systematic production of secondary data to better qualify the processes of infectious disease transmission with adequate quality and coverage for this level of analysis. This aspect has been identified in other studies as a limiting factor for the application of methods for stratifying areas of measles transmission (7, 18, 26, 27).

Another limitation was the use of outdated population estimates as denominators for many of the indicators. Given the delay in conducting and releasing data from the Brazilian demographic census of 2022, intercensal estimates based on population growth between the censuses of 2000 and 2010 were used, which may have resulted in inaccuracies in the indicators. Similarly, it is important to consider the use of outdated indicators of living conditions which came from the 2010 census.

Finally, it should be again noted that this tool is not predictive and should be used to guide strategies in priority municipalities threatened by the emergence of the measles virus. In the face of inadequate vaccination coverage, aspects such as living conditions, quality of health services, and indicators of threat (population density and transmission in neighboring municipalities) should be considered in disease prevention and control strategies. In this regard, it is important to highlight the need for intersectoral and coordinated actions between the surveillance systems of border municipalities located in areas classified as high and very high risk, to guide planning efforts aimed at achieving and maintaining disease elimination goals.

Conclusion

The findings of our study reinforce the importance of developing and implementing tools for stratifying measles risk areas to highlight border regions requiring greater intermunicipal coordination for surveillance and achievement of elimination goals. The spatial overlap of high and very high-risk areas with cases from the subsequent period demonstrated the method's effectiveness in identifying vulnerabilities associated with transmission other than low vaccine coverage, such as precarious living conditions, poor quality of health care services, and factors associated with importation of cases.

Author contributions. YTS, HLP, ASP, and GG conceived the idea for the study. HLP, ASP, and GG designed the study. YTS, PBC, and LNMR collected and analyzed the data. YTS, HLP, ASP, and GG interpreted the findings. YTS and HLP drafted the manuscript. GG and ASP critically reviewed the manuscript. All authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

Conflicts of interest. None declared.

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Elaboración de mapas de las áreas prioritarias para la vigilancia del sarampión: estratificación del riesgo de reintroducción y transmisión en Río de Janeiro (Brasil)

RESUMEN

Objetivo. Estratificar las zonas que presentan riesgo de transmisión del sarampión en el estado de Río de Janeiro mediante la herramienta de evaluación del riesgo elaborada por la Organización Mundial de la Salud y los Centros para el Control y la Prevención de Enfermedades, con las debidas adaptaciones al contexto regional.

Métodos. Para este estudio ecológico se tomaron como unidades de análisis los municipios del estado de Río de Janeiro. El riesgo general de transmisión del sarampión se evaluó mediante las puntuaciones de los indicadores agrupados en cuatro categorías: vacunación, evaluación de amenazas, calidad de los servicios de atención de salud y condiciones de vida. Después de sumar y estandarizar las puntuaciones de cada categoría, se aplicó una ponderación para obtener el índice de riesgo. Se usaron los percentiles 20, 60 y 90 como puntos de corte para clasificar los municipios como de riesgo bajo, mediano, alto y muy alto. Para evaluar el desempeño del índice de riesgo de transmisión del sarampión, se realizó una superposición espacial con los casos notificados en el periodo epidémico 2018-2020.

Resultados. Se observó un aumento progresivo de las tasas de incidencia de casos de sarampión en todos los municipios, que correspondía a un incremento del riesgo de transmisión en los diferentes estratos. Alrededor del 97% de los casos de sarampión se produjeron en municipios clasificados como de riesgo alto o muy alto, ubicados en su mayor parte en la región metropolitana del estado.

Conclusión. Dado el posible riesgo de transmisión del sarampión durante el periodo posterior a la eliminación, nuestros resultados destacan la importancia de diseñar y aplicar herramientas para determinar las zonas en las que la vigilancia debe ser prioritaria. La superposición espacial indicó la efectividad del método para detectar vulnerabilidades asociadas a la transmisión que se deben a factores distintos de la baja cobertura vacunal, como la precariedad de las condiciones de vida y la mala calidad de los servicios de atención de salud.

Palabras clave: Sarampión; medición de riesgo; incidencia; monitoreo epidemiológico; Brasil.

Mapeamento de áreas prioritárias para a vigilância do sarampo: estratificação do risco de reintrodução e transmissão no Rio de Janeiro, Brasil

RESUMO

Objetivo. Estratificar as áreas com risco de transmissão de sarampo no estado do Rio de Janeiro, utilizando a ferramenta de avaliação de risco desenvolvida pela Organização Mundial da Saúde e pelos Centros de Controle e Prevenção de Doenças dos Estados Unidos, com adaptações para o contexto regional.

Métodos. Estudo ecológico cujas unidades de análise foram municípios do estado do Rio de Janeiro. Avaliou-se o risco global de transmissão do sarampo com base nas pontuações de indicadores agrupados em quatro categorias: vacinação, avaliação de ameaças, qualidade dos serviços de saúde e condições de vida. Depois de somar e normalizar as pontuações em cada categoria, os dados foram ponderados para gerar o índice de risco. Os percentis de 20%, 60% e 90% foram usados como pontos de corte para classificar os municípios como de baixo, médio, alto e muito alto risco. Para avaliar o desempenho do índice do risco de transmissão do sarampo, foi feita uma análise de sobreposição espacial dos casos registrados no período epidêmico de 2018 a 2020.

Resultados. Foi observado um aumento progressivo nas taxas de incidência do sarampo nos municípios, que correspondia ao risco crescente de transmissão em diferentes estratos. Cerca de 97% dos casos ocorreram em municípios classificados como de alto ou muito alto risco, situados principalmente na região metropolitana do estado.

Conclusão. Dado o potencial risco de transmissão do sarampo durante o período pós-eliminação, nossos resultados reforçam a importância de desenvolver e implementar ferramentas para identificar áreas prioritárias para a vigilância. A análise de sobreposição espacial dos casos indicou a eficácia do método na identificação de vulnerabilidades associadas à transmissão que não uma baixa cobertura vacinal, como condições de vida precárias e má qualidade dos serviços de saúde.

Palavras-chave: Sarampo; medição de risco; incidência; monitoramento epidemiológico; Brasil.