Monthly Analysis of Infant Mortality Rate in Portugal during the COVID-19 Pandemic: Insights from Continuous Monitoring

Análise Mensal da Taxa de Mortalidade Infantil em Portugal durante a Pandemia de COVID-19: Perceções a partir da Monitorização Contínua

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ABSTRACT
Introduction: The COVID-19 pandemic significantly impacted global public health. Infant mortality rate (IMR), a vital statistic and key indicator of a population's overall health, is essential for developing effective health prevention programs. Existing evidence primarily indicates a decrease in IMR during the COVID-19 pandemic. We conducted a national-level analysis to calculate IMR and describe its course over the years (from 2016 until 2022), using a month-by-month analysis.
Methods: Data on the number of deaths under one year of age was collected from the Portuguese E-Death Certification System (SICO), and data on the number of monthly live births was obtained from Statistics Portugal. The IMR was calculated per month, considering the previous 12 months' cumulative number of deaths under one year of age and the number of live births.
Results: In Portugal, the IMR decreased before and during the COVID-19 pandemic. The lowest values were observed in September and October 2021 (2.15 and 2.14 per 1000 live births, respectively). The IMR remained below the threshold of three deaths per 1000 live births during the pandemic's critical period.
Conclusion: Portugal has achieved remarkable progress in reducing its IMR over the last 60 years. The country recorded its lowest-ever IMR values during the COVID-19 pandemic. Further studies are needed to fully understand the observed trends.
Keywords: COVID-19; Infant Mortality; Infant, Newborn; Pandemics; Portugal

RESUMO
Introdução: A pandemia da COVID-19 teve um impacto significativo na saúde pública mundial. A taxa de mortalidade infantil (TMI), uma estatística vital e indicador-chave da saúde geral de uma população, é essencial para o desenvolvimento de programas de prevenção eficazes no sector da saúde. Evidências existentes indicam uma diminuição da TMI durante a pandemia da COVID-19. Realizou-se uma análise a nível nacional para calcular a TMI e descrever a sua evolução ao longo dos anos (de 2016 até 2022) usando uma análise mês a mês.
Métodos: Os dados sobre o número de óbitos com menos de um ano de idade foram obtidos do Sistema de Certificação Eletrónica de Óbitos (SICO) e os dados sobre o número de nascimentos mensais foram obtidos a partir do Instituto Nacional de Estatística. A taxa de mortalidade infantil (TMI) foi calculada por mês, considerando o número acumulado de óbitos com menos de um ano de idade e o número de nascidos vivos nos 12 meses anteriores.
Resultados: Em Portugal, a TMI diminuiu antes e durante a pandemia da COVID-19. Os valores mais baixos foram observados em setembro e outubro de 2021 (2,15 e 2,14 por 1000 nascimentos vivos, respetivamente). A TMI permaneceu abaixo do limiar de três mortes por 1000 nascimentos vivos durante o período crítico da pandemia.
Conclusão: Portugal alcançou um progresso notável na redução da sua TMI ao longo dos últimos 60 anos. O país registou os valores mais baixos de sempre da TMI durante a pandemia da COVID-19. Estudos adicionais são necessários para compreender completamente as tendências observadas.
Palavras-chave: COVID-19; Mortalidade Infantil; Pandemia; Portugal; Recém-Nascido

INTRODUCTION

The COVID-19 pandemic has been a major public health crisis, resulting in over 774 million cases and 7 million deaths globally as of January 7th, 2024.[1] Vital statistics have played a crucial role in informing health authorities about the pandemic's impact on mortality,[2] including infant mortality rate (IMR), which is defined as the probability of

a child born in a given period (e.g., year) dying before one year of age.[3] Infant mortality rate is a key indicator of a population's overall health and is essential for developing and evaluating effective health interventions and policies.[4]

Existing evidence on infant mortality during the COVID-19 pandemic primarily indicates a decrease in

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IMR.[5,6] COVID-19 displayed a U-shaped pattern that paralleled all-cause mortality, which was disproportionally low in children under 12, with a slight increase in newborns and children during their first year. This U-shaped mortality pattern was also observed in pneumonia or influenza.[7]

In Portugal, IMR has significantly improved over the past six decades, with the lowest rates recorded during the pandemic in 2020 and 2021. Reviewing the official IMR – classically measured with whole data of each civil year[8] – high values were observed in the decades of 1960 (ranging from 88.8 to 54.8 per 1000 live births) and 1970 (ranging from 55.5 to 26.0 per 1000 live births). After the Portuguese National Health Service (SNS) was established in 1979, a steady decrease was observed in the IMR until the beginning of the 21st century, systematically registering numbers below 4.0 deaths per 1000 after 2004. In 2010, an unexpected IMR of 2.5 was observed, and subsequently, an oscillation of this rate around the value of 3.0 deaths per 1000 live births was observed up to 2019. An increase in the IMR could have been caused by the pandemic, as it was observed in other mortality indicators, e.g. excess all-cause mortality.[9] However, the opposite was observed, with the best IMR in Portugal being registered during the pandemic, in 2020 and 2021. To clarify this trend, we conducted a national-level analysis relying on publicly available data calculating the IMR and describing its course over the years (from 2017 until 2022) using a month-by-month analysis.

METHODS
Data
We obtained the number of deaths under one year of age from the Portuguese E-Death Certification System (SICO)[10] and the number of monthly live births from Statistics Portugal.[11,12] The data covered the period from January 1, 2014, to December 31, 2022.

Calculation of annual Infant Mortality Rate per month
We calculated the IMR for each month considering the cumulative number of deaths under one year of age and the number of live births for the previous 12 months.[13]

$$IMR_{mt} = \frac{\Sigma_{j=0}^{11} Deaths < 1\ year_{mt-j}}{\Sigma_{j=0}^{11} Live\ births_{mt-j}},$$

mt = December 2016, January 2017, (...), December 2022

This study used publicly available data and did not require ethics committee intervention. All data analyses were conducted in accordance with relevant guidelines and regulations, ensuring individual privacy.

RESULTS
In Portugal, the IMR steadily declined before and during the COVID-19 pandemic (Fig. 1). The lowest values were

Monthly evolution of the infant mortality rate in Portugal
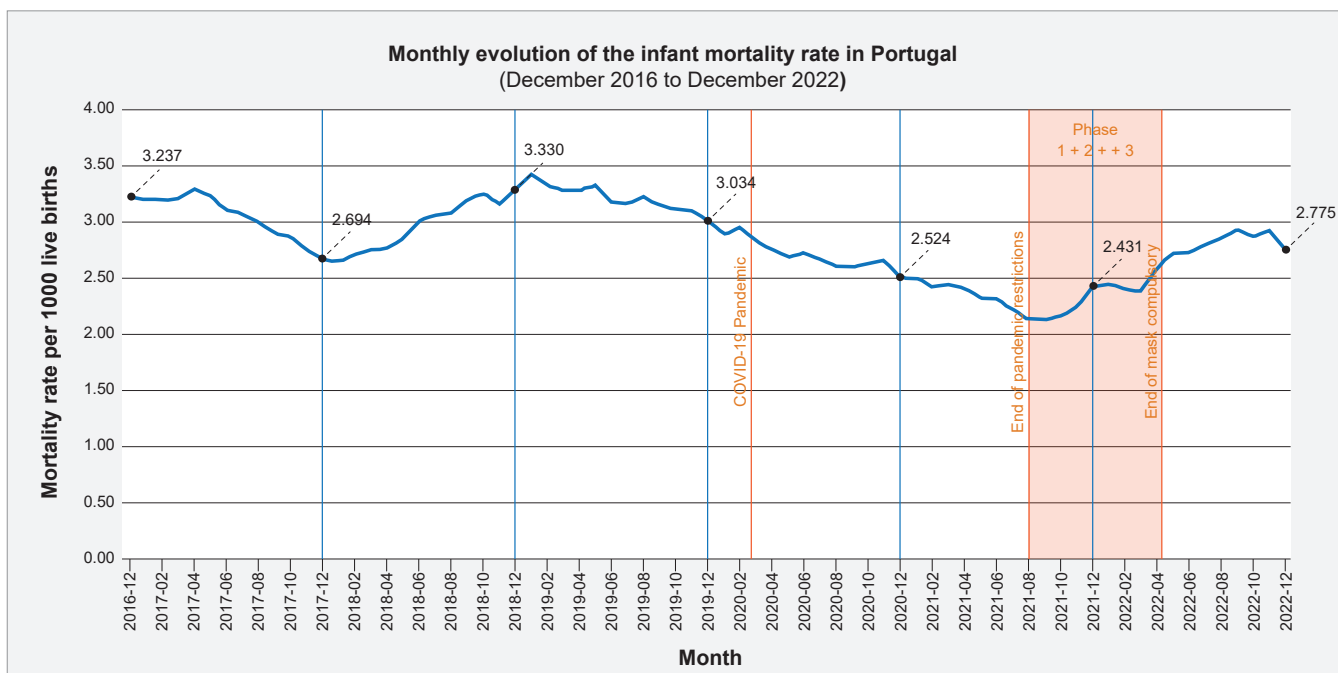(December 2016 to December 2022)

Figure 1 – Monthly evolution of the Annual (previous 12 months) Infant Mortality rate in Portugal. Vertical blue lines: end of year (moment of official IMR calculation); vertical orange lines: important moments of the COVID-19 pandemic. Phases 1, 2, and 3 refer to the pandemic easing strategy proposed by the Portuguese government (https://eportugal.gov.pt/noticias/covid-19-restricoes-vao-ser-levantadas-em-3-fases-ao-ritmo-da-vacinacao)

observed in September and October 2021 (2.15 and 2.14 per 1000 live births, respectively), coincident with the lowest-ever recorded number of live newborns in the country (Table 1). These lowest IMR monthly values followed the lifting of the most severe pandemic restrictions imposed by the government. However, this trend was not observed during the period of easing of pandemic restrictions, followed by a monthly increase in IMR values for more than one year. The peak of this 'post-pandemic' trend was observed in the last trimester of 2022. Nevertheless, the overall IMR remained below the critical threshold of 3.0 deaths per 1000 live births during the pandemic's critical period and until the end of 2022.

DISCUSSION

We herein introduced the monthly evolution of the IMR in Portugal, a novel approach that enables a closer monitoring of this vital statistic, which is essential for population health assessment.[4] Our analysis revealed a consistent decrease in IMR during the COVID-19 pandemic with the trend reversing following the easing of pandemic restrictions. While the usual end-of-year IMR rate would also show a global decreasing trend from 2018 to 2021 with a slight increase in 2022, the monthly dynamics provide more compelling insights that require further understanding.

Potential reasons contributing to this decrease might be related to the COVID-19 public health measures implemented, such as mandatory mask usage, social distancing, and school closures. Another hypothesis for this decrease may be prematurity[15,16] (an important component of IMR), where a decrease in preterm birth and deaths, particularly associated with extreme prematurity, was previously described.[17] Similarly, a decline in other infectious diseases, such as respiratory tract infections[18] and gastroenteritis,[19] was also registered and may have contributed to the decrease in IMR. However, further analysis is required to ascertain the causes of this effect.

Our findings highlight the importance and benefits of continuous IMR monitoring, which we believe to be feasible with a 3- to 4-month lag. This approach enables a timelier identification of trends, allowing a prompter design of potential interventions to improve infant health outcomes.

Our analysis provides a comprehensive view of the IMR in Portugal over a significant period, including during the COVID-19 pandemic. The use of publicly available data from reliable sources, such as the SICO and Statistics Portugal, adds credibility to the analysis. The month-by-month analysis approach allows for a more granular understanding of trends and fluctuations in IMR. However, the study has some limitations. The analysis is limited to data available up until December 2022, and therefore may not reflect more recent trends. Moreover, as the study relies on the accuracy and completeness of the data sources used, any errors or gaps in these data sources could impact the findings. Lastly, the analysis does not delve into the specific causes of the observed trends in IMR, which could be influenced by a variety of factors beyond the scope of this study.

This study contributes to the literature by providing a detailed examination of IMR trends in Portugal, particularly during the COVID-19 pandemic. It highlights the

Table 1 – Monthly numbers of live births in Portugal

Year*	2016	2017	2018	2019	2020	2021	2022	2016 - 2021[†]
January	7070	7114	7188	7298	7328	6003	6393	7000
February	6544	6344	6209	6437	6359	5734	6237	6271
March	7003	7110	6823	6971	7167	6653	6715	6955
April	6937	6684	6751	6820	6956	6304	6224	6742
May	7489	7258	7554	7238	7244	6810	6953	7266
June	7382	6933	7087	6809	6829	6546	6735	6931
July	7542	7515	7385	7647	7445	7009	7339	7424
August	7632	7318	7897	7665	7224	7159	7716	7483
September	8069	7587	7888	8055	7676	7246	7783	7754
October	7538	7772	7897	7863	7393	6840	7450	7551
November	7139	7641	7367	7259	6859	6565	7303	7138
December	7095	7222	7335	6964	6316	6926	7131	6976
Total	87 440	86 498	87 381	87 026	84 796	79 795	83 979	85 489
Average	7287	7208	7282	7252	7066	6650	6899	7124

* Statistics Portugal (https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&indOcorrCod=0007286&contexto=bd&selTab=tab2); * Statistics Portugal (https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_indicadores&indOcorrCod=0008086&xlang=pt&contexto=bd&selTab=tab2);
† month average.
Data available on April 1st, 2023.

unexpected decrease in IMR during the pandemic and the subsequent reversal of this trend following the easing of pandemic restrictions. Additionally, this study also proposes a method for continuous monitoring of IMR, offering timely insights and presenting new challenges for future research. Furthermore, it underscores the importance of IMR as a key indicator of a population's overall health, reinforcing its significance in public health research and policy development.

CONCLUSION

Portugal has remarkably reduced its IMR in the last 60 years. In recent years, before the COVID-19 pandemic, the IMR fluctuated around 3.0 per 1000 live births. During the pandemic, Portugal recorded its lowest-ever IMR values. Further studies are needed to fully understand this observed trend. Nevertheless, the continuous monitoring approach we propose for Portugal offers timely insights and new challenges for the future.

AUTHOR CONTRIBUTIONS

PJN: Study design, data analysis, drafting, critical review and approval of the manuscript.

CC, RFS, ASC, MAN, LBN, CF, CE: Drafting and critical review of the manuscript.

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