CUIDADO É FUNDAMENTAL

YELLOW FEVER VACCINE COVERAGE MONITORING AND EVALUATION: INTEGRATIVE REVIEW

Monitoramento e avaliação da cobertura vacinal da vacina contra febre amarela: revisão integrativa

Monitoreo y evaluación de la cobertura vacunal de la vacuna contra la fiebre amarilla: revisión integradora

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ABSTRACT

Objective: to describe strategies for monitoring and evaluating vaccination coverage of yellow fever (YF) vaccine in Brazil. **Method:** integrative review in the Lilacs, BDENF, Medline and SciELO databases. Boolean and truncation operators were used to build the search strategy based on the keywords: Monitoring; Assessment; Vaccination coverage; Yellow fever. Five articles were selected. **Results:** strategies for monitoring vaccination coverage of the YF vaccine were identified (e.g. calculations of vaccination coverage and doses applied; Rapid Monitoring of Vaccination Coverage, among others). As well as evaluation strategies (e.g. reaching the coverage target recommended; number of confirmed cases of AF, among others). **Conclusion:** in addition to achieving the objective, with the construction of a summary table, it was possible to observe a limitation in the number of articles found and a lack of development in studies in this area.

DESCRIPTORS: Epidemiological monitoring; Vaccination; Vaccination coverage; Yellow fever; Review;

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RESUMO

Objective: descrever as estratégias de monitoramento e avaliação da cobertura vacinal de vacina contra febre amarela (FA) no Brasil. **Método:** revisão integrativa nas bases Lilacs, BDENF, Medline e SciELO. Utilizou-se operadores booleanos e de truncamento para construir a estratégia de busca a partir das palavras chaves: Monitoramento; Avaliação; Cobertura vacinal; Febre amarela. Cinco artigos foram selecionados. **Resultados:** Identificou-se estratégias de monitoramento da cobertura vacinal da vacina contra FA (ex: cálculos de cobertura vacinal e de doses aplicadas; Monitoramento Rápido de Coberturas Vacinais, entre outras). Assim como estratégias de avaliação (ex: alcance de meta da cobertura preconizada; número de casos confirmados de FA, entre outras). **Conclusão:** Além do alcance do objetivo, com construção de um quadro-síntese, pôde-se observar limitação do número de artigos encontrados e incipiência na elaboração de estudos nesta área.

DESCRITORES: Monitoramento epidemiológico; Vacinação; Cobertura vacinal; Febre amarela; Revisão;

RESUMEN

Objetivos: describir estrategias para el seguimiento y evaluación de la cobertura vacunal de la vacuna contra la fiebre amarilla (FA) en Brasil. **Método:** revisión integrativa en las bases Lilacs, BDENF, Medline y SciELO. Se utilizaron operadores booleanos y de truncamiento para construir la estrategia de búsqueda basada en las palabras clave: Monitoreo; Evaluación; Cobertura de vacunación; Fiebre amarilla. Se seleccionaron cinco artículos. **Resultados:** se identificaron estrategias para el seguimiento de la cobertura vacunal de la vacuna contra la FA (ej., cálculos de cobertura vacunal y dosis aplicadas; Monitoreo Rápido de la Cobertura Vacunal, entre otros). Así como estrategias de evaluación (ej. alcanzar la meta de cobertura recomendada; número de casos confirmados de FA, entre otros). **Conclusión:** además de lograr el objetivo, con la construcción de un cuadro resumen, se puede observar una limitación en el número de artículos encontrados y una incipiencia en el desarrollo de estudios en esta área.

DESCRIPTORES: Monitoreo epidemiológico; Vacunación; Cobertura de vacunación; Fiebre amarilla; Revisión.

INTRODUCTION

Yellow fever (YF) is an acute febrile infectious disease, vaccine-preventable, caused by an arbovirus with high lethality and rapid evolution. It is included in the national list of notifiable diseases, conditions and public health events and is reported immediately (up to 24 hours) to the Municipal Health Secretariat (SMS), the State Health Secretariat (SES) and the Ministry of Health, thus ensuring opportunities to monitor this disease.[1]

In recent years, the reduction in the number of confirmed cases of the disease has been noticeable,[2] due to several actions, including the intensification of vaccination efforts, vector control activities, and the investigation and surveillance of epizootics in non-human primates (NHP).[3]

Since 2020, based on the detection of viral circulation and confirmation of sylvatic yellow fever (SYF) cases in areas without vaccination recommendation (WVR), the Ministry of Health has applied the area with vaccination recommendation (VR) to the entire country, including the Northeast region. This action was based on the existing territorial vulnerability of this region, with an increased risk of infection, in addition to the need to prevent significant outbreaks such as those that occurred in the southeastern region.[3]

Despite the well-known importance of vaccination as a strategy to prevent disease and reduce mortality,[4] vaccination coverage has decreased in recent years in Brazil[5-7] and in the rest of the world.[8-9]

In this context, monitoring and evaluation strategies become essential to understand the variations in vaccination coverage, to provide information in specific time periods that will support the evaluation(s) of the strategies implemented and to facilitate decisions regarding their modification, completion or maintenance.[10-11]

In view of the scenario presented, it is important to describe the strategies for monitoring and evaluating the YF vaccination coverage in Brazil.

METHOD

This is an integrative review. According to Dantas et al.,[12] six steps were followed: 1) identification of the subject and selection of the research question; 2) literature search: establishment of inclusion and exclusion criteria for studies; 3) data categorization; 4) critical analysis of the included studies; and 5) data interpretation; 6) presentation of the integrative review.

For the health information search, the following research question was formulated: What strategies have been used to monitor and evaluate YF vaccination coverage in Brazil?

Data collection was performed through a paired search in the following databases: a) Latin American and Caribbean Health Sciences Literature (LILACS); b) Nursing Database (BDENF); c) Medical Literature Analysis and Retrieval System Online (Medline). All databases were accessed through the Brazilian Virtual Health Library (BVS) portal and in the Scientific Electronic Library Online (SciELO).

For the search, we used the strategy described in Chart 1, consisting of the acronym PCC, which stands for Popula-

tion (population; Brazil), Concept (concept; monitoring and evaluation of vaccination coverage) and Context (context; administration of yellow fever vaccine).

Keywords in Portuguese, English and Spanish were used, since there are studies conducted in Brazil that are published exclusively in other languages. The search strategy was tested using the keyword "Brazil" in the three languages. However, the number of articles was lower, since there are studies in Brazil that do not directly mention the name of the country in the fields searched by the search types (only the municipality and/or state are explained).

The inclusion criteria established for the studies were articles available in full, published between 2018 and 2023, with data collected in Brazilian territory, in Portuguese, English or Spanish, and answering the research question directly or indirectly. The exclusion criteria were articles from manuals and technical documents, theses and dissertations, as well as articles repeated in the databases, counted in the first database in which they appear.

A single researcher performed the search and read the title and abstract of the articles found. In cases where there was doubt about the relevance of the study after reading both, a floating reading of the full article was performed.[13] The synthesis of the selection of studies was presented in a flowchart according to PRISMA guideline.[14]

Chart 1 - Strategy for searching scientific articles. Juiz de Fora, MG, Brazil 2023

Source	Database(s)	Search Types	Search Query*
BVS	BDENF Medline Lilacs	Title, Abstract, Subject	(Monitoramento OR Avaliação OR Monitoring OR Assessment OR Evaluation OR Monitoreo OR Evaluación) AND (Cobertura$ OR Coverage) AND (Vacina$ OR Imuniza$ OR Vaccin$ OR Immuniz$) AND ("Febre amarela" OR "Yellow fever" OR "Fiebre amarilla")
SciELO	-	All	

Source: The Authors (2023).
Subtitles: BVS = Brazilian Virtual Health Library; BDENF = Nursing Database; Medline = Medical Literature Analysis and Retrieval System Online; Lilacs = Latin American and Caribbean Literature in Health Sciences; SciELO = Scientific Electronic Library Online.
*The Brazilian site was removed from the search query because the search test showed that its presence reduced the number of articles found, limiting the search scope.

In order to systematize the data collection, a spreadsheet was used in Microsoft Excel 2016 software, in which each article received an identification from the alphabet in capital letters to facilitate data visualization, according to the following dimensions, adapted from the study by Laurindo et al.[15]

After the selection of articles, the selected studies were read in full by the researcher. The qualitative analysis of the studies was based on the reflexive synthesis of the data and discussions among the authors, with the construction of thematic categories, which included the following steps: a) searching for references and reading the material to identify information relevant to the topic; b) establishing relationships between the information and the data obtained from the research question; c) analyzing the consistency of the information and data presented by the authors; and d) interpreting the demonstrated results.[12-13]

RESULTADOS

A total of 100 productions were identified in the research sources, most of which were found in BVS (96; 96%). After applying the inclusion and exclusion criteria and reading the title, abstract and full article, a total of five productions were included in the integrative review (Figure 1).

Figure 1 - Flowchart adapted from the PRISMA guideline on the process of searching and selecting articles. Juiz de Fora, MG, Brazil 2023
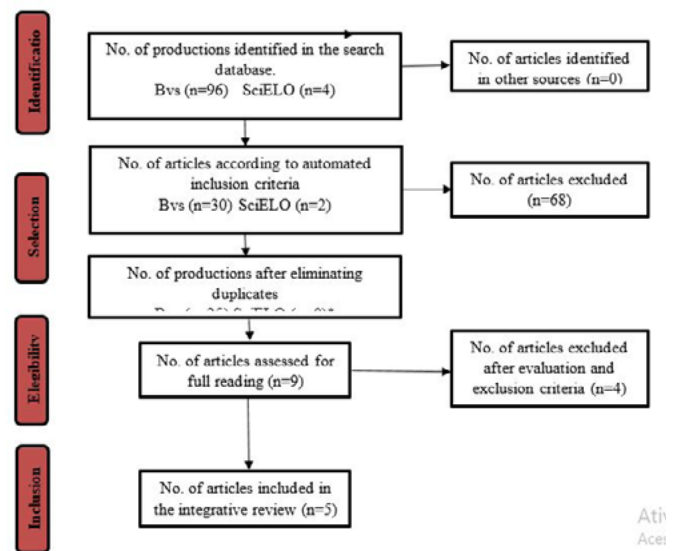
Source: The Authors (2023).
Subtitles: No. = number; BVS = Brazilian Virtual Health Library; SciELO = Scientific Electronic Library Online.
*The two productions found in SciELO were also found in BVS and were therefore treated as duplicates and excluded from the count.

Of the total number of scientific articles included the year with the highest number of publications was 2019 (2; 40%), and no articles published in 2021 and 2023 were included. All articles included in the review were found in the BVS and most of them are indexed in Medline (4; 80%). Two articles (40%) were published in Portuguese and English.

It was observed that most of the articles indirectly mentioned monitoring and/or evaluation strategies, and only two articles presented strategies for both (Chart 2). In order to socialize the strategies in the professional field, a summary table of potential monitoring and evaluation strategies was developed (Chart 3).

Chart 2 - Data on articles included by status and strategies for monitoring and evaluating vaccination coverage of yellow fever vaccine. Juiz de Fora, MG, Brazil 2023

Article title	Authorship and Publication Year	Publication Journal**	Status of mention of monitoring and/or evaluation strategy(s)	Strategies for the monitoring and evaluation of YF vaccination coverage
Bolsa Família Program and Incomplete Childhood Vaccination in Two Brazilian Cohorts	Silva et al. (2020)	Rev Saude Publica	Indirect	**Monitoring:** number of children aged 13 to 35 months whose guardians are beneficiaries of the Bolsa Família program*** (taking into account the recommendation of vaccination at 09 months).
Epidemiological monitoring of the last outbreak of yellow fever in Brazil - An outlook from Portugal	Selemane (2019)	Travel Med Infect Dis	Indirect	**Evaluation:** i) number of confirmed cases of YF, deaths from the disease and mortality among unvaccinated individuals; ii) number of preventive mass vaccination campaigns (MVCP) in risk areas (all/most age groups); iii) number of vaccination campaigns targeting unprotected subpopulations (e.g., forest workers); iv) number of private sector companies (forestry, transportation, mining, construction, etc.) involved in vaccination campaigns
Prevention and control of yellow fever: evaluation of surveillance activities in an unaffected area of Brazil	Gava et al. (2022)	Cad Saude Publica	Direct	**Monitoring:** i) doses received and administered (of YF vaccine); ii) events suspected to be due to vaccination or immunization (ESAVI) (of YF vaccine); iii) rapid vaccination monitoring (RVM) for YF vaccine; iv) house-to-house YF vaccination (scan intensification). **Evaluation:** i) Number of timely immunization activities; number of mass immunization activities (in football stadiums, large clubs, pavilions and universities); achievement of the 95% coverage target for YF vaccine recommended by the Ministry of Health.

Chart 2 - - Data on articles included by status and strategies for monitoring and evaluating vaccination coverage of yellow fever vaccine. Juiz de Fora, MG, Brazil 2023

Article title	Authorship and Publication Year	Publication Journal**	Status of mention of monitoring and/or evaluation strategy(s)	Strategies for the monitoring and evaluation of YF vaccination coverage
Use and loss of vaccine doses in the metropolitan region of Porto Alegre, Rio Grande do Sul: a descriptive study from 2015-2017	Mai et al. (2019)	Epidemiol Serv Saude	Direct	**Monitoring:** Vaccine Utilization Rate (TU) **Utilization Rate (UR)** = {A / [(B + C) - D]} *100. Where A: Number of doses administered; B: Number of usable doses at the beginning of the period; C: Number of usable doses received during the period; D: Number of usable doses in stock at the end of the period. **Loss rate (LR)** = {[(A + B) - (C+D)] / [(A+B) - C]} *100. Where A: number of usable doses at the beginning of the period; B: number of usable doses received during the period; C: number of usable doses in stock at the end of the period; D: number of doses administered. With a recommendation of a maximum of 25% for YF.
Yellow fever outbreak in Brazil: the puzzle of rapid viral spread and challenges for immunisation	Possas et al. (2018)	Mem Inst Oswaldo Cruz	Indirect	**Monitoring:** Number of NHP in surveillance areas (parks, reserves and zoos) vaccinated against YF. **Evaluation:** number of unvaccinated adults confirmed to have YF; number of unvaccinated rural workers suspected and confirmed to have YF; number of media campaigns on the importance of YF vaccination

Source: The Authors (2023).
*Authorship has been inserted according to the recommendations of the ABNT standards, using "et al." when there are four or more authors;
**Journal titles have been presented in abbreviated form; Although the study did not find an association between the variables, it remains a possible strategy to be used, with the necessary caveats.
Subtitles: YF = yellow fever; n = number; NHP = non-human primates (tamarins, monkeys, etc.).

Chart 3 - Summary table of potential strategies for monitoring and evaluating yellow fever vaccine coverage. Juiz de Fora, MG, Brazil 2023

Monitoring Strategies	Evaluation Strategies
•Absolute attendance of children aged 13 to 35 months whose guardians are beneficiaries of the Bolsa Família program* (taking into account the recommendation to vaccinate at 09 months); •Doses received and administered (of YF vaccine); •Events Suspected to be Associated with Vaccination or Immunization (ESAVI) (of YF vaccine); •Rapid vaccination monitoring (RVM) for YF vaccine; •House-to-house vaccination against YF (intensification of scanning); •Vaccine uptake and dose loss rates: •Utilization rate (UR) = {A / [(B + C) - D]} *100. Where A: number of doses administered; B: number of usable doses at the beginning of the period; C: number of usable doses received during the period; D: number of usable doses in stock at the end of the period. •Loss rate (LR) = {[(A + B) - (C+D)] / [(A+B) - C]} *100. Where A: number of usable doses at the beginning of the period; B: number of usable doses received during the period; C: number of usable doses in stock at the end of the period; D: number of doses administered. With a recommendation of a maximum of 25% for atrial fibrillation. •Absolute frequency of NHP from monitored areas (parks, reserves and zoos) vaccinated against YF.	•Absolute frequency of confirmed cases of YF, deaths from the disease and mortality in unvaccinated individuals; •Absolute frequency of preventive mass vaccination campaigns (MPVC) in risk areas (all/most age groups); •Absolute frequency of vaccination campaigns targeting unprotected subpopulations (e.g., forest workers); •Absolute frequency of private sector companies (forestry, transport, mining, construction, etc.) involved in vaccination campaigns; •Absolute frequency of timely vaccination campaigns; •Absolute frequency of mass vaccination campaigns (in football stadiums, large clubs, pavilions and universities); •Achievement of the 95% coverage target for YF vaccine recommended by the Ministry of Health; •Absolute frequency of adults with confirmed YF who were not vaccinated; •Absolute frequency of suspected and confirmed cases of YF in agricultural workers who were not vaccinated; •Absolute frequency of media campaigns on the importance of YF vaccination.

Sources: The Authors (2023).
*Although the study supporting this potential strategy did not find an association between the variables, it remains a possible strategy to be used with the necessary caveats.
Subtitles: YF = yellow fever; NHP = non-human primate.

DISCUSSION

Strategies for monitoring YF vaccination coverage in Brazil

Regarding the strategies for monitoring the coverage of the YF vaccine in Brazil, it was possible to retrieve contributions from the articles published by Gava et al.[16] and Mai et al.[17], directly, and Possas et al.18 and Silva et al.[19], indirectly.

The articles that could be cited directly are characterized by the application of surveillance strategies in the context of immunization, with direct reference to the YF vaccine. Gava et al.16 directly mention four surveillance strategies. The first

is the traditional calculation of vaccination coverage, with stratification of doses received and applied, to monitor the implementation of vaccination within a given territory, and is commonly used in other studies.[5,6]

About this strategy, Mai et al.[17] make an important contribution by emphasizing the need to work not only with vaccination coverage and the absolute number of doses, but also with the calculation of vaccine use and dose loss rates.

The second strategy proposed by Gava et al.[16] is the survey of Events Supposedly Attributable to Vaccination or Immunization (ESAVI) (of the YF vaccine), which is presented by Gava et al.16 as being of fundamental importance because

the increase in ESAVI without adequate management of the population can negatively affect acceptance and directly contribute to the phenomenon of vaccine hesitancy,[7,9,20-21] and the correct dissemination of information by health service teams and municipal and state secretaries is a shared responsibility.

The third, also traditionally implemented, is the implementation of RVM, a strategy used in other productions, as can be seen in the studies of Moura et al.[22] and Nascimento et al.[23] The last one is the implementation of house-to-house vaccination, in a scan format, both strategies described here, essential for a better understanding of the vaccination status of the population of the territory and for monitoring the performance of immunization actions.[24]

In addition to these strategies, which can be considered the main ones, Silva et al.[19] studied the relationship between vaccination coverage, including the YF vaccine, among children aged 13 to 35 months whose parents or guardians are beneficiaries of the Bolsa Família program, taking into account the recommendation of vaccination at nine months and the obligation to be up to date with the vaccination schedule to access the benefit. However, the study found that there was no association between vaccination coverage and being a beneficiary of the Bolsa Família Program, so it is not a good indicator for monitoring, but remains as a contribution.

Finally, Possas et al.[18] indirectly bring, in a complementary way to the monitoring of the coverage of the YF vaccine in humans, the coverage of the vaccine in NHP in monitored areas, i.e. parks, reserves and zoos, being a strategy that is still incipient and not so widespread in Brazil·

Strategies to assess YF vaccine coverage in Brazil
Regarding the strategies for evaluating the coverage of the YF vaccine in Brazil, it was possible to retrieve contributions from the articles published by Gava et al.[16], directly, and by Possas et al.[18] and Selemane[25], indirectly.

Gava et al.[16] highlight three strategies for evaluating vaccination coverage, the first being the number of timely vaccination actions, the higher the better, which opens the possibility for each locality to develop its own concept of opportune time, but aware that before the Ministry of Health, the opportunity for action will always be immediate and premeditated, that is, immediately after the identification of a sentinel event or even before it occurs.

The second strategy proposed by Gava et al.[16] is the number of actions of mass preventive vaccination campaigns (MPVC) that take place in football stadiums, large clubs, pavilions or even in universities, and in principle, the higher the number, the better the evaluation of the coverage. In this respect, Selemane[25] also offers the possibility of stratifying the performance of these campaigns according to risk areas or even targeting unprotected subpopulations (e.g. forest workers) to have a more sensitive evaluation. However, as emphasized by Jesus et al.,[26] mass vaccination campaigns should be accompanied by strategies to raise public awareness and to improve sani-

tary control, since both would have a more lasting effect in the long term.

The third strategy is the traditional one, related to the comparison of vaccination coverage with the target recommended by the Ministry of Health for the YF vaccine, which is 95%.[24]

Indirectly, as suggested by Possas et al.[18] and Selemane[25], it is also possible to evaluate the coverage of the YF vaccine based on the number of confirmed cases of YF, deaths from the disease and lethality in unvaccinated individuals, since vaccination is the main strategy for preventing the disease and reducing mortality.[4] It is also possible to stratify for populations at higher risk of infection, such as rural workers.

Other ways to assess, albeit indirectly, the coverage of the YF vaccine are to survey the number of private sector companies (forestry, transportation, mining, construction, etc.) involved in vaccination campaigns and the number of media actions on the importance of YF vaccination,[18,25] since the greater the number of both, the possibility of favoring the adequacy of vaccination coverage based on a greater reach of the population is understandable and thus more effective.

CONCLUSION

From the integrative review conducted, it was possible to describe the strategies for monitoring and evaluating the coverage of the YF vaccine in Brazil, with the elaboration of a synthesis table that has the potential to contribute to the dissemination of information among researchers, managers and health professionals in Brazil.

Regarding the direct strategies for monitoring the coverage of YF vaccine in Brazil, the following were identified: i) calculations of coverage and doses administered; ii) RVM; iii) intensification of vaccination; iii) ESAVI survey; and iv) use and loss fees. Indirect strategies: i) number of NHP of monitored areas (parks, reserves and zoos) vaccinated against YF; and ii) the possibility of using the number of children aged 13 to 35 months whose guardians are beneficiaries of the Bolsa Família program.

In terms of direct strategies to evaluate the coverage of YF vaccine in Brazil, the following were identified: i) number of timely vaccination campaigns; ii) number of mass vaccination campaigns (in soccer stadiums, large clubs, pavilions and universities); iii) achievement of the 95% coverage target for YF vaccine recommended by the Ministry of Health. On the other hand, in an undirect way: i) the number of confirmed cases of YF, deaths from the disease and lethality in unvaccinated individuals, which can be stratified by risk groups (e.g. rural workers); ii) the number of MPVCs targeting unprotected subpopulations (e.g. forestry workers) or areas at risk; iii) the number of private sector companies (forestry, transport, mining, construction, etc.) involved in vaccination campaigns.

Despite the results, there was a limitation in the number of articles that met the inclusion and exclusion criteria, in addition to identifying an even smaller number of articles

that directly mentioned the strategies that were the subject of this study. Besides, it was possible to see, amid the productions, the inception of the elaboration of monitoring and evaluation studies regarding the coverage of the vaccine against yellow fever.

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