

# Assessment of compliance regarding the first dose of the MMR vaccine, after the 2012 update of the Portuguese National Vaccination Program: a cross-sectional study in a Portuguese central hospital

Leonor Veiga<sup>1\*</sup>  and Filipa Prata<sup>2</sup> 

<sup>1</sup>Departamento do Tórax, Serviço de Pneumologia, Hospital de Santa Maria; <sup>2</sup>Departamento de Pediatria, Serviço de Pediatria Médica, Unidade de Infeciologia Pediátrica, Unidade Local de Saúde, Hospital de Santa Maria. Lisbon, Portugal

## Abstract

**Introduction and Objectives:** In 2012, the Portuguese National Vaccination Program (PNVP) brought the first dose of the measles, mumps and rubella (MMR) vaccine forward, from 15 to 12 months. The main objectives of this study were to assess compliance with this recommendation and to identify which factors may be associated with incorrect vaccination. **Methods:** An observational cross-sectional study was conducted through anonymous surveys, delivered by hand, to caregivers of children attending the Pediatric Emergency Department of a Lisbon Public Hospital (PERLPH) between January and March 2023. Sociodemographic characteristics, the timing of the first MMR dose, and reasons for delay/non-vaccination were analyzed. An information leaflet on the 2020 PNVP and false contraindications was provided. **Results:** A total of 203 caregivers participated. Out of the children, 40.4% were immigrants or had immigrant parents; 95.6% resided in the Lisbon district and were aged between 13 months and 11 years old. Although 93.1% had received the first MMR dose, 27.1% were vaccinated with an average delay of 2.24 months. A statistically significant link between the immigrant population and the delay with the first MMR dose was identified ( $p$  value = 0.012). **Discussion:** Vaccination coverage at 12 months of age with the first MMR dose, in the studied population, was below the recommended threshold. Immigrant status, municipality of residence, and contextual national and international factors may impact vaccination rates. These findings underscore the need for targeted information campaigns and strategies to promote timely vaccination, particularly among vulnerable populations.

**Keywords:** PNVP. MMR. Compliance. Delay.

## *Avaliação do cumprimento da primovacinação com a VASPR, após a atualização de 2012 do Programa Nacional de Vacinação: um estudo transversal num hospital central português*

## Resumo

**Introdução e Objetivos:** Em 2012, o Programa Nacional de Vacinação (PNV), da Vacina contra o Sarampo, Parotidite Epidémica e Rubéola (VASPR) adiantou a primeira dose dos 15 para os 12 meses de idade. Os principais objetivos deste estudo foram avaliar: o cumprimento da primovacinação com a VASPR, aos 12 meses de idade; quais os fatores relacionados com

### \*Correspondence:

Leonor Veiga

E-mail: leonor.veiga@ulssm.min-saude.pt

2184-3333 / © 2025 Portuguese Society of Pediatrics. Published by Permayer. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Received: 20-07-2024

Accepted: 17-10-2025

<https://pjp.spp.pt>

Available online: 15-01-2026

Port J Pediatr. 2026;57(2):84-91

DOI: 10.24875/PJP.24000070

a sua vacinação incorreta. **Métodos:** Estudo observacional, transversal, realizado através da aplicação de um inquérito anónimo, entregue em mão, aos acompanhantes das crianças que se dirigiram ao Serviço de Urgência Pediátrica de um Hospital Público de Lisboa, entre janeiro e março de 2023. Analisaram-se os parâmetros sociodemográficos, realização da primeira dose da VASPR e razões do possível atraso/não realização. Entregou-se um folheto informativo com o esquema vacinal mais recente e falsas contraindicações das vacinas. **Resultados:** Participaram 203 acompanhantes, sendo 40,4% das crianças imigrantes ou com pais imigrantes; 95,6% residiam no distrito de Lisboa, com idade compreendida entre os 13 meses e os 11 anos. Embora 93,1% tenham feito a primeira dose da VASPR, 27,1% realizaram com um atraso médio de 2,24 meses. Verificou-se uma relação estatisticamente significativa entre a população imigrante e o atraso na primovacinação com a VASPR ( $p$  value = 0,012). **Discussão:** A cobertura vacinal com a primeira dose da VASPR aos 12 meses, na população estudada, encontra-se abaixo do limite recomendado. O concelho de residência, ser integrante da população imigrante e os contextos nacionais e internacionais, podem influenciar a cobertura vacinal. Assim, é importante a implementação de campanhas de informação e estratégias para promover a vacinação atempada, principalmente em populações vulneráveis.

**Palavras-chave:** PNVP. VASPR. Cumprimento. Atraso.

## Keypoints

### What is known

- A vaccination coverage against measles of at least 95% is required to meet the herd immunity threshold to achieve and sustain measles elimination.
- Socioeconomic factors, health or military crises, and disin-formation campaigns can affect vaccination coverage rates in a population.
- Portugal has an MMR vaccination rate above 95%.

### What is added

- The immigrant population is unequally covered compared to the non-immigrant population in terms of vaccination with the first dose of the MMR vaccine.
- Vaccination rates, when calculated using data from primary health care centers (PHCC), may be overestimated.
- The vaccination rate of the population in this study was < 95%.

## Introduction

The Portuguese Nacional Vaccination Program (PNVP) was established in 1965 as universal, free of charge, and accessible to all Portuguese citizens.<sup>1</sup> Vaccination of children under 16 years of age requires the presence of the individual who has custody of the minor or to whom the minor has been entrusted, and it is possible to refuse vaccination, with all or any one vaccine.<sup>1</sup> The measles, mumps and rubella (MMR) vaccine is a trivalent live attenuated vaccine, which is included in the World Health Organization (WHO) immunization schedule and protects against three viral infections that generally occur in childhood.<sup>2</sup> In 1974, the first combined MMR vaccine was added to the WHO immunization program.<sup>3</sup>

According to the most recent WHO recommendations, the first dose of the MMR vaccine should be administered between nine and 15 months of age, with the second dose given either at least 28 days later or between four and 10 years of age. Two doses of the MMR vaccine are associated with a seroconversion rate of 95-98%.<sup>4</sup> Globally, between 2000 and 2019 vaccination coverage rates for the first dose of the measles vaccine increased from 72% to 85%, and from 18% to 71% for the second dose. Between 2000 and 2017, the annual incidence of measles reduced by 83%

and mortality reduced by 80%.<sup>4</sup> In Portugal, the measles vaccination was included in the PNVP in 1973. Later, in 1987, the MMR vaccine was added to the PNVP, initially with a single dose at 15 months of age, and a second dose, administered between five and six years of age, was added three years later.<sup>5</sup> Through universal MMR vaccination, Portugal achieved measles and mumps elimination status in 2017, as verified by the WHO European Regional Commission for Verification of the Elimination of Measles and Rubella.<sup>6</sup>

In the 2012 PNVP update, the age to administer the first dose of the MMR vaccine was changed from 15 to 12 months.<sup>7</sup> Since then, various social, political, and public health developments may have affected the optimal timing of vaccination. Although European countries have high vaccination rates, over the last two decades, there has been a reemergence of measles outbreaks, with several European Union (EU) member states experiencing renewed community transmission of measles, mumps, and rubella.<sup>2,3,8</sup> One of the main reasons has been the growth of anti-vaccine movements and the decline in children's vaccination adherence due to parental refusal.<sup>9</sup> The COVID-19 pandemic may have introduced new concerns about vaccines, although Portugal continues to have the highest levels of confidence in vaccines in Europe.<sup>10,11</sup>

The objectives of this study were to evaluate compliance with MMR vaccination following the 2012 update of the PNVP, and to identify factors that may be associated with incorrect vaccination.

## Methods

An observational, cross-sectional study was carried out through the application of an anonymous, voluntary survey, to a convenience, random sample of children's parents or caregivers who went to the Pediatric Emergency Department of one of Lisbon's public hospitals (PERLPH) between January and March 2023.

The study included children born between January 2012 and March 2022, and considered the updated 2012 scheme recommended by the PNVP regarding the first dose of the MMR vaccine. Questionnaires (Supplementary data) were delivered in person to caregivers who accompanied children to the PERLPH, between the ages of one year and 11 years and two months, and those caregivers were asked by the main investigator to review the Vaccination Bulletin (VB). The VB of these children was analyzed and, if unavailable, their vaccination calendar was consulted on the Health Data Platform. Participation was voluntary, although an informed consent form had to be signed prior to survey completion.

The confidentiality of the data obtained was respected. Ethical issues were considered during the course of this study, and it was approved by the Ethics Committee of the Institution where this study took place and the Medical Academic Center of Lisbon. Data collection took place over a period of three months, between January 10 and March 16, 2023.

The exclusion criteria were the absence of a signed informed consent form and data that was incomplete or poorly collected.

Sociodemographic data was collected, including the child's nationality (Portuguese, Brazilian, Sao Tomean, Angolan, Cape Verdean, Colombian, Chinese, Moroccan, Ukrainian, Russian, Algerian, French, and Turkish), date of birth (from January 2012 to March 2022), county of residence (Lisbon, Amadora, Odivelas, Loures, Sintra, Oeiras, Almada, Torres Vedras, Mafra, Salvaterra de Magos, Grândola, Cascais, Olhão, Alenquer, Seixal, Crato, Setúbal, Moita, and Vila Franca de Xira), and whether there was a delay or failure in being administered the primary MMR vaccination.

In cases of delayed vaccination, the duration of the delay in months and the underlying reasons for the delay or non-vaccination were documented. A vaccination delay was considered to be when the first dose of

the MMR vaccine was administered after 12 months and 30 days of age. Primary MMR vaccination failure was defined as the absence of any documented administration of the vaccine. Incorrect vaccination was defined as when a vaccination delay or failure occurred.

Children who were born and/or whose parents were born outside the national territory were considered as immigrant population. Children who were born in Portugal and whose parents were also born in Portugal were considered as non-immigrant population.

The collected data was analyzed using the "Statistical Package for the Social Sciences" program (SPSS, Chicago, IL, USA), version 28.0 for Windows.

As this was predominantly an exploratory study, descriptive statistics were applied, including absolute and relative frequencies and measures of central tendency (average). To assess the independence of variables, a Chi-Square test ( $\chi^2$ ) was performed to compare the immigrant and non-immigrant population regarding vaccination with the first MMR dose within or after 12 months and 30 days of age. A p value of  $< 0.05$  was considered statistically significant.

## Results

During the survey period, 211 caregivers were contacted, of whom eight declined to participate. Between January and March 2023, 203 surveys were included in the study, comprising 121 (59.6%) children of the non-immigrant population and 82 (40.4%) of the immigrant population. The sociodemographic characteristics of the population are presented in [table 1](#).

In the studied population, 27.1% of children received the first dose of the MMR vaccine after 12 months and 30 days of age, with a minimum delay of one and a maximum of nine months, with an average delay of 2.24 months.

Out of the total population of this study ( $n = 203$ ), born between January 2012 and March 2023, 14 (6.9%) children had not been vaccinated with the first dose of the MMR vaccine whereas 189 (93.1%) were vaccinated. Overall, 72.9% of the population received primary vaccination at the recommended age (12 months and zero to 30 days of age, according to the current PNVP). Among the unvaccinated children, 92.9% ( $n = 13$ ) were from the immigrant population.

The three main reasons reported by caregivers for the delayed or non-administration of the first dose of the MMR vaccine were: no known reason (43.6%), lack of awareness of the PNVP (20%), and absence of a family doctor or difficulty scheduling an appointment

**Table 1.** Sociodemographic characteristics of the studied population

| Variable                                |             | Absolute value | %    |
|-----------------------------------------|-------------|----------------|------|
| Year of birth                           | 2012        | 12             | 5.9  |
|                                         | 2013        | 14             | 6.9  |
|                                         | 2014        | 11             | 5.4  |
|                                         | 2015        | 25             | 12.3 |
|                                         | 2016        | 15             | 7.4  |
|                                         | 2017        | 24             | 11.8 |
|                                         | 2018        | 30             | 14.8 |
|                                         | 2019        | 21             | 10.3 |
|                                         | 2020        | 25             | 12.3 |
|                                         | 2021        | 22             | 10.8 |
|                                         | 2022        | 4              | 2.0  |
| County of residence                     | Lisbon      | 105            | 51.7 |
|                                         | Amadora     | 23             | 11.3 |
|                                         | Odivelas    | 20             | 9.9  |
|                                         | Loures      | 18             | 8.9  |
|                                         | Sintra      | 17             | 8.4  |
|                                         | Oeiras      | 5              | 2.5  |
| Nationality                             | Portuguese  | 172            | 84.7 |
|                                         | Brazilian   | 15             | 7.4  |
|                                         | Sao Tomeans | 5              | 2.5  |
|                                         | Angolan     | 2              | 1.0  |
| Immigrant and/or with immigrant parents | Yes         | 82             | 40.4 |
|                                         | No          | 121            | 59.6 |

at the PHCC (14.5%). Only two caregivers (3.6%) refused vaccination.

Regarding birth cohorts, failure to receive the first dose of the MMR vaccine on time was most frequent among children born between 2012 and 2015. Data from the 2022 cohort was not considered valuable due to the small sample size. [Table 2](#) presents the proportions of children vaccinated on time or with a delay/failure, according to their year of birth, county of residence, and inclusion in the immigrant population.

In terms of the county of residence, only data from Sintra, Loures, Lisbon, Amadora, and Odivelas was valued, as the number of respondents residing in each of the remaining counties was too small for meaningful interpretation ([Table 2](#)). The population density and

proportion of immigrants with resident status in each of those specific counties are presented in [table 3](#).<sup>12</sup>

Considering the immigrant population, 36.6% did not receive the first MMR dose at the correct time, compared with 20.7% in the non-immigrant population.

A statistically significant association between the immigrant population and receipt of the first MMR dose after 12 months and 30 days was established (p value = 0.012) ([Table 4](#)).

## Discussion of the results

According to WHO, vaccination coverage of at least 95% is needed for herd immunity against measles in a population.<sup>3,11</sup> The General Directorate of Health (GDH)

**Table 2.** Was the child vaccinated at the correct time?

| Variable                                |          |                | Yes  | No   | Total |
|-----------------------------------------|----------|----------------|------|------|-------|
| Year of birth                           | 2012     | Absolute value | 8    | 4    | 12    |
|                                         |          | %              | 66.7 | 33.3 | -     |
|                                         | 2013     | Absolute value | 6    | 8    | 14    |
|                                         |          | %              | 42.9 | 57.1 | -     |
|                                         | 2014     | Absolute value | 5    | 6    | 11    |
|                                         |          | %              | 45.5 | 54.5 | -     |
|                                         | 2015     | Absolute value | 17   | 8    | 25    |
|                                         |          | %              | 68.0 | 32.0 | -     |
|                                         | 2016     | Absolute value | 11   | 4    | 15    |
|                                         |          | %              | 73.3 | 26.7 | -     |
|                                         | 2017     | Absolute value | 21   | 3    | 24    |
|                                         |          | %              | 87.5 | 12.5 | -     |
|                                         | 2018     | Absolute value | 22   | 8    | 30    |
|                                         |          | %              | 73.3 | 26.7 | -     |
|                                         | 2019     | Absolute value | 15   | 6    | 21    |
|                                         |          | %              | 71.4 | 28.6 | -     |
|                                         | 2020     | Absolute value | 22   | 3    | 25    |
|                                         |          | %              | 88.0 | 12.0 | -     |
|                                         | 2021     | Absolute value | 17   | 5    | 22    |
|                                         |          | %              | 77.3 | 22.7 | -     |
|                                         | 2022     | Absolute value | 4    | 0    | 4     |
|                                         |          | %              | 100  | 0.0  | -     |
|                                         | Total    | Absolute value | 148  | 55   | 203   |
|                                         |          | %              | 71.9 | 27.1 | -     |
| County of residence                     | Lisboa   | Absolute value | 76   | 29   | 105   |
|                                         |          | %              | 72.4 | 27.6 | -     |
|                                         | Amadora  | Absolute value | 17   | 6    | 23    |
|                                         |          | %              | 73.9 | 26.1 | -     |
|                                         | Odivelas | Absolute value | 16   | 4    | 20    |
|                                         |          | %              | 80.0 | 20.0 | -     |
|                                         | Loures   | Absolute value | 13   | 5    | 18    |
|                                         |          | %              | 72.2 | 27.8 | -     |
|                                         | Sintra   | Absolute value | 9    | 8    | 17    |
|                                         |          | %              | 52.9 | 47.1 | -     |
| Immigrant and/or with immigrant parents | Yes      | Absolute value | 52   | 30   | 82    |
|                                         |          | %              | 63.4 | 36.6 | -     |
|                                         | No       | Absolute value | 96   | 25   | 121   |
|                                         |          | %              | 79.3 | 20.7 | -     |
|                                         | Total    | Absolute value | 148  | 55   | 203   |
|                                         |          | %              | 72.9 | 27.1 | -     |

**Table 3.** Counties of residence included in the discussion of the results

| Counties of residence | Population density (average number of individuals per km <sup>2</sup> ) | Proportion of immigrants with resident status (%) |
|-----------------------|-------------------------------------------------------------------------|---------------------------------------------------|
| Lisbon                | 5466                                                                    | 19.9                                              |
| Amadora               | 7310                                                                    | 13.9                                              |
| Odivelas              | 5642                                                                    | 14.0                                              |
| Loures                | 1215                                                                    | 10.7                                              |
| Sintra                | 1215                                                                    | 11.0                                              |

**Table 4.** Link between the immigrant population and the delay in the first dose of the MMRV

| Variable              | Value | df | Asymptotic significance (bilateral) - p |
|-----------------------|-------|----|-----------------------------------------|
| Pearsons chi-square   | 6.275 | 1  | 0.012                                   |
| Continuity correction | 5.494 | 1  | 0.019                                   |
| Number of valid cases | 203   | -  | -                                       |

calculates the vaccination coverage as the proportion (as a percentage) of vaccinated users in certain birth cohorts. Those vaccination coverages are assessed using data from the VACINAS platform by Shared Services of the Ministry of Health, a platform where nurses enter information when a vaccine is administered. All the NVP vaccines are administered in PHCCs.<sup>13</sup> According to the last annual vaccination report released by the GDH, the vaccination coverage rate for the first dose of the MMR vaccine was 98% (in the 2021 cohort) and 95% for the second dose (in the 2017 cohort). Data presented by the GDH in the 2021 and 2022 PNVP bulletin was superimposable.<sup>13,14</sup>

The median age of our sample is 5.79 years. The vaccination coverage of primary vaccination with MMR in this study sample was slightly lower, namely 93.1%, and at 12 months of age it was only 72.9%, which may indicate the existence of susceptible pockets with children being vaccinated after 12 months and 30 days, in the district of Lisbon. Of the 14 (6.9%) children aged between two and seven years who did not receive any doses of the MMR vaccine, 13 were part of the immigrant population. Of those 13, 12 were not born in Portugal, but in Brazil, China, Algeria, Colombia, Sao Tome and Principe, and Cape Verde.

The primary reason reported by caregivers was not knowing or not remembering the reason for the delay/

absence of vaccination with the first dose of the MMR vaccine (24 caregivers; 43.6% of participants). Some of these delays may have been caused by false contraindications regarding vaccination, either by the general population or by healthcare professionals.<sup>1</sup> As such, an information campaign was conducted for the caregivers who responded to the survey, providing an information leaflet detailing false contraindications regarding vaccination presented in the PNVP 2020.<sup>1</sup> The second most frequent reason for incorrect MMR vaccination was lack of awareness of the PNVP (11 caregivers; 20% of participants). All those who gave this reason were part of the immigrant population. Administrative and economic barriers, fear of discrimination, lack of information, unfamiliarity with the Portuguese healthcare facilities, language barriers, intercultural barriers, and religious beliefs may contribute to underutilization of health care services within the immigrant population. The third most frequent reason was the absence of a family doctor or difficulty scheduling an appointment at the PHCC (eight caregivers; 14.5% of participants). In 2010, a report from the Central Administration of the Health System estimated that approximately 1.5 million users did not have an assigned family doctor, and by April 2023, this value has increased to over 1.6 million.<sup>15-18</sup> Only two respondents refused the first dose of the MMR vaccine, supporting a study carried out by the European Commission in 2020 as Portugal having the highest rate of confidence in vaccination.<sup>10,19</sup>

Children born after January 1, 2011 began to follow the 2012 PNVP update.<sup>7</sup> The first years of implementing the PNVP that was updated by bringing the first dose of the MMR vaccine forward from 15 to 12 months (birth cohorts from 2012 to 2015), showed the highest rates of incorrect vaccination, which could be indicative of a period of adaptation to the updating of the PNVP by PHCC. Subsequent cohorts in 2016, 2018, and 2019 demonstrated a similar proportion of children not vaccinated at the correct time: 26.7% in 2016 and 2018, and 28.5% in 2019. The period between 2017 and 2019 coincided with several measles outbreaks in Europe, including Portugal, as well as in the USA and Brazil.<sup>3,9,20-22</sup>

Portugal faced five waves of COVID-19 between 2020 and 2022.<sup>23</sup> Although there was a national decrease in the number of administered doses of PNVP vaccines,<sup>24</sup> MMR vaccination in the children's cohort born in 2020 was not affected by this factor, with only 12% of cases being incorrectly vaccinated. In the 2019 cohort, vaccinated in 2020, there was a proportion of 23.8% of children with a delay in primary vaccination, and in the 2021 cohort, 22.7% of children were not vaccinated with the first dose of the MMR vaccine on time, possibly a

reflection of confinement measures and a reduction in visits to the PHCC,<sup>4,24-26</sup> Even with this percentage increase in the 2019 and 2021 cohorts, these values are not greater than those recorded in pre-pandemic years. Therefore, in this study, the COVID-19 pandemic does not appear to have had a major impact on vaccination delays in primary MMR vaccination.

The counties of Lisbon, Amadora, Odivelas, Loures, and Sintra displayed the highest percentages of incorrect primary MMR vaccination.<sup>12</sup> These municipalities are among the most densely populated in Portugal, which may facilitate the spread of MMR-related infectious diseases. The immigrant population in these municipalities is particularly vulnerable, as most originate from developing countries, according to the Human Development Index (HDI) (Guinea-Bissau, Pakistan, Angola, Nepal, Sao Tome and Principe, Cape Verde, India, Brazil, and China, from the lowest HDI to the highest HDI), often with endemicity and/or a high incidence of infectious diseases such as measles and, on average, they have a low socioeconomic level, live in crowded conditions, and have poor housing conditions.<sup>27</sup> In this study, analysis of survey results revealed a statistically significant association between the immigrant population and incorrect primary MMR vaccination, with immigrant children tending to have more delays/failure in the administration of this vaccine than the non-immigrant population.

However, this study had some limitations. The population consisted primarily of children residing in the Lisbon Metropolitan Area and attending the PERLPH. The relatively small number of children in each subpopulation restricts the representativeness of those specific subpopulations. Children's parents or caregivers may also misstate the reasons for incorrect vaccination with the first dose of the MMR vaccine. There is a scarcity of studies conducted in Portuguese populations, and much of the available published data on the MMR vaccine is outdated. Finally, the methodology applied in this study differs from that of the GDH, as we calculated vaccination coverage using cohorts from multiple birth years, whereas the GDH estimates coverage based on a single birth cohort for each vaccine.

In conclusion, this study found that vaccination coverage among the analyzed population was below the threshold needed for herd immunity against measles, with even lower coverage at 12 months of age. The greater discrepancy observed between the immigrant population and non-immigrant population may demonstrate inequalities in adequate immunization, suggesting the need for targeted information campaigns on the vaccines included in the PNVP and the benefits of

completing the full vaccination schedule. Concurrently, in Portugal, vaccination coverage rates are primarily calculated based on PHCC records, which may overestimate actual coverage by excluding individuals not yet registered at a PHCC, and, consequently, not yet vaccinated. Therefore, collecting data in a hospital may have revealed lower coverage rates, by including such individuals. Hence, future research should assess vaccination rates across health institutions that cover all users of the Portuguese National Health System and who live in Portugal, ensuring that unregistered populations are also accounted for in national estimates.

#### Author contributions

All authors participated in the conception and design of the study; drafting the article; critical review of the article; final approval of the version to be published; agreement to be accountable for the accuracy and integrity of the work. L. Veiga additionally participated in the acquisition of data from caregivers; research studies and literature; analysis and interpretation of the collected data, research studies and literature. F. Prata additionally participated in the correction of the data analysis.

#### Funding

None.

#### Conflicts of interest

None.

#### Ethical considerations

**Protection of humans and animals.** The authors declare that no experiments involving humans or animals were conducted for this research.

**Confidentiality, informed consent, and ethical approval.** The authors have followed their institution's confidentiality protocols, obtained informed consent from patients, and received approval from the Ethics Committee. The SAGER guidelines were followed according to the nature of the study.

**Declaration on the use of artificial intelligence.** The authors declare that no generative artificial intelligence was used in the writing of this manuscript.

#### Supplementary data

Supplementary data are available at DOI: 10.24875/PJP.24000070. These data are provided by the corresponding author and published online for the benefit of the reader. The contents of supplementary data are the sole responsibility of the authors.

## References

- Freitas G, Marques JG, Santos LA, Vaz Luísa Rocha, Calé ME, Fernandes T. *Programa Nacional de Vacinação 2020*. Direção-Geral de Saúde; 2020:107. Accessed February 5, 2023. <https://www.dgs.pt/normas-orientacoes-e-informacoes/normas-e-circulares-normativas/norma-n-0182020-de-27092020-pdf.aspx>
- Di Pietrantonj C, Rivetti A, Marchione P, Debalini MG, Demicheli V. Vaccines for measles, mumps, rubella, and varicella in children. *Cochrane Database Syst Rev*. 2021;2021(11):CD004407.
- Berche P. History of measles. *La Presse Médicale*. 2022;51(3):104149.
- Kauffmann F, Heffernan C, Meurice F, Ota MOC, Vetter V, Casabona G. Measles, mumps, rubella prevention: how can we do better? *Expert Review of Vaccines*. 2021;20(7):811-826.
- Gomes MC. VASPR- vacina tripla contra o sarampo, parotidite (papeira) e rubéola. Manuel Cramo Gomes Faculdade de Ciências da Universidade de Lisboa. Published 2003. Accessed March 9, 2023. <https://webpages.ciencias.ulisboa.pt/~mcgomes/vacinacao/VASPR/index.html>
- Sarampo e Rubéola mantêm-se eliminadas em Portugal - INSA. Published August 21, 2018. Accessed April 12, 2023. <https://www.insa.gov.pt>
- Leça A, Calé ME, Freitas G, Valente PM. *Programa Nacional de Vacinação 2012*. Direção-Geral de Saúde; 2012:66. Accessed February 5, 2023. [https://www.spp.pt/UserFiles/file/EVIDENCIAS%20EM%20PEDIA%20TRIA/NORMA%20DGS\\_040.2011%20ACT.%2001.2012.pdf](https://www.spp.pt/UserFiles/file/EVIDENCIAS%20EM%20PEDIA%20TRIA/NORMA%20DGS_040.2011%20ACT.%2001.2012.pdf)
- Measles Annual Epidemiological Report for 2019. European Centre for Disease Prevention and Control; 2020:9. Accessed March 2, 2023. <https://www.sip-spp.pt/media/afxhnmhw4/sarampo-relato-rio-anual-ecdc.pdf>
- Oliveira IS, Cardoso LS, Ferreira IG, Alexandre-Silva GM, Jacob BC, Cerni FA, Monteiro WM, Zottich U, Pucca MB. Anti-vaccination movements in the world and in Brazil. *Rev Soc Bras Med Trop*. 2022;55:e0592.
- Branco F. *Influência e Caracterização do Movimento Antivacinação nas Redes Sociais em Portugal*. Faculdade de Ciências Sociais e Humanas da Universidade Nova de Lisboa; 2021. [https://run.unl.pt/bitstream/10362/131416/1/FILIPA\\_BRANCO\\_57573\\_MCC.pdf](https://run.unl.pt/bitstream/10362/131416/1/FILIPA_BRANCO_57573_MCC.pdf)
- OMS: cobertura vacinal contra o sarampo é a mais baixa desde 2008 | As Nações Unidas no Brasil. Published 2022. Accessed May 26, 2023. <https://brasil.un.org/pt-br/208747-oms-cobertura-vacinal-contra-o-sarampo-%C3%A9-mais-baixa-desde-2008>
- Densidade populacional. Published 2021. Accessed May 8, 2023. <https://www.pordata.pt/Municipios/Densidade+populacional-452>
- Boletim nº5 do Programa Nacional de Vacinação 2022. Direção-Geral de Saúde; 2022:11. <https://www.dgs.pt/documentos-e-publicacoes/boletim-n-5-do-programa-nacional-de-vacinacao-abril-2022-pdf.aspx>
- Machado, Rita, André Santos, Benvinda Santos, Bruno Alves, Bernardo Pedroso, Carina Pinto, Lucínia Sebastião, Susana Cardoso, e Teresa Fernandes. «Relatório Síntese Anual da Vacinação 2024». Lisboa: Direção-Geral de Saúde, 2024. <https://www.dgs.pt/em-destaque/cobertura-vacinal-ate-aos-7-anos-mantem-se-elevada-pdf.aspx>
- «Não há falta de médicos de família em Portugal». TVI Notícias. Published January 2012. Accessed May 30, 2023. <https://tvi.iol.pt/noticias/sociedade/videos/nao-ha-falta-de-medicos-de-familia-em-portugal>
- Borja-Santos R. *Faltam 800 médicos de família em todo o país, mais de metade em Lisboa*. PÚBLICO. Published May 19, 2015. Accessed May 30, 2023. <https://www.publico.pt/2015/05/19/sociedade/noticia/faltam-800-medicos-de-familia-em-todo-o-pais-1696048>
- Quatro milhões de portugueses sem acesso a um médico de família devido à COVID-19 – Ordem dos Médicos. Published 2022. Accessed May 8, 2023. <https://ordemdosmedicos.pt/quatro-milhoes-de-portugueses-sem-acesso-a-medico-de-familia-devido-a-covid-19/>
- Portugal R e T de. Falta de médicos de família. *Governo fala em mais aposentações e mais utentes inscritos*. Falta de médicos de família. Governo fala em mais aposentações e mais utentes inscritos. Published April 5, 2023. Accessed May 8, 2023. [https://www.rtp.pt/noticias/politica/falta-de-medicos-de-familia-governo-fala-em-mais-aposentacoes-e-mais-utentes-inscritos\\_v1477665](https://www.rtp.pt/noticias/politica/falta-de-medicos-de-familia-governo-fala-em-mais-aposentacoes-e-mais-utentes-inscritos_v1477665)
- State of Vaccine Confidence. Published 2020. Accessed June 12, 2023. [https://health.ec.europa.eu/vaccination/state-vaccine-confidence\\_en](https://health.ec.europa.eu/vaccination/state-vaccine-confidence_en)
- Measles - number of reported cases. Accessed June 1, 2023. <https://www.who.int/data/gho/data/indicators/indicator-details/GHO/measles---number-of-reported-cases>
- Sarampo em Portugal e na Europa. Published 2021. Accessed April 18, 2023. <https://www.sip-spp.pt/publicacoes/noticias/sarampo-em-portugal-e-na-europa/>
- Sarampo em Portugal. Published January 2019. Accessed June 1, 2023. <https://www.sns.gov.pt/noticias/2019/01/31/sarampo-em-portugal-11/>
- ECO. *Dois anos de pandemia em cinco gráficos*. ECO. Published March 2, 2022. Accessed May 4, 2023. <https://eco.sapo.pt/2022/03/02/doisanos-de-pandemia-em-cinco-graficos/>
- Pandemia derruba vacinação infantil em Portugal. Medscape. Published June 2020. Accessed May 8, 2023. <http://portugues.medscape.com/verartigo/6504923>
- Carias C, Pawaskar M, Nyaku M, Conway JH, Roberts CS, Finelli L, Chen YT. Potential impact of COVID-19 pandemic on vaccination coverage in children: A case study of measles-containing vaccine administration in the United States (US). *Vaccine*. 2021;39(8):1201-1204.
- Ji C, Piché-Renaud PP, Apajee J, Stephenson E, Forte M, Friedman JN, Science M, Zlotkin S, Morris SK, Tu K. Impact of the COVID-19 pandemic on routine immunization coverage in children under 2 years old in Ontario, Canada: A retrospective cohort study. *Vaccine*. 2022;40(12):1790-1798.
- List of LDCs | Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States [Internet]. [citado 2 de julho de 2025]. Disponível em: <https://www.un.org/ohrls/content/list-ldcs>