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COVID-19 Pandemic impact on Brazil's Public Dental System

Luiz Alexandre CHISINI[a]
Francine dos Santos COSTA[a]
Leticia Regina Morello SARTORI[b]
Marcos Britto CORRÊA[b]
Otávio Pereira D'AVILA[c]
Flávio Fernando DEMARCO[b]

[a]Universidade do Vale do Taquari – Univates, Center of Biological Sciences and Health, Lajeado, RS, Brazil.

[b]Universidade Federal de Pelotas – UFPel, School of Dentistry, Department of Restorative Dentistry, Pelotas, RS, Brazil.

[c]Universidade Federal de Pelotas – UFPel, School of Dentistry, Department of Social and Preventive Dentistry, Pelotas, RS, Brazil.

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Corresponding Author:
Flávio Fernando Demarco
E-mail: ffdemarco@gmail.com

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Abstract: The present study aimed to estimate the impact of the COVID-19 pandemic on dental care procedures in the Public Health System in Brazil. A retrospective, ecological study was carried out, comprising 5,564 Brazilian municipalities. The number of dental procedures (per 100,000 inhabitants) performed in the Brazilian Public Health System (SUS) was the outcome. The impact of the pandemic was estimated by comparing the rate of procedures for each month of 2020 with the rates observed in the equivalent months in 2019, considering the period from March to August. Regulatory legislation regarding restrictions on dental care, issued by the state governments of 27 Brazilian federative units, was used for mediation analysis. A 55% reduction was observed in March for all procedures (IRR = 0.45, 95%CI 0.39–0.51), while in the other months, the rate of reduction remained ≥ 88%. The biggest decrease was observed in collective preventive procedures (reduction ≥99%) between April and August. Procedures that were less likely to generate aerosols (tooth extraction and prosthetic) and emergencies showed the smallest reduction. The reduction was not mediated by the restrictions imposed by state governments (p>0.05). The impact of the COVID-19 pandemic was noteworthy in terms of the decrease in the number of dental procedures carried out in the Brazilian Public Dental Service. The lack of access, the delay of elective procedures and the lack of preventive collective procedures could result in an overburdened system, post-Pandemic.

Keywords: COVID-19; Epidemiology; Health Services Research; Public Health Dentistry.

Introduction

The COVID-19 (Coronavirus Disease 2019) pandemic manifested as pneumonia, origins unknown, in Wuhan, China, in December 2019.[1,2] Currently, official data point to more than 165 million people infected and more than 3.4 million deaths worldwide.[3] The first case in Brazil was detected in February 2020 and, since then, the Pandemic has evolved rapidly and, considering the large territorial expanse, the spread is unevenly distributed across the country.[4] To mitigate infection and avoid overloading health systems, collective and individual measures of social distancing, social isolation, quarantine, use of face masks and encouraging hygiene habits were instituted and have recently been acknowledged as

efficient.[5-11] However, these recommendations are difficult to implement in clinical dental practice, where there is a proximity between dentists and patients, exposure and direct contact with oral and nasal secretions and the use of instruments that amplify the spread of aerosols in the air and on surfaces.[2,5,12,13]

Dentists are among the professionals most susceptible to contamination by COVID-19.[14] Moreover, Brazil has the largest population of dentists in the world and also the largest Public National Health System (SUS), which includes free dental care, with more than 29,000 dentists working in Primary Health Care.[15,16] Currently, only 23.7% of Brazilians have private medical or dental insurance, showing that almost ¾ of the population relies on the public sector, especially the more vulnerable population.[17] Because of the pandemic's evolution and the need to reduce contamination, the Brazilian government recommended that elective dental clinical activities should be minimized by prioritizing urgent and emergency services.[18,19,20] However, state governments are also able to enact regulations regarding available services, including dental clinics, based on the situation of the pandemic in each of the 27 Federal states.

Thus, the objective of this study was to estimate the impact of the COVID-19 pandemic on dental procedures carried out in the Public Health System. In addition, we tested if regulation by the state could mediate the impact.

Methodology

The present study was reported in accordance with the guideline entitled Strengthening the Reporting of Observational Studies in Epidemiology (STROBE).

Study design and setting

This is a retrospective, ecological time-series study including almost all Brazilian municipalities with data on information systems within the National Public Health System (*Sistema Unico de Saúde* - SUS) (n = 5,564, 99.9% of the 5,570 municipalities). Secondary data from the SUS Computer Department (DATASUS; http://www.datasus.gov.br) were used: Ambulatory Information System (SIA-SUS) and *e-gestor* (information and management of primary care). Data from the Brazilian Institute of Geography and Statistics (IBGE; http://www.ibge.gov.br) were also used (population size and regions).

Data on the Human Development Index (HDI), by municipality, were obtained from the databases of the United Nations Development Program (UNDP) (http://www.atlasbrasil.org.br/2013/). State regulations regarding social distancing and the functioning of dental clinics were collected from the official websites of the 27 state governments of Brazil. Data were collected during the month of October 2020 by a single trained researcher.

Dependent variables

The absolute number of procedures per 100,000 inhabitants, performed by Brazilian public services, was the outcome of the present study. The number of dental procedures was collected through the dental procedures registered in the SIA/SUS (Table 1). The procedures were also subdivided into different categories as follows: a) Access to dental service (first dental visit); b) Urgency and Emergency treatments; c) Restorative treatments; d) Tooth extractions; e) Endodontics; f) Individual preventive procedures (*e.g.*: fluoride varnish application); g) Collective procedures (e.g.: epidemiological surveys); h) Basic periodontal treatment; i) Prosthesis and j) Surgical periodontal treatment.

Exposure

The impact of the pandemic was estimated by comparing the rate of procedures for each month in 2020 with the rates observed in the equivalent months of 2019, considering the period from March to August. For example, the March 2020 procedure rate was compared to the March 2019 rate. For the mediation analysis, the entire pandemic period (from March to August 2020) was compared with the corresponding period in 2019, prior to the pandemic (from March to August 2019).

Mediator

To gain access to the restrictions on dental services, the official regulations implemented by the 27 state governments regarding social distancing and the functioning of dental clinics, were collected from the official press and on the state government websites

Table 1. Description of investigated procedures and respective groups and attention health level.

Attention level	Procedures group	SUS - Procedure codes	Procedure
Basic	Access	301010153	First programmatic dental consultation
	Restorative	307010023	Primary tooth restoration
		307010031	Anterior permanent tooth restoration
		307010040	Posterior permanent tooth restoration
		307010015	Pulp Capping
		307020070	Pulpotomy
		101020090	Temporary cavity sealing
	Tooth extraction	414020120	Primary tooth extraction
		414020138	Permanent tooth extraction
		414020146	Multiple extraction with alveoloplasty by sextant
	Preventive procedures	101020074	Individual fluoride topical application per session
		101020058	Tooth cariostatic application
		101020066	Tooth sealant application
		307030040	Prophylaxy/ bacterial plaque removal
		101020082	Bacterial plaque disclosure
	Collective procedures	101020031	Collective action of supervised tooth brushing
		101020015	Collective action of fluoride gel topical application
		101020023	Collective action of fluorinated mouthwash
		101020040	Collective action of oral examination with epidemiological purpose
	Periodontics	307030016	Supragingival scraping, smoothing and polishing (by sextant)
		307030059	Supragingival scraping, smoothing and polishing (by sextant)
Basic/Specialized	Urgency	307020010	Access to dental pulp and medication (by tooth)
		404020054	Abscess drainage from the mouth and attachments
		414020383	Alveolitis treatment
		414020340	Surgical treatment of intraoral and/or extraoral fistula
		414020359	Surgical treatment of oral-dental hemorrhage
		414020391	Emergency treatment for reduction of tooth socket fracture
Specialized	Prosthetics	701070099	Removable partial mandibular denture
		701070102	Removable partial maxillary denture
		701070110	Temporary denture
		701070129	Mandibular complete denture
		701070137	Maxillary complete denture
		701070145	Fixed / adhesive intraradicular coronary prostheses by tooth
		701080027	Dental implant prosthesis
	Endodontics	307020088	Endodontic retreatment in permanent biradicular tooth
		307020096	Endodontic retreatment in permanent tooth with three or more roots
		307020053	Endodontic retreatment in permanent uniradicular tooth
		307020045	Permanent biradicular tooth filling
		307020053	Permanent tooth filling with three or more roots
		307020061	Permanent uniradicular tooth filling
		307020037	Primary tooth filling
	Periodontics	307030024	Subgingival scraping and smoothing (by sextant)
		307030032	Coronoradicular scraping (by sextant)
		414020375	Surgical periodontal therapy (by sextant)

(every 15 days, from March to August 2020; n = 11). Data on restrictions on dental services were collected from state executive decrees/laws promulgated by the offices of governors, categorized as i) no restriction on dental care (without a report of restriction on dental services) and b) restriction on dental care (mentioning only the possibility of urgent and emergency care). We estimated trajectory groups of dental care restrictions at the municipal level, using group-based trajectory models. A quadratic trajectory was considered, commencing with just one group, i.e., a null model. Five models were originally identified, however, the four-class model was the best fit because it had the lowest BIC (24276.6) and lowest sample-adjusted BIC (24344.1), being classified as a) long-term dental service restriction; b) one month's restriction; c) two months' restriction and d) no restrictions (Figure). Details of trajectory constructions are presented in Table 2.

Confounding variables

The confounding variables evaluated in the study were the population size of municipalities, coverage by the primary health care (Family Health Strategy) and Oral Health teams, the Human Development Index (HDI), Gini Index, months in which the dental procedures were performed, and the regions of Brazil. The population size of municipalities was obtained from the Brazilian Institute of Geography and Statistics and categorized as: a) ≤ 20,000 inhabitants; b) 20,001 to 50,000 inhabitants; c) 50,001 to 150,000 inhabitants; d) > 150,000 inhabitants.[2,21] The coverage by the Family Health Strategy and Oral Health Teams (Proportion %) at the country level were collected from the information and management of primary care databases and both categorized as follows: a) absent (0%); b) incipient (< 30%); c) intermediate (30%–70%); and d) consolidated (≥ 70%). Regarding

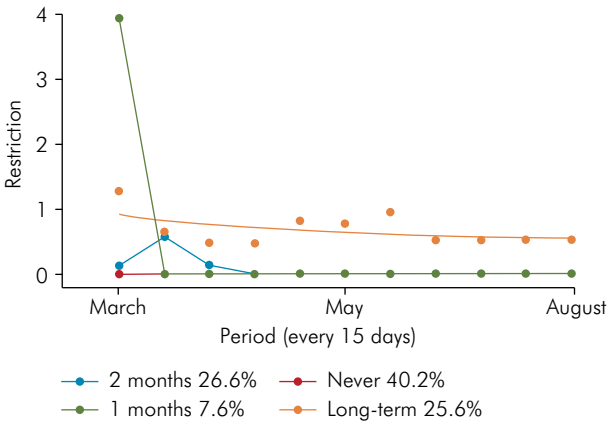

Figure. The trajectory of dentistry activity restriction in Brazilian municipalities (n = 5,564).

Table 2. The goodness of fit statistics and parameter estimates for quadratic trajectories of dentistry procedures restriction.

Groups	Intercept	SE	p-value	Linear Slope	SE	p-value	Quadratic slope	SE	p-value	AIC	BIC	Sample Adjusted BIC
1 (null)	-0.20768	0.02384	< 0.001	-0.44201	0.01111	< 0.001	0.02695	0.00097	< 0.001	34619	34636.3	34622.8
2	-8.034.461	4.902.128	0.9869	777.357	4155.44	0.9851	-192.069	85.740.843	0.9821	26426.7	26458.3	26449.9
	0.67163	0.02479	< 0.001	-0.42235	0.01138	< 0.001	0.02625	0.00098	< 0.001			
3	-9.022.451	6.173.122	0.9883	858.212	5144.50	0.9867	-207.815	1025.29	0.9838	24306.5	2456.1	24342.9
	276.339	0.09742	< 0.001	-179.337	0.10187	< 0.001	0.05992	0.02043	< 0.003			
	0.01939	0.03236	0.5490	-0.10597	0.01323	< 0.001	0.00460	0.00110	< 0.001			
4	-627.808	0.24690	< 0.001	574.888	0.24039	<.001	-144.101	0.05828	< 0.001	24276.4	24344.1	24326.1
	-4.366.213	251.305	0.9999	962.606	130.200	0.9999	-127.704	16607.0	0.9999			
	2.558.695	7.487.299	0.9727	-262.216	817.600	0.9773	200.046	7.024.339	0.9993			
	0.01708	0.03216	0.5955	-0.10364	0.01313	< 0.001	0.00446	0.00110	< 0.001			
5	-2.434.956	5.336.692	0.9964	-0.19804	1390.91	0.9999	0.04783	8.787.121	0.9996	24511.6	24597.31	24574.53
	3.638.095	46328.49	0.9994	-379.010	49705.8	0.9994	288.578	49705.84	0.9994			
	-653.206	0.27455	< 0.001	596.536	0.26285	< 0.001	-149.466	0.06395	< 0.001			
	-229.278	0.08160	< 0.001	0.41794	0.02531	< 0.001	-0.01836	0.00182	< 0.001			
	0.42390	0.04223	< 0.001	0.10344	0.02237	< 0.001	-0.04428	0.00246	< 0.001			

S: linear slope; Q: quadratic slope; SE: standard error; AIC: Akaike information criterion; BIC: Bayesian information criterion; * Significant if p < 0.05.

HDI, municipalities were classified as follows: a) below 0.55 was considered low HDI; b) between 0.55 and 0.699 as average HDI; c) between 0.70 and 0.799 as high HDI; d) 0.80 or above as very high. The Gini index (DATASUS) was used continuously in the model. The Brazilian regions are: South, Southeast, Midwest, North and Northeast.

Data analysis

All analyses were performed using STATA 16.0 software (https://www.stata.com). Descriptive statistics were developed using the mean, standard deviation, minimum, maximum and median of independent variables. For the outcome, the mean rates and respective 95% confidence intervals (95%CI) of the procedures were presented. Due to the overdispersion of the data, multilevel mixed-effects negative binomial regression was used to analyze the longitudinal association between the number of procedures and the impact of COVID-19; analysis was performed comparing the respective months of 2020 with the equivalent months in 2019. A stepwise backward procedure was used to select variables in the adjusted model. Only variables presenting a $p< 0.250$ were retained in the final model.

The parametric g-formula approach was used to estimate the total causal effect, the natural direct effect, the natural indirect effect and the controlled direct effect of the associations between the COVID-19 pandemic and dental procedures, considering restriction on services as a mediator. To perform this analysis, we used data from January 2019 to August 2020, with the period from March to August 2020 being considered the pandemic period. We used as the base confounder the months the procedures took place, the Gini Index, HDI and coverage by the Family Health Strategy and Oral Health Teams and, as the post confounder, the regions of Brazil. The Monte Carlo method was employed to estimate the effects. The bootstrap method was used to estimate standard error and the confidence interval of the estimated effects. To perform this assessment, we chose to use 1,000 resamples out of a total of 10,000 observations.

Results

Almost all Brazilian municipalities (n= 5,564) were included in the present study. Table 3 displays the description of confounders and the mediator. The mean rate of total procedures from March to August of 2019 was 88,081.0 95%CI (87,203.8–88,924.2) and 3,605.8 95%CI (3,479.0–3,733.1) from March to August of 2020. Table 4 displays the average monthly procedure rates according to the different groups of procedures.

Table 5 presents the monthly incidence rate ratio of dental procedures investigated and subgroups according to the COVID-19 pandemic. Considering the impact of COVID-19 on the total number of procedures, a reduction of 55% (IRR = 0.45, 95%CI 0.39–0.51) was observed in March; 94% in April (IRR = 0.06, 95%CI 0.06–0.07]; 93% in May (IRR = 0.07, 95%CI 0.06–0.08); 91% in June (IRR = 0.09, 95%CI 0.09–0.10); 88% in July (IRR = 0.12, 95%CI 0.10–0.14); and 91% in August (IRR = 0.09, 95%CI 0.07–0.10). The biggest decrease was observed in collective preventive procedures, with a reduction of ≥ 99% from April to August. Procedures that were less likely to generate aerosols presented the smallest reduction in procedure rates: tooth extraction, prosthesis, and even emergency procedures (42%, 78%, 75%, 68%, 66%, 72%, from March to August, respectively).

The parametric g-formula analysis found a direct effect on the association between the COVID-19 pandemic and dental procedures, considering the total number of procedures (Coef. = -0.23, 95%CI -0.24–-0.22) (Table 6). Moreover, for all procedure groups, the pandemic

Table 3. Description of dental procedure rates and characteristics of health services in Brazilian municipalities (n = 5.564).

Variables	Mean	SD	Minimum	Median	Maximum
Family health strategy coverage in % of inhabitants, 2020 (SIAB)	89.4	21.2	0	100	100
IDH of Brazilian municipalities 2010 (UNDP)	0.66	0.07	0.41	0.66	0.86
Gini index of Brazilian municipalities 2010 (UNDP)	0.50	0.07	0.28	0.50	0.80
The trajectory of states with always social isolation in %	25.1	-	-	-	-

SD: standard deviation.

Table 4. Average monthly procedures rate (per 100,000 inhabitants) and respective 95% confidence intervals (95%CI) of March to July according to different group procedures. (n = 5.564)

Procedures	March to August 2019		March to August 2020	
	Mean Rate	95%CI	Mean Rate	95%CI
Total of procedure	88,081.0	(87,203.8–88,924.2)	3,605.8	(3,479.0–3,733.1)
First dental visit	2,651.2	(2,535.3–2,769.1)	33.0	(19.2–51.1)
Emergency	275.9	(235.5–323.3)	143.3	(114.2–178.6)
Restoration	31,271.1	(30,005.5–32,509.2)	946.7	(871.5–1,027.1)
Tooth Extraction	3,798.1	(3,669.8–3,926.6)	1,303.2	(1,215.6–1,394.3)
Endodontics	61.0	(42.3–85.3)	23.1	(12.5–39.9)
Individual preventives	70,747.8	(69,525.4–71,933.8)	628.6	(566.5–696.1)
Collective preventives	10,597.6	(9,806.7–11,442.6)	675.4	(611.2–744.9)
Basic periodontal	1,234.3	(1,149.9–1,324.0)	368.6	(320.5–421.3)
Prosthetics	448.4	(394.7–505.2)	138.0	(109.3–172.6)
Surgical periodontal	919.4	(845.5–999.2)	326.8	(281.9–377.3)

presented a direct effect on the reduction of the rate of procedures ($p < 0.001$). The association was not mediated by state restrictions.

Discussion

The overall findings from this study are that the COVID-19 pandemic had a heavy and negative impact on the supply of dental treatments in the Public Health System in Brazil. The decrease in the number of procedures varied from 55% in the first month of the COVID-19 pandemic to over 88% in the following months of the evaluation. The reduction was observed for all procedures, including emergencies. A reduction is to be expected considering that, since the middle of March, several regions were recommending quarantine, social distancing measures, closure of schools and the reduction of non-essential activities to flatten the curve and prevent the health system from collapsing.[22,23] Also, considering the high risk of contamination in dental clinics,[2,24,25,26] health institutions and professional councils issued guidance to reduce activities in dental services to only emergency and urgent care. Even though the reduction at the beginning of the pandemic was considerable, when the exponential growth took off, the systems almost suffered a shutdown.[20,27,28,29] A national online survey with more than 3,000 dentists from all regions found that more than 95% of those interviewed had reduced the number of patients they were seeing or were only attending emergencies or were not attending at all.[30] Also, there was a difference between dentists working in public and private networks. While almost 80% of the dentists in public clinics were maintaining only emergency appointments, 52% of private dentists reported seeing fewer patients than usual due to the pandemic. This reduction may result in a sharp increase in the demand for dental care post-COVID-19.[31,32] An improvement in Brazilian oral health indicators has been observed, especially among children and adolescents.[33] The lack of promotion of preventive activities could have a significantly negative impact, compromising the good results observed over the past decade.[34] Thus, the drastic reduction in dental services offered due to the Pandemic, in the public health system, may further polarize the huge inequalities already present in oral health.[34,35]

Our results also pointed to significant reductions in specialized dental procedures, such as prosthetics, endodontics and periodontal surgical treatment. However, prosthetics procedures exhibited a smaller decrease, probably due to the less frequent use of instruments that generate aerosols.[36] In addition, prosthesis procedures may be being performed due to the long manufacturing lead time and the need to finalize procedures started prior to the pandemic. The reduction in endodontic procedures may be explained by the high production of aerosols and the prioritization of tooth extractions in view of its more

Table 5. Adjusted* incidence rate ratio (IRR) and 95%CI for total procedures, first dental visit, emergencies, restorative procedures, endodontics, tooth extractions, individual preventives, collective preventives, basic periodontal, prosthetic, surgical periodontal treatments, in models of multilevel mixed-effects negative binomial regression for Brazilian municipalities (n = 5,564). March to August 2019 and March to August 2020.

Group of procedures Ref. No pandemic	Impact of COVID 19 monthly compared											
	March		April		May		June		July		August	
	IRR (95%CI)	p-value	IRR (95%CI)	p-value	IRR (95%CI)	p-value	IRR (95%CI)	p-value	IRR (95%CI)	p-value	IRR (95%CI)	p-value
Total of procedure	0.45 (0.39–0.51)	< 0.001	0.06 (0.06–0.07)	< 0.001	0.07 (0.06–0.08)	< 0.001	0.09 (0.07–0.10)	< 0.001	0.12 (0.10 0.14)	< 0.001	0.09 (0.07–0.10)	< 0.001
First dental visit	0.52 (0.43–0.63)	< 0.001	0.08 (0.07–0.10)	<.001	0.10 (0.08–0.12)	< 0.001	0.14 (0.11–0.17)	< 0.001	0.15 (0.12–0.19)	< 0.001	0.09 (0.07–0.12)	< 0.001
Emergency	0.58 (0.49–0.68)	< 0.001	0.22 (0.18–0.27)	< 0.001	0.25 (0.21–0.30)	< 0.001	0.32 (0.27–0.39)	< 0.001	0.34 (0.28–0.40)	< 0.001	0.28 (0.23–0.34)	< 0.001
Restoration	0.49 (0.41–0.57)	< 0.001	0.08 (0.01–0.10)	< 0.001	0.10 (0.08–0.12)	< 0.001	0.13 (0.11–0.16)	< 0.001	0.12 (0.10–0.15)	< 0.001	0.06 (0.05–0.07)	< 0.001
Tooth Extraction	0.48 (0.41–0.56)	< 0.001	0.06 (0.05–0.07)	< 0.001	0.14 (0.11–0.17)	< 0.001	0.14 (0.12–0.16)	< 0.001	0.22 (0.19–0.27)	< 0.001	0.17 (0.14–0.21)	< 0.001
Endodontics	0.60 (0.53–0.69)	< 0.001	0.14 (0.01–0.20)	< 0.001	0.02 (0.01–0.03)	< 0.001	0.04 (0.03–0.05)	< 0.001	0.06 (0.05–0.09)	< 0.001	0.17 (0.12–0.24)	< 0.001
Individual preventives	0.45 (0.38–0.53)	< 0.001	0.01 (0.00–0.01)	< 0.001	0.01 (0.01–0.02)	< 0.001	0.02 (0.01–0.02)	< 0.001	0.03 (0.02–0.03)	< 0.001	0.05 (0.04–0.06)	< 0.001
Collective preventives	0.24 (0.17–0.14)	< 0.001	0.00 (0.00–0.01)	< 0.001	0.00 (0.00–0.01)	< 0.001	0.00 (0.00–0.01)	< 0.001	0.00 (0.00–0.01)	< 0.001	0.00 (0.00–0.01)	< 0.001
Basic periodontal	0.55 (0.44–0.67)	< 0.001	0.01 (0.01–0.02)	< 0.001	0.01 (0.01–0.02)	< 0.001	0.01 (0.01–0.02)	< 0.001	0.04 (0.03–0.06)	< 0.001	0.05 (0.04–0.06)	< 0.001
Prosthetics	0.66 (0.53–0.81)	< 0.001	0.29 (0.23–0.37)	< 0.001	0.29 (0.23–0.38)	< 0.001	0.33 (0.26–0.42)	< 0.001	0.41 (0.32–0.51)	< 0.001	0.32 (0.25–0.40)	< 0.001
Surgical periodontal	0.50 (0.42–0.60)	< 0.001	0.03 (0.02–0.04)	< 0.001	0.03 (0.02–0.04)	< 0.001	0.05 (0.04–0.06)	< 0.001	0.06 (0.05–0.08)	< 0.001	0.07 (0.06–0.10)	< 0.001

*Human Development Index; Populational size; Gini index; Brazilian Regions.

Table 6. G-computation analysis of dentistry services restriction as a mediator in the association between COVID-19 pandemic (from the March 2020 to August 2020) and dentistry procedures in Brazilian Public Services. (n = 5,564).

Variable	G-computation estimate (Coef.)	Bootstrap std. err.	p-value	95%CI (OR)
Total procedures				
TCE	-0.23	0.0069	< 0.001	-0.24– -0.21
NDE	-0.23	0.0061	< 0.001	-0.24– -0.22
NIE	0.00	0.0023	0.858	-0.00– 0.01
CDE	-0.22	0.0058	< 0.001	-0.23– -0.22
Dentistry Access				
TCE	-0.15	0.0058	< 0.001	-0.16– -0.14
NDE	-0.15	0.0060	< 0.001	-0.16– -0.14
NIE	0.00	0.0020	0.324	-0.00– 0.00
CDE	-0.10	0.0037	< 0.001	-0.11– -0.09
Emergency				
TCE	-0.16	0.0070	< 0.001	-0.17– -0.14
NDE	-0.16	0.0069	< 0.001	-0.16– -0.15
NIE	0.00	0.0019	0.222	-0.00– 0.01
CDE	-0.12	0.0052	< 0.001	-0.14– -0.11
Restoration				
TCE	-0.16	0.0071	< 0.001	-0.17– -0.14
NDE	-0.16	0.0072	< 0.001	-0.17– -0.14
NIE	0.00	0.0021	0.245	-0.00– 0.01
CDE	-0.14	0.0059	< 0.001	-0.15– -0.13
Tooth extraction				
TCE	-0.17	0.0070	< 0.001	-0.18– -0.16
NDE	-0.17	0.0070	< 0.001	-0.18– -0.16
NIE	0.00	0.0021	0.679	-0.00– 0.00
CDE	-0.15	0.0058	< 0.001	-0.16– -0.14
Endodontics				
TCE	-0.14	0.0037	< 0.001	-0.15– -0.13
NDE	-0.14	0.0039	< 0.001	-0.15– -0.14
NIE	0.00	0.0009	0.568	-0.00– 0.00
CDE	-0.15	0.0046	< 0.001	-0.16– -0.14
Individual preventives				
TCE	-0.23	0.0063	< 0.001	-0.24– -0.21
NDE	-0.22	0.0063	< 0.001	-0.24– -0.21
NIE	0.00	0.0018	0.815	-0.00– 0.00
CDE	-0.18	0.0050	< 0.001	-0.19– -0.18
Collective preventives				
TCE	-0.13	0.0043	< 0.001	-0.14– -0.12
NDE	-0.13	0.0042	< 0.001	-0.14– -0.13
NIE	0.00	0.0011	0.661	-0.00– 0.00
CDE	-0.07	0.0026	<0.001	-0.08 – -0.06
Basic periodontal				
TCE	-0.17	0.0049	<0.001	-0.18 – -0.16
NDE	-0.17	0.0049	<0.001	-0.19 – -0.16
NIE	0.00	0.0015	0.913	-0.00 – 0.00
CDE	-0.11	0.0032	<0.001	-0.11 – -0.10

Continue

Continue

Variable	G-computation estimate (Coef.)	Bootstrap std. err.	p-value	95%CI (OR)
Prosthetic				
TCE	-0.19	0.0039	<0.001	-0.19 – -0.18
NDE	-0.18	0.0039	<0.001	-0.19 – -0.18
NIE	0.00	0.0012	0.766	-0.00 – 0.00
CDE	-0.19	0.0046	<0.001	-0.20 – -0.18
Surgical periodontal				
TCE	-0.22	0.0054	<0.001	-0.23 – -0.21
NDE	-0.21	0.0057	<0.001	-0.23 – -0.21
NIE	0.00	0.0014	0.394	-0.00 – 0.00
CDE	-0.18	0.0050	<0.001	-0.19 – -0.17

conservative treatment.[37] Additionally, endodontic procedures and periodontal surgical procedures depend on referrals of primary care made in elective dental visits.[38]

The pandemic required measures to be taken by governments to curb the spread of the virus,[11] one of which was the restriction of elective dental procedures. The mediation analysis carried out in this study showed that, regardless of the restrictive regulations adopted for elective procedures, there was a reduction in the number of procedures performed, *i.e.*, the restriction did not mediate the association between the pandemic and the number of procedures performed. This may be explained by the reorganization of services in the Health Units to cope with the circumstances imposed by the pandemic, not just those related to dental services.

To reduce the negative impact of the Pandemic on the population´s oral health, some efforts should be made by policymakers, including the use of teledentistry for primary oral health care,[39] which could be adapted for preventive approaches. Brazilian dentists have already attempted to implement teledentistry in their practices since the start of the Pandemic.[30] Also, a more minimally invasive approach should be considered, especially reducing the use of aerosols in the dental.[40] In addition, emergency care should be maintained. Before the pandemic, despite the expansion in Primary Health Care services, the SUS system was already challenged by several problems, including the fragmentation of actions, underfunding and low quality of management.[41] With the Pandemic, the difficulties were exacerbated, requiring a reorganization of health practices to contain the spread of the virus, incorporating new biosafety routines and protocols into the service, which would require additional human and physical resources and equipment.[42]

Considering the strengths of this study, we investigated the association between the COVID-19 pandemic and procedures performed in Brazilian oral health public services, at a municipal level, using time-series analysis and controlling the analyses through the factors that could bias the results or even be mediators. Also, we have followed up on the number of procedures carried out during 6 months of Pandemic development and compared them with the same months from the previous year. Moreover, this study presents weaknesses that we should point out, such as those related to the use of secondary data, which may be under- or over-reported. Furthermore, the reporting of these data may have been affected by the context of the COVID-19 Pandemic. Moreover, the evaluation of state restrictions for dental care might include regulations from state health departments, information not investigated by this study.

Conclusion

This study observed a drastic reduction in dental procedures performed in the Public Dental Health System after the appearance of COVID-19 in Brazil, which resulted in a near shutdown of the system. A significant reduction was observed for all kinds of treatment, preventive, curative or emergency and, reductions in all groups of procedures were

associated with the period of the COVID-19 Pandemic in Brazil. Additionally, the restrictions imposed through state executive decrees did not mediate the association between the COVID-19 pandemic and dental procedures, considering the total number of procedures and all groups of dental procedures.

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