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Impact of COVID-19 pandemic on completed treatments and referrals during urgent dental visits

Luciéli Andréia ZAJKOWSKI[a]
Roberta Kochenborger SCARPARO[a]
Heloisa Grehs e SILVA[a]
Roger Keller CELESTE[a]
Patrícia Maria Poli KOPPER[a]

[a]Universidade Federal do Rio Grande do Sul – UFRGS, Graduate Program in Dentistry, Porto Alegre, RS, Brazil.

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Corresponding Author:
Roger Keller Celeste
E-mail: roger.keller@ufrgs.br

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Abstract: This ecological study assessed the impact of the COVID-19 pandemic on completed treatments (CTs) and referrals during urgent dental visits to primary health care units in Brazil, and their associations with socioeconomic, geodemographic, and pandemic index factors in Brazilian municipalities. The difference in rates of procedures 12 months before and during the pandemic was calculated. Data were extracted at baseline from health information systems of all municipalities that provided urgent dental care (n = 5,229 out of 5,570). Multiple logistic regression predicted the factors associated with referrals and CTs. The number of dental urgencies increased from 3,987.9 to 4,272.4 per 100,000 inhabitants. The rates of referrals decreased in 44.1% of the municipalities, while 53.9% had lower rates of CTs. Municipalities with a greater number of oral health teams in the primary health care system (OR = 1.52, 95%CI:1.21–1.91) and with specialized services (OR = 1.80, 95%CI:1.50–2.16) were more likely to decrease referrals during the pandemic. Higher HDI and GDP per capita were associated with a larger decrease in referrals and smaller decrease in CTs. The calamity generated by the long pandemic period resulted in a greater demand for urgent visits. Less developed and larger cities seem to have been more likely to not complete treatments during urgent visits in primary dental care units in times of calamity. Primary dental care offices in smaller and less developed municipalities should be better equipped to provide appropriate assistance and to improve the problem-solving capacity of dental services during emergencies.

Keywords: COVID-19; Dentistry; Pandemics; Dental Health Services.

Introduction

Brazil is one of the few countries in the world where oral health care is part of the universal health care system, offered at no direct cost to the users.[1] The universal health care system is funded by federal, state, and local governments, but services are delivered by municipalities in the Brazilian public health system ("Sistema Único de Saúde" [SUS]). Therefore, official health surveillance systems and administrative databases are available to provide information about visits in municipalities.[2,3]

The pandemic caused by the SARS-CoV-2 virus, which spread worldwide at the end of 2019, has become a historical landmark with an impact on the delivery of health services.[4-7] Aerosols are the most common mode of transmission, putting dentists at a high risk of acquiring and transmitting the disease when appropriate biosafety measures are not adopted.[8] To contain the spread of SARS-CoV-2, governmental measures of social isolation and lockdown of non-essential services were interspersed with the removal of some restrictions on economic activities.[9]

During the initial period of the pandemic, the recommendations of the dental societies worldwide were focused on maintaining only emergency and urgency dental care. Several guidelines for dental practice were published, stating that professionals had to maintain regular observation of local health department reports, ensure the use of personal protective equipment (PPE), and screen all patients for COVID-19 signs and symptoms. The use of appropriate PPE, i.e., gloves, disposable fluid-resistant gown, eye protection (face shield or goggles), and a medical mask (N95 or KN95), was recommended for the whole staff during dental care consultations.[10] Moreover, the use of teledentistry, which was also recommended, increased.[11-14]

The pandemic may have changed the profile of urgent health care Conditions that would be otherwise referred to a specialist might have been treated by clinical dentists as much as possible. In addition, the reductions in primary and secondary dental care services may differ according to the characteristics of the municipalities. Studies about changes in the profile of urgent visits during the COVID-19 pandemic indicated an increase of dental pain associated with oral infections.[15,16] Symptomatic irreversible pulpitis accounted for the largest proportion of dental emergencies in Wuhan.[15] Dental and oral infections increased, while dental trauma decreased during the COVID-19 pandemic.[16] However, previous reports have included only convenience samples in specific emergency services, and no representative population-based studies have been conducted to compare findings before and during the pandemic. A recent bibliometric analysis has found a low level of scientific evidence provided by the dental literature on COVID-19.[17]

Evidence on to what extent urgent visits may provide complete treatments or referrals may help to predict dental care demands and to plan strategies to avoid the collapse of health services, while ensuring that people receive appropriate health care. This is especially relevant when an unmet demand may turn into an emergency. In Brazil, access to primary dental care is significantly higher in more developed municipalities.[18] Therefore, socioeconomic and demographic factors, public policies, and oral health service coverage possibly have an important role after a calamity.

This study assessed the impact of the COVID-19 pandemic on rates of completed treatments and referrals made during urgent dental visits to primary health units in Brazil, as well as theirassociation with socioeconomic, geodemographic, and pandemic index factors in the municipalities.

Methodology

This study used two reporting guidelines for observational studies, the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement and the REporting of studies Conducted using Observational Routinely collected Data (RECORD) statement.

Study design

This ecological longitudinal study used all Brazilian municipalities as the units of analysis. Comparisons were made between two time points: a) before (March 2019 to February 2020) and b) during (March 2020 to February 2021) the COVID-19 pandemic. The study included only data for municipalities that provided urgent dental care at baseline (n = 5,229 out of 5,570). The rates of referrals to dental centers and of completed treatments during urgent dental visits in the Brazilian primary health care units were calculated. The association of geodemographic, socioeconomic, and pandemic indices with both outcomes were analyzed. This study did not require ethical approval as it used only data aggregated from public sources.

Data source

Data were extracted from several open secondary databases: the Primary Health Care Information System (SISAB), the Ambulatory Care Information System (SIA-SUS), the Hospital Information System (SIH), the Brazilian Institute of Geography and Statistics (IBGE), and the National Register of Health Facilities (CNES). These databases are official sources of information made available by federal government agencies on their websites. Data were collected in May 2021 and extracted for each municipality.

Outcome variables

The outcome variables were the differences between the rates per 100,000 inhabitants and year of urgent dental visits with a treatment completed or a patient referred to a specialist in Brazilian municipalities before and during COVID-19. The difference was dichotomized for each municipality and classified as a "decrease" (code = 1) or an "increase/stable" (code = 0).

Main predictors and covariates

All Brazilian states implemented restrictions for municipalities based on several factors, such as the number of COVID-19 hospitalizations, index used as an instrumental variable to predict COVID-19 pandemic restrictions. The rates of hospitalizations due to COVID-19 per 100,000 inhabitants were classified as none, zero to one hundred (0–100), and more than one hundred (> 100). COVID data were collated from March 2020 to February 2021.

Socioeconomic development was measured using the human development index (HDI), gross domestic product (GDP) and income distribution (Gini) index. HDI was calculated for each municipality based on the 2010 census and classified as very low/low (41.8–61.9), medium (62.0–70.1) and high/very high (70.2–86.2). GDP per capita in 2017 was dichotomized into ≤ US$ 5,177 and > US$ 5,177. The Gini index distribution was also based on the 2010 census and classified into three categories (≤ 0.45; 0.46–0.54; ≥ 0.55), where zero means equal distribution and 1 indicates completely unequal distribution.

Broad public policies, as previously described,[19] town/city size, geographical region, primary dental care coverage and presence of dental specialized centers were also incorporated into the analytical model, as they were potential confounding factors. Broad public policies were described according to the national median values; town/city size was classified into five categories according to the number of inhabitants (< 10,000, 11,000–20,000, 21,000–50,000, 51,000–100,000, or > 100,000); the Brazilian territory was divided into its five geographical regions (Midwest, Northeast, North, Southeast, and South); coverage of primary dental services was classified into five categories (0–10; 11–20; 21–30; 31–40; and >40) according to the number of oral health teams per 100,000 inhabitants in the Brazilian Family Health Strategy; and data about specialized centers were dichotomized as zero or greater than zero (> 0).

Statistical analysis

Annual mean numbers and standard deviations of urgent visits per 100,000 inhabitants before and during the COVID-19 pandemic and of referrals to dental centers and completed treatments in Brazilian municipalities were described in tables. The differences between the two time points were also described as annual mean and standard deviation values. The comparison of rates before and during the COVID-19 pandemic was tested using the sign test for medians.

The percentage of municipalities with decreased rates of referrals to dental centers and of completed treatments in the comparison of the 12 months before the pandemic and during the pandemic was described. Bivariate analyses used the Kruskal-Wallis test for rate differences and the chi-square test for dichotomous variables. A stepwise multiple logistic regression was conducted to predict the chances of decrease of the rate of referral to dental centers and of completed treatments in municipalities.

Results

For all Brazilian municipalities, compared with the 12 months before, the number of urgent visits increased by 7.1% during the COVID-19 pandemic (3,987.9 to 4,272.4 per 100,000 inhabitants/year). The

rates of treatments completed during urgent visits increased by 11.1% (1,856.3 to 2,063.7 per 100,000 inhabitants/year), whereas the rates of referrals to dental centers decreased by 3.5% (525.3 to 506.4 per 100,000 inhabitants/year) (Table 1).

There was a decrease in the rates of completed treatment during urgent visits in most Brazilian municipalities (53.9%) (Table 2), with the greatest decreases in the rates of completed treatments in the North (mean= -347.0, SD = ± 3017.1), Northeast (mean = -806.3, SD = ± 3052.8), and Midwest (mean = -28.2 ± 3284.1). Moreover, municipalities with the lowest HDI (mean = -690.4, SD = ± 3386.6) and worst income distribution (mean = -463.4, SD = ± 2929.7) had a higher decrease in completed treatments (Table 3). Despite the decrease in the annual mean value of referrals to dental centers after urgent visits, there was an increase in most Brazilian municipalities (55.9%). Referrals increased only in the South (mean= 91.9, SD= ±809.5). In addition, the rates of referrals increased in municipalities without specialized centers (mean = 6.5, SD = ±1390.0) and decreased in those where specialized services were offered (mean = -133.5, SD= ±1125.1). Municipalities with fewer than 10,000 inhabitants were less affected by the decrease in referrals (mean= -11.6, SD = ±1724.6) (Table 4). Bivariate analyses revealed that, except for the presence of specialized centers, all variables had an effect on the number of completed treatments. In contrast, only the presence of specialized centers, public health scores, and geographic region affected referrals to dental centers (Tables 2, 3, and 4).

Stepwise multiple logistic regression revealed that town/city size, geographic region, HDI, GDP per capita, primary dental care coverage, and presence of dental specialized centers were associated with the decrease in referrals to dental centers during the COVID-19 pandemic. The chance of a decrease in the number of referrals was directly associated with town/city size, and cities with more than 100,000 inhabitants were more likely to have greater decreases (OR = 1.73, 95%CI:1.25–2.38). The North (OR = 0.75, 95%CI: 0.59–0.96) and South (OR = 0.54, 95%CI: 0.45–0.65) were less likely to have a decrease in referrals than the Southeast. Cities with a higher HDI (OR = 1.33, 95%CI: 1.05–1.69) and GDP per capita (OR = 1.18, 95%CI: 1.00–1.39) had slightly fewer referrals to dental centers after urgent visits than cities with lower indices. The number of oral health teams in the Family Health Strategy was directly associated with decreases in referrals, and odds were 1.52 times greater for cities with more than 40 teams than cities with 0–10 teams. Similarly, the presence of specialized centers in the municipalities favored the decrease of referrals to dental centers (OR = 1.80, 95%CI: 1.50–2.16) (Table 5).

The stepwise multiple logistic regression revealed that town/city size, geographic region, HDI, and GDP per capita were associated with the number of completed treatments during urgent visits. The Northeast had a greater decrease of completed treatments than did the Southeast (OR = 3.57, 95%CI: 2.95–4.33). A higher HDI (OR = 0.79, 95%CI: 0.62–1.01) and GDP per capita (OR = 0.86, 95%CI: 0.73–1.01) increased the rates of completed treatments after urgent visits (Table 5).

Table 1. Local annual mean rate and standard deviation (+/-SD) per 100,000 inhabitants per year of urgent dental visits, referrals to dental centers, and completed treatments before (March 2019 to February 2020) and during (March 2020 to February 2021) the COVID-19 pandemic in Brazil.

Variable	Annual mean rate	SD
Urgent dental visits		
March 2019 – February 2020	3987,9	± 5979.9
March 2020 – February 2021	4272,4	± 6393.0
Rate difference	284,4	± 4596.4
Referrals to dental centers		
March 2019 – February 2020	525,3	± 1431.0
March 2020 – February 2021	506,4	± 1477.0
Rate difference	-18,9	± 1346.8
Completed treatments		
March 2019 – February 2020	1856,3	± 3268.1
March 2020 – February 2021	2063,7	± 4118.0
Rate difference	207,4	± 4446.5

*Significant difference showed by sign test for medians before and during the COVID-19 pandemic ($p < 0.05$).

Table 2. Percentage of municipalities with annual decrease in referrals to dental centers and in completed treatment during urgent dental visits comparing 12 months before and during the COVID-19 pandemic in Brazil at city level.

Variable	Total	Decrease in referrals to dental centers		Decrease in completed treatment	
	n	%	p-value	%	p-value
City size (thousands) in 2020					
< 10 inhab	2225	37,0	< 0.01	51,5	< 0.01
10–20 inhab	1289	45,5		55,9	
20–50 inhab	1058	49,5		60,0	
50–100 inhab	338	54,7		55,3	
> 100 inhab	319	59,6		40,1	
Gross domestic product per capita in 2017**					
US$ ≤5177	2701	44,4	0,70	62,0	< 0.01
US$ > 5177	2528	43,9		45,2	
Primary dental care coverage in 2019 (oral health teams in the family health strategy per 100,000 inhabitants)					
0–10	860	42,7	0,56	40,9	< 0.01
> 10–20	840	45,0		53,8	
> 20–30	1102	45,4		56,9	
> 30–40	1134	45,0		55,4	
> 40	1293	42,8		58,6	
Dental specialized centers					
None	4280	40,2	< 0.01	53,9	0,93
> 0	949	61,8		53,7	
Municipal Human Development Index in 2010					
41.8–61.9 (very low/low)	1370	42,0	0,17	68,8	< 0.01
62.0–70.1 (medium)	2084	45,0		54,9	
70.2– 86.2 (high/very high)	1771	44,9		41,1	
Income distribution in 2010 (0 = equal; 1= completely unequal)					
≤0.45	1394	40,5	< 0.01	46,4	< 0.01
0.46–0.54	2706	45,1		54,1	
≥ 0.55	1121	46,3		62,3	
Public Policy Score					
Better than National Median	2562	46,3	< 0.01	48,1	< 0.01
Worse than National Median	2613	42,3		59,7	
Hospitalization rate due to COVID-19 per 100 thousand inhabitants (March 2020- February 2021)					
None	2989	40,4	< 0.01	53,7	< 0.01
0–100	1082	47,7		59,4	
> 100	1158	50,4		49,2	
Geographical Region					
Middle-west	444	45,3	< 0.01	57,2	< 0.01
Northeast	1770	48,4		71,2	
North	424	38,4		59,9	
Southeast	1583	47,6		35,8	
South	1008	33,1		47,7	
Total	5229	44,1		53,9	

Table 3. Municipal mean and standard deviation (SD) of completed treatments rate before (March 2019 to February 2020) and during (March 2020 to February 2021) the COVID-19 pandemic according to several characteristics at city level (n = 5,229).

Variable	Total		Annual rate of completed treatments before pandemic			Annual rate completed treatments during pandemic			Rate diference		
	n	%	Mean	SD	p-values*	Mean	SD	p-values*	Mean	SD	p-values*
City size (thousands) in 2020											
<10 inhab	2225	42,6	2303,0	4262,2	< 0.01	2672,3	5428,0	0,04	369,3	5971,8	< 0.01
10-20 inhab	1289	24,7	1747,7	2534,5		1798,3	3053,5		50,6	3294,1	
20-50 inhab	1058	20,2	1611,1	2173,3		1609,8	2643,2		-1,3	2731,4	
50-100 inhab	338	6,5	1219,1	1521,3		1365,5	1965,1		146,3	1920,6	
> 100 inhab	319	6,1	668,0	936,7		1136,8	1643,8		468,8	1573,6	
Gross domestic product per capita in 2017**											
US$ ≤ 5.177	2701	51,7	2044,8	3516,5	< 0.01	1982,8	4294,6	< 0.01	-61,9	4703,8	< 0.01
US$ > 5.177	2528	48,3	1655,0	2967,3		2150,1	3919,5		495,2	4135,7	
Primary dental care coverage in 2019 (oral health teams in the family health strategy per 100,000 inhabitants)											
0-10	860	16,4	867,4	1902,6	< 0.01	1239,9	2383,3	< 0.01	372,5	2636,8	< 0.01
> 10-20	840	16,1	1127,8	1854,7		1403,9	2362,2		276,1	2418,9	
> 20-30	1102	21,1	1580,7	2082,5		1806,5	3052,4		225,8	3012,0	
> 30-40	1134	21,7	2162,4	3137,9		2382,5	4007,6		220,1	4435,7	
> 40	1293	24,7	2953,9	4888,5		2980,0	6121,5		26,1	6822,3	
Dental specialized centers											
None	4280	81,9	1902,3	3443,2	0,05	2127,1	4372,3	< 0.01	224,8	4710,6	0,59
> 0	949	18,1	1649,0	2309,2		1777,8	2669,9		128,8	2978,5	
Municipal Human Development Index in 2010											
41.8–61.9 (very low/low)	1370	26,2	2002,8	3066,9	< 0.01	1312,3	2662,6	< 0.01	-690,4	3386,6	< 0.01
62.0–70.1 (medium)	2084	39,9	1898,3	3362,9		2378,9	4797,7		480,7	4955,8	
70.2– 86.2 (high/very high)	1771	33,9	1693,9	3303,2		2278,4	4111,7		584,5	4445,0	
Income distribution in 2010 (0 = equal; 1= completely unequal)											
≤ 0.45	1394	26,7	2242,8	4519,7	0,03	3007,6	5806,8	< 0.01	764,8	6284,2	< 0.01
0.46–0.54	2706	51,7	1731,8	2642,8		1935,4	3548,1		203,5	3736,4	
≥ 0.55	1121	21,4	1672,7	2701,9		1209,3	2216,5		-463,4	2929,7	
Public Policy Score											
Better than National Median	2562	49,0	2202,2	3920,2	< 0.01	2775,6	5153,8	< 0.01	573,4	5536,7	< 0.01
Worse than National Median	2613	50,0	1517,8	2384,0		1360,7	2554,1		-157,1	2905,6	
Hospitalization rate due to COVID-19 per 100 thousand inhabitants (March 2020- February 2021)											
None	2989	57,2	2093,7	3733,7	< 0.01	2362,7	4872,6	0,44	269,1	5221,7	< 0.01
0-100	1082	20,7	1667,4	2788,3		1665,8	2882,8		-1,6	3376,0	
> 100	1158	22,1	1420,3	2150,7		1663,8	2646,4		243,5	2867,5	
Geographical Region											
Middle-west	444	8,5	1801,9	2993,6	< 0.01	1573,8	2717,8	< 0.01	-228,2	3284,1	< 0.01
Northeast	1770	33,8	2077,8	2971,4		1271,5	2407,8		-806,3	3052,8	
North	424	8,1	1516,0	2619,9		1169,1	2164,4		-347,0	3017,1	
Southeast	1583	30,3	2036,1	4146,4		3625,2	5924,5		1589,1	6168,0	
South	1008	19,3	1352,3	2379,2		1594,8	3449,0		242,4	3594,3	
Total	5229	100,0	1856,3	3268,1		2063,7	4117,9		207,4	4446,5	

*Kruskal-Wallis test; **In July 30, 2017 US$ 1 = RS$ 5.17.

Table 4. Municipal annual mean urgent dental visits and standard deviation (SD) of referrals to dental centers before (March 2019 to February 2020) and during (March 2020 to February 2021) the COVID-19 pandemic according to several characteristics at city level (n = 5,229).

Variable	Total		Annual rate of referral before pandemic			Annual rate referral during pandemic			Rate diference		
	n	%	Mean	SD	p-values*	Mean	SD	p-values*	Mean	SD	p-values*
City size (thousands) in 2020											
< 10 inhab	2225	42,6	538,4	1866,8	< 0.01	526,9	1871,3	< 0.01	-11,6	1724,6	0,02
10–20 inhab	1289	24,7	508,8	1073,3		463,2	1012,6		-45,6	1009,4	
20–50 inhab	1058	20,2	545,6	1023,1		569,3	1336,0		23,7	1100,9	
50–100 inhab	338	6,5	572,1	892,5		500,5	945,0		-71,6	764,0	
> 100 inhab	319	6,1	384,0	525,6		336,1	537,0		-47,9	483,5	
Gross domestic product per capita in 2017**											
US$ ≤ 5.177	2701	51,7	470,5	1377,8	0,19	464,4	1324,3	0,96	-6,1	1432,3	0,19
US$ > 5.177	2528	48,3	583,9	1483,8		551,3	1623,3		-32,6	1249,2	
Primary dental care coverage in 2019 (oral health teams in the family health strategy per 100,000 inhabitants)											
0–10	860	16,4	347,0	1122,5	< 0.01	339,2	965,1	< 0.01	-7,8	947,3	0,15
> 10–20	840	16,1	410,7	887,1		367,7	798,0		-43,0	819,8	
> 20–30	1102	21,1	539,3	1370,2		532,9	1644,4		-6,4	1554,4	
> 30–40	1134	21,7	607,0	1341,9		550,6	1363,7		-56,4	1143,8	
> 40	1293	24,7	634,9	1926,2		646,4	1950,9		11,6	1760,0	
Dental specialized centers											
None	4280	81,9	462,1	1478,0	< 0.01	468,6	1512,9	< 0.01	6,5	1390,0	<0.01
> 0	949	18,1	810,5	1154,4		676,9	1289,4		-133,5	1125,1	
Municipal Human Development Index in 2010											
41.8–61.9 (very low/low)	1370	26,2	342,4	914,0	< 0.01	367,5	1070,8	< 0.01	25,1	1003,0	0,03
62.0–70.1 (medium)	2084	39,9	557,8	1541,8		518,8	1388,3		-39,0	1549,4	
70.2– 86.2 (high/very high)	1771	33,9	629,2	1601,9		599,2	1806,3		-30,0	1323,5	
Income distribution in 2010 (0 = equal; 1= completely unequal)											
≤ 0.45	1394	26,7	669,5	2019,3	< 0.01	645,6	1999,1	< 0.01	-23,8	1967,5	0,89
0.46–0.54	2706	51,7	507,9	1175,1		498,2	1333,1		-9,7	1074,1	
≥ 0.55	1121	21,4	385,3	1044,7		352,9	931,3		-32,4	921,7	
Public Policy Score											
Better than National Median	2562	49,0	707,3	1789,1	< 0.01	653,9	1841,9	< 0.01	-53,4	1673,8	<0.01
Worse than National Median	2613	50,0	349,3	936,9		362,0	985,4		12,7	930,7	
Hospitalization rate due to COVID-19 per 100 thousand inhabitants (March 2020- February 2021)											
None	2989	57,2	527,9	1639,8	< 0.01	523,0	1673,5	< 0.01	-4,9	1506,9	0,14
0-100	1082	20,7	481,7	1156,7		424,7	997,3		-57,0	1045,6	
> 100	1158	22,1	559,5	1027,1		539,9	1298,9		-19,5	1144,0	
Geographical Region											
Middle-west	444	8,5	484,8	990,7	< 0.01	424,2	1047,9	< 0.01	-60,6	1000,1	<0.01
Northeast	1770	33,8	439,8	1062,9		412,1	1027,9		-27,7	982,9	
North	424	8,1	242,0	769,2		207,6	667,5		-34,4	687,4	
Southeast	1583	30,3	841,2	2149,0		777,5	2163,8		-63,8	2019,9	
South	1008	19,3	316,3	680,0		408,2	1123,3		91,9	809,5	
Total	5229	100,0	525,3	1431,0		506,4	1477,0		-18,9	1346,8	

*Kruskal-Wallis test; **In July 30, 2017 US$ 1 = RS$ 5.17.

Table 5. Odds ratio and 95% confidence interval (95%CI) of decreasing referrals to dental centers rates and decreasing completed treatment rates at city-level factors in stepwise multiple logistic regression analysis (n = 5229).

Variable	Referrals to dental centers			Completed treatments		
	OR*	95% CI		OR*	95% CI	
City size (thousands) in 2020						
< 10 inhab	1			1		
10–20 inhab	1,39	1,20	1,62	1,00	0,87	1,16
20–50 inhab	1,49	1,24	1,78	1,25	1,06	1,46
50–100 inhab	1,61	1,21	2,14	1,13	0,88	1,45
> 100 inhab	1,73	1,25	2,38	0,80	0,61	1,03
Geographical Region						
Southeast	1			1		
Middle-west	0,87	0,70	1,09	2,40	1,93	3,00
Northeast	1,09	0,90	1,33	3,57	2,95	4,33
North	0,75	0,59	0,96	2,26	1,78	2,88
South	0,54	0,45	0,65	1,78	1,50	2,12
Municipal Human Development Index in 2010						
41.8 – 61.9 (very low/low)	1			1		
62.0 – 70.1 (medium)	1,28	1,08	1,52	0,95	0,80	1,14
70.2– 86.2 (high/very high)	1,33	1,05	1,69	0,79	0,62	1,01
Gross domestic product per capita in 2017**						
US$ ≤ 5.177	1			1		
US$ > 5.177	1,18	1,00	1,39	0,86	0,73	1,01
Primary dental care coverage in 2019 (oral health teams in the family health strategy per 100,000 inhabitants)						
0–10	1			-		
> 10–20	1,24	1,01	1,53	-	-	-
> 20–30	1,35	1,10	1,67	-	-	-
> 30–40	1,49	1,19	1,85	-	-	-
> 40	1,52	1,21	1,91	-	-	-
Dental specialized centers						
None	1			-		
> 0	1,80	1,50	2,16	-	-	-

*All variables mutually adjusted; **In July 30, 2017 US$ 1 = RS$ 5.17.

Discussion

This study improved the understanding of relevant factors associated with the demand for urgent dental care during the COVID-19 pandemic. After one year of pandemic in Brazil, the number of urgent visits and the rate of completed treatments significantly increased, whereas referrals to dental centers decreased in comparison with the 12 months before. The increase in the problem-solving capacity of primary care during urgent visits might have been associated with the fact that specialized centers were closed during the time of restrictions,[11,13,20] and primary dental care units had to solve as many problems as possible. This indicated that primary care might be able to solve more complex situations and that referrals from primary care to specialized dental centers might have to be re-evaluated. In this context, the COVID-19 pandemic highlighted the importance

of the Brazilian health care model, in which family health teams work in a specific catchment area. The performance of primary health care services had positive impacts on the population's health, playing an important role in the care network and contributing vigorously to community assistance, necessary to face any calamitous situation.[21]

Despite the increase in the annual mean rate of completed treatments during urgencies, most Brazilian municipalities had a decrease in the total number of visits. Moreover, the municipalities with an increase in completed treatments were not necessarily those where referrals decreased. According to the findings reported here, town/city size, geographical region, HDI, and GDP per capita were associated with both outcomes. However, the number of oral health teams in the Family Health Strategy and specialized centers affected only referrals to dental centers. It is plausible to assume that there was a reduction in overall work overload among oral health teams due to a decrease in elective procedures, which could have allowed them to increase rates of completed treatment. However, this may be unlikely because there were no structural changes in primary health care, such as an increase in X-rays and other dental materials. In the adjusted model, higher coverage of oral health teams was only associated with a decrease in referrals but not with an increase in completed treatment. In fact, higher coverage of oral health teams was associated with higher rates of completed treatment before the pandemic, and those rates remained similar during this period. Understanding how these factors may affect the problem-solving capacity of urgent visits is decisive to plan actions for periods after emergencies.

Despite the important contribution of this investigation, available health system databases contain notification errors and missing reports, which increased the standard deviation. However, these may be random errors, and the large sample size partially compensates for this limitation. A strength of this study is its longitudinal design, as it allowed for the determination of a temporal effect, which might indicate a cause-and-effect association. In addition, the selection bias was ruled out because database coverage ensured that all Brazilian municipalities were included.

Differently from previous investigations into the COVID-19 pandemic,[5-7] this study provided an understanding of the longer effects of the pandemic on dental care. The observation of a year of pandemic included not only times of greater restrictions, but also those of relaxation of socioeconomic limitations. Interestingly, the pandemic index (rate of hospitalizations due to COVID-19) was not associated with the outcomes. These findings differ from those reported by Chisini et al., [7] who found an association between the COVID-19 pandemic index and dental procedures. These differences are probably associated with our longitudinal analysis, which revealed that the effect of the pandemic index on the problem-solving capacity of urgent visits was washed out. After the first period of the COVID-19 pandemic, the society and oral health professionals were able to understand the pandemic risks and dynamics,[8,22] and the pandemic effects became part of people's routine and no longer a limiting factor for their actions. The regression model confirmed that socioeconomic and demographic factors, public policies, and oral health service coverage had an important role in the decrease of the rates of referrals in urgent visits during the pandemic. As Brazilian municipalities are responsible for the local management of health services and actions,[23] the resources invested in the health care system differ from place to place. Large and developed cities, as well as places with a higher coverage of primary and secondary dental care, were more likely to have a decrease in referrals. This may be associated with better-equipped centers where dentists are able to complete treatments without referring patients to specialized dental centers.

Towns or cities with specialized centers had a greater decrease in the number of referrals. This finding may be related to the fact that municipalities with their own referral system may have a less equipped primary health care system and are not prepared to provide complex treatments. These towns or cities were, therefore, the most affected ones by the closure of specialized centers. Moreover, the absence of public specialized centers in some municipalities should not prevent referral, as the primary care dentist may refer the patient to a private service in this case. The decrease in the number of referrals may also be

a direct effect of the long-lasting closure of centers, but this information is unknown. These findings suggest that, after a calamity, specialized centers have to deal with a large unmet demand.

Only public policies and socioeconomic and demographic factors were associated with a decrease in the number of completed treatments during the pandemic. This outcome is in line with what was found for referrals. Higher HDI and GDP per capita, which affected the decrease in referrals, favored the increase in completed treatments. This might be explained by the better services found in primary care in those places. Despite the increase in primary dental care coverage in municipalities with a lower HDI between 2008 and 2015, Santos et al.[24] demonstrated that it was still insufficient, and inequalities persisted. Moreover, the Northeast was more likely to have a decrease in completed treatments during the pandemic than the Southeast (OR = 3.57, 95%CI: 2.95–4.33). Regional and cultural differences between the Brazilian macroregions may influence health behaviors, thus affecting the profile of urgent visits to public dental services.[25,26]

Conclusion

The calamity generated by the long-lasting pandemic led to a greater demand for urgent visits. Moreover, less developed and smaller municipalities were more likely not to complete treatments during urgent visits in primary dental care during the pandemic. In these cases, dentists need to refer patients to elective and specialized care. In the absence of a referral system, there may be an increase in the unmet demand in both primary and secondary care services. This study did not find any effect of the pandemic intensity index (hospitalizations) on treatment completion and referrals after urgent visits to primary dental care. However, municipalities with fewer resources were more affected by the lack of elective and specialized services during the pandemic. This indicates that public policies should be in place to fulfill unmet needs. In the long term, actions for equipping primary care in smaller and less developed municipalities may help improve the problem-solving capacity of primary care, preparing these places for possible future calamities.

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