DOI: 10.1590/1413-812320232812.11572022EN

Effects of the COVID-19 pandemic on dental services in primary care in Maranhão, Brazil

Francenilde Silva de Sousa (http://orcid.org/0000-0003-0681-7620) [1]
Elisa Miranda Costa (http://orcid.org/0000-0001-5364-0384) [1]
Elisa Santos Magalhães Rodrigues (https://orcid.org/0000-0003-4091-9452) [1]
Mariana Borges Sodré Lopes (https://orcid.org/0000-0001-6631-1491) [1]
Erika Barbara Abreu Fonseca Thomaz (http://orcid.org/0000-0003-4156-4067) [1]

Abstract *This article aims to analyze indicators of the utilization of oral health services (UOHS) in primary health care in the state of Maranhão, Brazil, before and during the COVID-19 pandemic. We conducted an ecological time series study. The unit of analysis was the state of Maranhão, and the exposure variable was the COVID-19 pandemic, dichotomized into pre-pandemic and pandemic. The outcome variables were the monthly rates per 1,000 population of three UOHS indicators: rate of preventive procedures (RPP-PHC); rate of urgent procedures (RUP-PHC), and rate of curative procedures (RCP-PHC). The data were collected from the Primary Health Care Information System (SISAB) and the Brazilian Institute of Geography and Statistics (IBGE) for the period from 2015-2022. The analyses were performed using the Seasonal Autoregressive Integrated Moving Average (SARIMA) model. The three indicators showed an upward trend up to January 2019. The pandemic caused a significant reduction in the RPP (Xreg = -6.55; p-value = 0.0008) and RCP (Xreg = -4.74; p-value = 0.0005), starting in the first semester of 2020 and continuing into the second semester of 2022, but did not influence the RUP (Xreg = -0.03; p-value = 0.12). The COVID-19 pandemic caused a reduction in preventive and curative oral health services in Maranhão.*

Key words *COVID-19, Oral Health, Primary Health Care, Interrupted Time Series Analysis*

[1] Programa de Pós-Graduação em Saúde Coletiva, Departamento de Saúde Pública, Universidade Federal do Maranhão. R. Barão de Itapari 155, Centro. 65020-070 São Luís MA Brasil. erika.barbara@ufma.br

Introduction

The inclusion of the first oral health teams (OHts) in the Family Health Program (FHP)/ Family Health Strategy (FHS) in the 2000s led to improvements in oral health indicators[1-3]. However, the role of oral health professionals working in primary health care (PHC) services was limited during the COVID-19 pandemic due to the measures adopted in response to the health crisis[4,5] and people's fear of exposure to the virus in dental surgeries[6], leading to lower availability of and demand for public oral health services and, consequently, negatively affecting oral health indicators.

Studies in Brazil have highlighted the impact of the pandemic on the provision of oral health care under the country's public health system, *o Sistema Único de Saúde* (SUS) or Unified Health System. Da Cunha et al. (2021) compared the rate of hospitalization due to oral and oropharyngeal cancer before and during the pandemic, demonstrating that admissions dropped by 49.3% across the country between 2019 and 2020[7]. There is also evidence of the effects of the pandemic on access to oral health care in PHC[8], the number of oral biopsies performed[9], prosthetic treatments[10], and dental appointments for children[6].

Santos et al. (2021) reported a reduction of 66% in outpatient dental procedures on the SUS between January and June 2020 and were the only researchers to investigate the effects of the COVID-19 pandemic on oral health care provision under the SUS across states. Although a decline in indicators was identified in states across all of Brazil's five regions, the highest reduction in dental treatments in PHC services was observed in Maranhão, one of the three states in the country with the lowest Human Development Indicators (HDIs)[11]. Maranhão was also one of the states that saw a rapid spread of the disease. During May 2020, the number of municipalities with confirmed cases increased from 15 to 212 (of a total of 217)[12].

Studies are limited to comparisons of the average number of procedures performed in the first semester of 2020 and the same period in 2019. These studies used tests that fail to consider trends, seasonality, and residuals, which can lead to biased estimates of the effects of the pandemic on oral health indicators. In addition, it is not known whether the identified effects persisted in the second semester of 2020, when, to reduce the adverse effects of the pandemic on oral health, new resolutions encouraged dental surgeons to return to work activities, with the adoption of prevention and control measures for the treatment of suspected and confirmed cases of COVID-19[13,14].

The aim of this study was to perform an interrupted time series analysis of indicators of the utilization of oral health services (UOHS) in PHC in Maranhão, one of Brazil's poorest states and the state that showed the largest reduction in availability of dental treatment before and after the COVID-19 pandemic. This analysis provides a more accurate quantification of the effects of the pandemic on oral health indicators due to the higher number of observations of indicators over time[15]. Our hypothesis is that the pandemic caused a decline in indicators, which persisted up to the second semester of 2022.

Methods

Study design

We performed an interrupted time series analysis, where data are collected before and after an event to quantify the effects of interruptions occurring in the data series[16,17]. The data were collected from databases in the public domain and the unit of analysis was the state of Maranhão.

Study location

Maranhão is located in the Northeast region, which is part of the Legal Amazon. It has a population of 7,075,181 inhabitants and is the country's eighth largest state, with an area of 329,642,182 sq km[18]. The latest data show that PHC coverage in the state in 2020 was 87.75%, while oral health team coverage rose from 62.75% in 2015 to 71.88% in 2021[19,20].

Study variables and data sources

The exposure variable (interruption in the time series) was the COVID-19 pandemic, considered a dichotomous variable, where the value "0" represents pre-interruption (January 2015 to March 2020) and value "1" is the point of interruption (April 2020 to December 2022). This categorization was adopted considering that the effects of the pandemic began in April, the month after the notification of the first case of the disease in the state, according to the disease bulletins available on the website of the Maranhão State Department of Health (SES-MA)[21].

The outcome variables were the monthly rates per 1,000 population of three UOHS indicators: rate of preventive procedures (RPP-PHC); rate of urgent procedures (RUP-PHC), and rate of curative procedures (RCP-PHC). The numerator data were obtained from the Primary Health Care Information System (SISAB) for the period 2015-2022 and the denominator data were derived from census population projections provided by the Brazilian Institute of Geography and Statistics (IBGE). The procedures in each category (preventive, urgent, and curative) are shown in Table 1.

Data processing and statistical analysis

A brief descriptive statistical analysis of dental procedures was performed, estimating measures of central tendency (means) and dispersion (standard deviation and minimum and maximum values). The interrupted time series was analyzed using the Seasonal Autoregressive Integrated Moving Average (SARIMA) model.

SARIMA is employed with non-stationary seasonal time series and comprises the parameters p, d, q (P, D, Q): AR: (p = degree of the autoregressive part); I: (d = degree of the first difference); MA: (q = degree of moving-average part); and S: (P, Q and D relative to seasonality). The analysis was divided into three stages: 1) Identification of the appropriate model, visualizing the series breakdown process; 2) Estimation of best-fitting model parameters, considering the parsimony analysis of specific criteria and residual autocorrelations; and 3) Application of the model using interruption analysis[22].

The identification of the appropriate model commenced with a random exploratory analysis of trends, seasonality, and residual values. The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test was then applied, adopting a 5% significance level and null hypothesis of series stationarity. The automatic *ndiffs* command from the urca package was used to estimate the number of differences required to make the time series stationary[23,24].

An initial estimation of the model parameters was performed using parsimony analysis of the smallest values for the Akaike information criterion (AIC) and Bayesian information criterion (BIC), mean absolute percentual error (MAPE), and root mean squared error (RMSE) resulting from parameter combinations[23-25]. To determine the final model, we used the automatic *auto.arima* command from the forecast package to indicate the best-fitting model, based on combinations of unit root tests, AIC minimization, and maximum likelihood estimation. Both determinations coincided, confirming the accuracy of the selection of the adjusted model.

The adjustment of the model involved the removal of trend and seasonality, reducing differences between model values and observed values to close to zero[23,24]. The application of the model was tested using the series interruption coefficient (*alpha* = 5%).

The time series was tested for residual autocorrelations using the Ljung-Box and Box-Pierce tests, adopting a 5% significance level[24,25]. All analyses were performed using the R programming language for statistical analysis and RStudio Desktop version 1.3.1093.

Ethical aspects

The study protocol was approved by the Maranhão Federal University Hospital's research ethics committee (code number CAAE: 35645120.9.0000.5086).

Results

A total of 154,000, 1,848, and 124,447 preventive, urgent, and curative procedures, respectively, were carried out in Maranhão in January 2019, compared to only 5,324, 226, and 3,320, respectively, in May 2020. Preventive procedures were the most common type of procedure, with the total number of procedures in this category exceeding the sum of the other categories. Mean (± standard deviation) RPP, RUP, and RCP were 9.86 ± 5.00, 0.10 ± 0.03, and 7.47 ± 3.15, respectively (data not presented).

Although the three outcome variables showed variation throughout the time series, there was a predominantly upward trend up to 2019, followed by a reduction in rates in 2020. The findings show a regular six-monthly pattern in rates throughout the time series, with smaller monthly variations being observed in the final months of each semester (Figure 1).

Variations in rates were similar across the outcome variables, being greater in the first three months of the semesters and lower in the last three months. December had the lowest monthly variation across all dental procedures (Figure 2).

The best-fitting models were selected based on the parsimony analysis of Akaike and Bayesian information criteria, mean absolute percent-

Table 1. Procedure categories and corresponding PHC dental appointment form codes included in the search strategy.

Dental procedures	Code*
Disease prevention/health promotion	
ATF (individual per session)	ABPO003
Application of dental sealant (per tooth)	ABPO004
Application of cariostatic agents (per tooth)	ABP005
Oral hygiene advice	ABPO015
Temporary cavity filling	ABPO016
Removal of bacterial plaque	ABPO025
Urgent care	
Dental pulp access and medication	ABPO001
Abscess drainage	ABPG008
Dry socket treatment	ABPO026
Curative procedures	
Deciduous tooth extraction	ABPO011
Permanent tooth extraction	ABPO012
Removal of surgical stitches	ABPG018
Ulotomy/ulectomy	ABPO027
Restoration of anterior permanent tooth	ABPO021
Restoration of posterior permanent tooth	ABPO022
Restoration of deciduous tooth	ABPO023
Pulp capping	ABPO006
Identification of bacterial plaque	ABPO010
Periapical/interproximal X-ray	ABPO018
Pulpotomy	ABPO017
Dressing with or without biomechanical preparation	ABPO008
Lower gum scaling, planing, and polishing (by sextant)	ABPO019
Upper gum scaling, planing, and polishing (by sextant)	ABPO020
Adaptation of dental prosthesis	ABPO002
Dental prosthesis cementation	ABPO007
Fitting of dental prothesis	ABPO013
Tooth gum molding for construction of dental prosthesis	ABPO014

* PHC dental appointment forms, available at https://integracao.esusab.ufsc.br/pdf.html?include=/.

Source: Authors.

age error, root mean squared error, and residual autocorrelations. The parameters of the best-fitting models were as follows: (0.1,0) (1.0,0) for preventive procedures; (0.1,1) (1.0,0) for urgent procedures; and (1.0,0) (1.0,0) for curative procedures (Table 2).

The pandemic caused a significant reduction in the utilization of all dental services except urgent procedures during 2020, 2021, and 2022. In the first semester of 2020, the rate of preventive and curative procedures per 1,000 population dropped by 7.19 (Xreg = -7.19; p-value = 0.0001) and 5.62 (Xreg = -5.62; p-value = 0.0002), respectively. This trend persisted up to the second semester of 2022, with rates dropping by 6.54 (Xreg = -6.54; p-value = 0.0008) and 4.74 (Xreg = -4.74; p-value = 0.0005), respectively (Table 3).

Discussion

This interrupted time series study analyzed the effect of the COVID-19 pandemic on the utilization of oral health services in PHC in Maranhão between January 2015 and December 2022. During this period, the pandemic caused a significant reduction in the number of preventive and curative procedures per 1,000 population (-6.54 and -4.74, respectively). Urgent procedures were not affected by the pandemic.

Preventive procedures were the most common type of procedure, which may be due to the focus on health promotion and disease prevention in PHC[26]. The highest rate of preventive procedures was observed in January 2019. This may be the result of public health and intersectoral

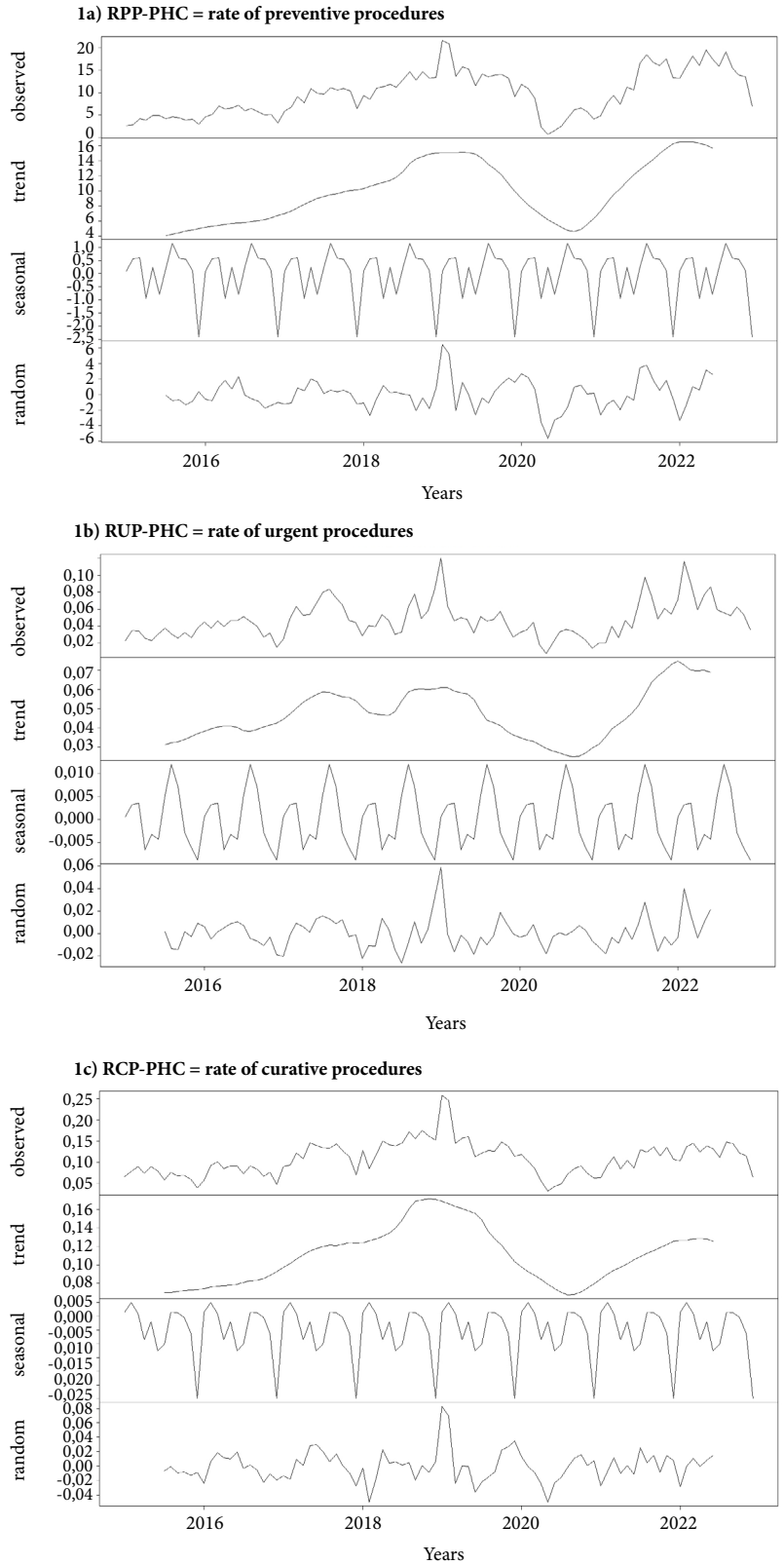

Figure 1. Breakdown of the time series into indicators of utilization of oral health services in PHC in Maranhão, Brazil (2015-2022).

Source: Authors.

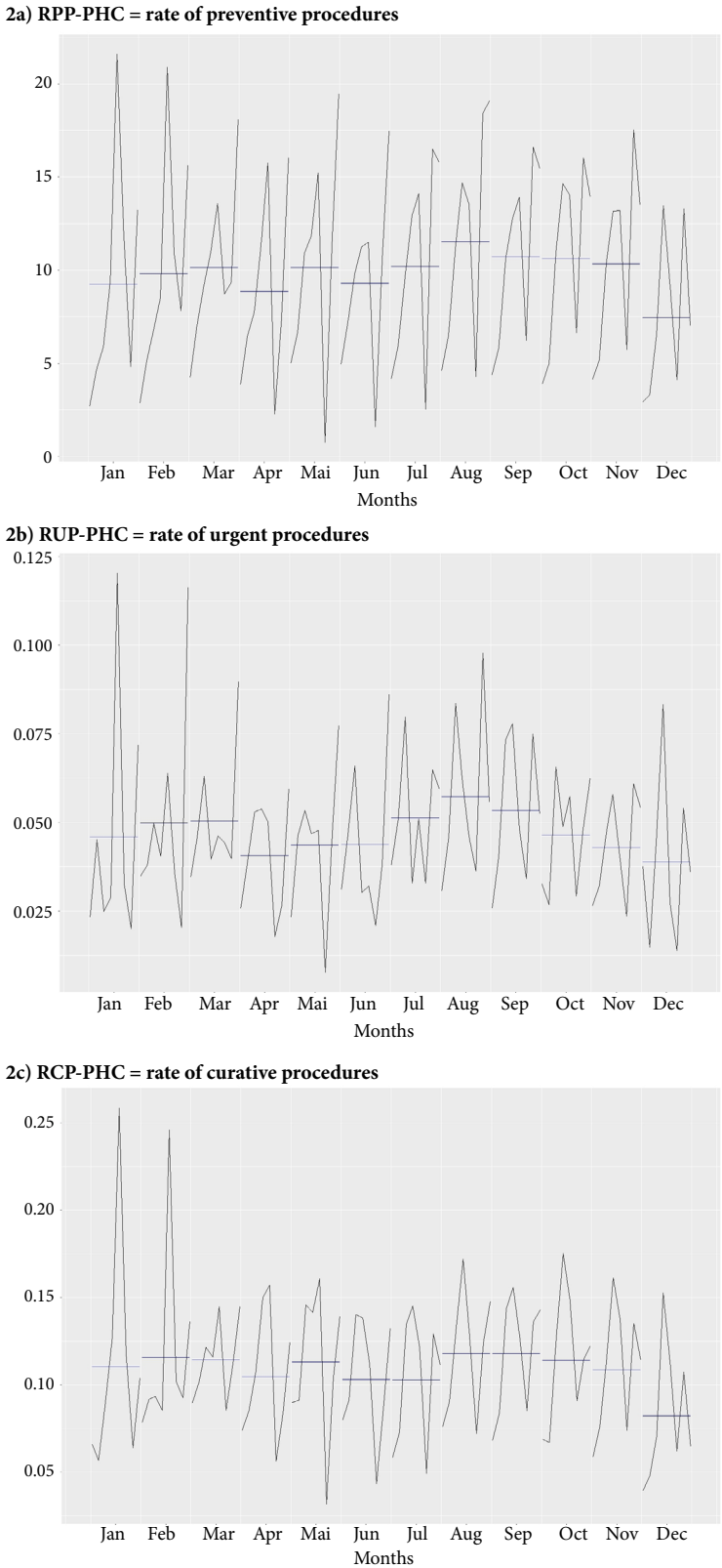

Figure 2. Monthly variation of indicators of utilization of oral health services in PHC in Maranhão, Brazil (2015-2022).

Source: Authors.

Ciência & Saúde Coletiva, 28(12):3587-3597, 2023

policies, such the School Health Program (PSE) and new National Primary Health Care Policy (PNAB), both enacted in 2017, and the publication of Ministry of Health guidance documents, including the book *A Saúde Bucal no Sistema Único de Saúde* (Oral Health under the Unified Health System) in 2018.

The repetition of six-monthly trends where procedure rates always fall off at the end of the semester may be a result of seasonal trends in the

Table 2. Parameters of the best-fitting models for indicators of utilization of oral health services in PHC in Maranhão. Brazil (2015-2022).

Variable	Parameter	Criteria					
		AIC	BIC	MAPE	RMSE	Box-Pierce	Ljung-box
Preventive procedures	(0.1.0) (1.0.0)	425.88	430.98	21.70	2.20	0.29	0.19
Urgent procedures	(0.1.1) (1.0.0)	-431.70	-424.03	17.28	0.02	0.85	0.80
Curative procedures	(1.0.0) (1.0.0)	367.54	377.79	17.01	1.55	0.29	0.13

AIC = Akaike information criterion; BIC = Bayesian information criterion; MAPE = mean absolute percentual error; RMSE = root mean squared error; box-Pierce and Ljung-box = tests for residual autocorrelations.

Source: Authors.

Table 3. Effects of the COVID-19 pandemic on indicators of the utilization of oral health services in PHC in Maranhão, Brazil (2015-2022).

Variable	Adjusted model		
	Parameter	Xreg**	P-value
Up to June 2020 (2020.1)			
Preventive procedures	(0.1.0) (1.0.0)	-7.18	0.0002
Urgent procedures	(0.1.1) (1.0.0)	-0.03	0.1374
Curative procedures	(1.0.0) (1.0.0)	-5.61	0.0003
Up to December 2020 (2020.2)			
Preventive procedures	(0.1.0) (1.0.0)	-7.19	0.0001
Urgent procedures	(0.1.1) (1.0.0)	-0.03	0.1390
Curative procedures	(1.0.0) (1.0.0)	-5.62	0.0002
Up to June 2021 (2021.1)			
Preventive procedures	(0.1.0) (1.0.0)	-6.52	0.0004
Urgent procedures	(0.1.1) (1.0.0)	-0.03	0.1507
Curative procedures	(1.0.0) (1.0.0)	-5.18	0.0004
Up to December 2021 (2021.2)			
Preventive procedures	(0.1.0) (1.0.0)	-6.51	0.001
Urgent procedures	(0.1.1) (1.0.0)	-0.03	0.1210
Curative procedures	(1.0.0) (1.0.0)	-4.79	0.0002
Up to June 2022 (2022.1)			
Preventive procedures	(0.1.0) (1.0.0)	-6.54	0.0005
Urgent procedures	(0.1.1) (1.0.0)	-0.03	0.1137
Curative procedures	(1.0.0) (1.0.0)	-4.65	0.0009
Up to December 2022 (2022.2)			
Preventive procedures	(0.1.0) (1.0.0)	-6.54	0.0008
Urgent procedures	(0.1.1) (1.0.0)	-0.03	0.1258
Curative procedures	(1.0.0) (1.0.0)	-4.74	0.0005

**Xreg = interruption effect coefficient.

Source: Authors.

organization of oral health services and in patient demand. These trends may have been affected by staff leave patterns, school holidays, and end-of-year festivities[27].

The reduction in UOHS in Maranhão is consistent with the findings of previous studies in Brazil[6-11]. Santos et al. (2021) reported statistically significant reductions in outpatient dental procedures performed in Brazil when comparing the first semester of 2019 and the same period in 2020. Reductions in preventive actions were identified across all states, including those with a high HDI, such as the Federal District (-31.55%; p-value < 0.001) and Rio Grande do Sul (-49.09%; p-value < 0.001), and those with low HDI, such as Alagoas (-61.21%; p-value < 0.001) and Maranhão (-91.83%; p-value < 0.001)[11]. Reductions were more pronounced in states with low HDIs, corroborating the hypothesis stating that there is an association between poverty and social inequality and oral diseases[28]. In addition, it is possible that poorer states need more time to reorganize the safe provision of oral health services to ensure that indicators return to pre-pandemic levels. Further research is required to address this gap.

International studies have also noted a significant reduction in specialized curative procedures in private clinics, public health systems, and/or teaching clinics[29-31]. For example, in a study analyzing the medical records of patients of an integrated adult dental clinic linked to a degree in Dentistry offered by the Rey Juan Carlos University of Madrid, Gómez-Costa et al. (2022) found that periodontal and endodontic treatments were the procedures most affected during the pandemic[31]. Another example is a study conducted in private dental clinics in Germany with different provider scenarios (low/high volume practice, low/high proportion of non-statutory insurance revenue; and low/high staff pool and costs). The findings show reduced utilization of all services, with reductions being more severe for prevention (-80% on average), periodontics (-76%), and prosthetics (-70%)[29].

The fact that there were no significant differences in urgent procedure rates may be explained by the guidelines produced by health organizations around the world, which recommended the suspension only of elective non-emergency dental care[32,33]. In addition, patients suffering pain continued to seek urgent care despite the fear of visiting health facilities in the midst of a pandemic[6].

A study in the University Center of Dentistry and Specialized Medicine in Poland found a significant increase in urgent surgical procedures when comparing two periods: pre-pandemic (1 February 2019-31 January 2020) and pandemic (1 February 2020-31 January 2021)[30]. The broad interpretation of what comprises urgent care and unclear codes on appointment forms are factors that may explain these controversial findings[34].

Other long-term impacts of the pandemic include the aggravation of oral diseases. For example, the absence of oral cancer screening, which is performed during routine dental appointments, may have resulted in delays in diagnosis and treatment[35,36].

Despite the resumption of elective dental care, vaccination of health workers and the general population, improvements in biosafety, teleconsultations, and the use of minimally invasive approaches[14,33,34], it is evident that these strategies may not have been enough for indicators to return to pre-pandemic levels.

We recommend the organization of dental care to ensure the safe provision of services and enable a return to pre-pandemic levels. Based on published guidelines, measures that can be incorporated into everyday practice in primary care facilities offering dental services include: entry respiratory syndrome screening of patients and the provision of rapid tests for suspected cases; use of adequate personal protective equipment, including N95/PFF2 masks, goggles, face shields, lab coats, and disposable bouffant caps; reducing the number of scheduled appointments; increasing the frequency of cleaning and disinfection of surfaces; and ensuring well-ventilated and clean spaces, with large windows or the use of appropriate filters in air-conditioning units[4,5,13,14].

Our study has some limitations. The selection of the best-fitting model may have been affected by the surveillance data available in the SISAB. However, this system is the official government data source and the professionals responsible for inputting data receive specialist training to avoid double entry and guarantee data quality, and data are validated to ensure internal consistency. This information system is also used by studies that provided support for health manager and professional decision-making[37,38]. While we chose to dichotomize the intervention to be able to analyze the data in the presence and absence of the pandemic, future research should analyze effects in different contexts, considering, for example, number of cases and deaths, the lockdown, and urban mobility rates.

Study strengths include the following: the study period covered three years of the pandem-

ic, enabling the analysis of prolonged effects on indicators; the modeling technique employed increases the robustness of analyses of the effects of health interventions on indicators, using an automatic command (*auto.arima*) to select the best-fitting model based on a combination of multiple tests; we indirectly analyzed the effects of service planning during the pandemic.

It is concluded that the pandemic caused a significant reduction in preventive and curative dental procedures in PHC in Maranhão and that this effect continued up to the second semester of 2022. The results of this study contribute to a better understanding of the effects of the COVID-19 pandemic on oral health indicators in regions with low socioeconomic status. However, caution should be taken when making generalizations.

It is recommended that the discussion of strategies and modifications and adaptations to health facilities during the pandemic and post-pandemic in the case of new waves of the disease should be a constant process. The results of this study can also contribute to the reorganization of health services during states of public calamity and the revamping of the National Oral Health Care Policy.

Collaborations

FS Sousa contributed to the conception of the study, data collection, analysis and interpretation, manuscript writing and revision. EM Costa, ESM Rodrigues, and MBS Lopes contributed to data analysis and manuscript revision. EBAF Thomaz contributed to the conception of the study, data analysis and interpretation, and manuscript revision. All authors approved the final version.

Acknowledgment

The authors are grateful for the support of the following funding agencies: Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq); Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) finance code 001; and Fundação de Amparo à Pesquisa e ao Desenvolvimento Científico e Tecnológico do Maranhão (FAPEMA).

References

1. Chaves SCL, Almeida AMF L, Rossi TRA, Santana SF, Barros SG, Santos CML. Oral health policy in Brazil between 2003 and 2014: scenarios, proposals, actions, and outcomes. *Cien Saude Colet* 2017; 22(6):1791-1803.
2. Marques AB, Oneda G, Buffon MCM, Ditterich RG. Information systems as a tool to monitoring the oral health actions in the Family Health Strategy in the metropolitan region of Curitiba-PR. *Brazilian J Heal Res* 2014; 16(1):82-89.
3. Brasil. Ministério da Saúde (MS). *SB Brasil 2010: Pesquisa Nacional de Saúde Bucal. Resultados Principais*. Brasília: MS; 2012.
4. Brasil. Ministério da Saúde (MS). *Guia de orientações para Atenção Odontológica no contexto da COVID-19*. Brasília: MS; 2020.
5. Conselho Federal de Odontologia. Recomendações para atendimentos odontológicos em tempos de covid-19. 2020.
6. Chisini LA, Sartori LRM, Costa FS, Salvi LC, Demarco FF. COVID-19 pandemic impact on paediatric dentistry treatments in the Brazilian Public Health System. *Int J Paediatr Dent* 2020; 31(01):31-34.
7. Cunha AR, Antunes JLF, Martins MD, Petti S, Hugo FN. The impact of the COVID-19 pandemic on hospitalizations for oral and oropharyngeal cancer in Brazil. *Community Dent Oral Epidemiol* 2021; 49(3):211-215.
8. Lucena EHG, Freire AR, Freire DEWG, Araújo ECF, Lira GNW, Brito ACM, Padilha WWN, Cavalcanti YW. Access to oral health in primary care before and after the beginning of the COVID-19 pandemic in Brazil. *Pesq Bras Odontopediatria Clin Integr* 2020; DOI: https://doi.org/10.1590/SciELOPreprints.819.
9. Cunha AR, Antunes JLF, Martins MD, Petti S, Hugo FN. The impact of the COVID-19 pandemic on oral biopsies in the Brazilian National Health System. *Oral Dis* 2020; 28(Suppl. 1):925-928.
10. Chisini LA, Sartori LRM, Costa FS, Salvi LC, Demarco FF. COVID-19 pandemic impact on prosthetic treatments in the Brazilian Public Health System. *Oral Dis* 2020; 28(Suppl. 1):994-996.
11. Santos MBF, Pires ALC, Saporiti JM, Kinalski MA, Marchini L. Impact of COVID-19 pandemic on oral health procedures provided by the Brazilian public health system: COVID-19 and oral health in Brazil. *Heal Policy Technol* 2021; 10(1):135-142.
12. Oliveira Jardim R, Pereira CRP, Rodrigues ZMR. Rotas de COVID-19 no estado do Maranhão, BR. *Hygeia* 2022; 18:14-28.
13. Brasil. Ministério da Saúde (MS). Nota técnica nº 3/2021-CGSB/DESF/SAPS/MS. COVID-19 e atendimento odontológico no SUS. Brasília; 2021.
14. Brasil. Ministério da Saúde (MS). Nota técnica GVIMS/GGTES/ANVISA nº 4/2020. Orientações para serviços de saúde: medidas de prevenção e controle que devem ser adotadas durante a assistência aos casos suspeitos ou confirmados de infecção pelo novo coronavírus (SARS-CoV-2). Brasília; 2020.
15. Bernal JL, Cummins S, Gasparrini A. Interrupted time series regression for the evaluation of public health interventions: A tutorial. *Int J Epidemiol* 2017; 46(1):348-355.

16. Hudson J, Fielding S, Ramsay CR. Methodology and reporting characteristics of studies using interrupted time series design in healthcare. *BMC Med Res Methodol* 2019; 19(1):137.
17. Turner SL, Karahalios A, Forbes AB, Taljaard M, Grimshaw JM, Cheng AC, Bero L, McKenzie JE. Design characteristics and statistical methods used in interrupted time series studies evaluating public health interventions: a review. *J Clin Epidemiol* 2020; 122:1-11
18. Instituto Brasileiro de Geografia e Estatítica (IBGE). Cidades@ | Maranhão [Internet]. 2022. [acessado 2022 jul 13]. Disponível em: https://cidades.ibge.gov.br/brasil/ma/panorama
19. Brasil. Ministério da Saúde (MS). Informação e Gestão da Atenção Básica [Internet]. 2020. [acessado 2022 jul 13]. Disponível em: https://egestorab.saude.gov.br/paginas/acessoPublico/relatorios/relHistoricoCoberturaAB.xhtml
20. Brasil. Ministério da Saúde (MS). Secretaria de Atenção Primária à Saúde. Cobertura de Saúde Bucal. e-Gestor. Informação e Gestão da Atenção Básica. 2020. p. 2.
21. Maranhão. Boletim Epidemiológico COVID-19 [Internet]. 2020. [acessado 2021 mar 20]. Disponível em: https://www.saude.ma.gov.br/boletins-covid-19-2020/
22. Sato RC. Disease management with ARIMA model in time series. *Einsten* 2013; 11(1):128-131.
23. Leite V, Mattos D, Nakamura LR. Evaluation of the predictive capacity of ARIMA and VAR-VEC models : the case of electricity demand in Rio Grande do Sul. *Exacta Eng Prod* 2022; 20(2):307-335.
24. Hyndman RJ, Khandakar Y. Automatic Time series forecasting: the forecast package for R. *J Stat Softw* 2008; 27(3):22.
25. Ljung GM, Box GEP. On a measure of lack of fit in time series models. *Biometrika* 1978; 65(2):297-303.
26. Schwendicke F, Krois J, Gomez J. Impact of SARS-CoV2 (COVID-19) on dental practices: economic analysis. *J Dent* 2020; 99:103387.
27. Facchini LA, Tomasi E, Dilélio AS. Quality of primary health care in brazil: advances, challenges and perspectives. *Saude Debate* 2018; 42(Esp. 1):208-223.
28. Andrade FB, Pinto RS, Antunes JLF. Trends in performance indicators and production monitoring in specialized dental clinics in Brazil. *Cad Saude Publica* 2020; 36(9): e00162019.
29. Fraga BT, Barbosa MLP, Silva SNF, Guimarães LM, Carvalho MD, Azevedo BMB. Income inequalities in oral health and access to dental services in the Brazilian population: National Health Survey, 2013. *Rev Bras Epidemiol* 2019; 22(Supl. 2):E190015.Supl.2.
30. Nijakowski K, Ciéslik K, Łaganowski K, Gruszczynski D, Surdacka A. The impact of the COVID-19 pandemic on the spectrum of performed dental procedures. *Int J Environ Res Public Health* 2021; 18(7):3421.
31. Gómez-Costa D, Ramírez JM, García Guerrero I, Giovannini G, Rojo R, Gómez-de Diego R. A retrospective study on the effect of the COVID-19 pandemic on dental treatments in adults. *BMC Oral Health* 2022; 22(1):122.
32. Brasil Ministério da Saúde (MS). Nota técnica nº 9/2020-CCSBDESF/SAPS/MS. Atendimento Odontológico no SUS. Brasília; 2020.
33. Jiang CM, Duangthip D, Auychai P, Chiba M, Folayan MO, Hamama HHH, Kamnoedboon P, Lyons K, Matangkasombut O, Mathu-Muju KR, Mathur VP, Mei ML, Morgan M, Poolthong S, Rahul M, Srinivasan M, Takahashi T, Yaklai S, Zhang S, Zou XC, Chu CH, Lo ECM. Changes in oral health policies and guidelines during the COVID-19 pandemic. *Front Oral Heal* 2021; 2:668444.
34. Matsumoto MSA, Gatti MAN, De Conti MHS, Simeão SFDAP, Braga Franzolin SDO, Marta SN. Determinants of demand in the public dental emergency service. *J Contemp Dent Pract* 2017; 18(2):156-161.
35. Rocha TAH, Boitrago GM, Mônica RB, Almeida DG, Silva NC, Silva DM, Terabe SH, Staton C, Facchini LA, Vissoci JRN. National COVID-19 vaccination plan: using artificial spatial intelligence to overcome challenges in Brazil. *Cien Saude Colet* 2021; 26(5):1885-1898.
36. Silva PCMC. Vaccination against COVID-19 in health care workers. *Rev Bras Med Trab*. 2021; 19(1):1-2.
37. Brasil. Sistema de Informação em Saúde para a Atenção Básica - SISAB. Nota Técnica Relatório de Indicadores de Saúde e Cadastro. Brasília; 2017.
38. Haried P, Claybaugh C, Dai H. Evaluation of health information systems research in information systems research: a meta-analysis. *Health Informatics J* 2019; 25(1):186-202.

Article submitted 15/07/2022
Approved 06/03/2023
Final version submitted 08/03/2023

Chief editors: Romeu Gomes, Antônio Augusto Moura da Silva