

The COVID-19 Impact on Oral Healthcare Demand and Performance: The Experience of a Clinical and Academic Centre in Portugal (EU)

O Impacto da COVID-19 na Procura e Desempenho dos Cuidados de Saúde Oral: A Experiência de um Centro Académico e Clínico em Portugal (UE)

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ABSTRACT

Introduction: The SARS-CoV-2 pandemic has reshaped the global landscape as we know it and had a tremendous effect on healthcare systems around the world. However, its impact on oral healthcare is still to be fully assessed. The aim of this study was to understand if and how COVID-19 affected the demand and performance of oral healthcare, taking the Clinical and Academic Centre of Coimbra as an example, more specifically, the Department of Stomatology of the Coimbra Hospital and University Centre and the Dentistry Department of the Faculty of Medicine of the University of Coimbra.

Material and Methods: An observational study was designed for collecting the data of a series of key oral healthcare indicators: number of appointments; referrals from primary healthcare; missed appointments; number of surgeries performed in the operating room; number of biopsies; number of patients admitted through the emergency department and epidemiologic parameters over two 18-month periods between September 2018 and August 2021: pre-COVID-19 and during the COVID-19 pandemic, with the latter divided in four stages. A statistical analysis which included descriptive and inferential procedures was then performed, with an established significance level of 5% and the application of parametric tests, *t*-Student test for a sample and for independent samples and One-Way ANOVA for the variance analysis.

Results: There was a general decline in all indicators comparing the pre-COVID-19 with the COVID-19 period, with a reduction of 50.61% in the number of appointments, 44.06% in referrals, 24.41% in surgeries, 26.30% in biopsies and 32.33% in patients seen in the Emergency Room. The number of missed appointments also increased by 181.82%. All variations revealed statistically significant differences ($p < 0.05$). The individual COVID-19 stage analysis, when compared with the pre-COVID-19 reference, and variance analysis of these different stages also showed statistically significant differences ($p < 0.05$ and $p < 0.001$), except for the number of biopsies during the third and fourth stages.

Conclusion: The results of this study suggest that the SARS-CoV-2 pandemic has had a considerable impact on oral healthcare demand and performance. However, results also show a remarkable adjustment and improvement in the provided care, with a positive evolution throughout the COVID-19 period.

Keywords: COVID-19; Dental Care; Health Services Accessibility; Pandemics; Portugal; SARS-CoV-2

RESUMO

Introdução: A pandemia por SARS-CoV-2 provocou repercussões globais, influenciando os sistemas de saúde por todo o mundo. Contudo, o seu impacto a nível da prestação de cuidados de saúde oral não foi completamente demonstrado. Este estudo tem como objetivo compreender se, e como, a pandemia da COVID-19 afetou a procura e o desempenho dos cuidados de saúde oral, tendo como exemplo o Centro Académico Clínico de Coimbra, mais concretamente do Serviço de Estomatologia do Centro Hospitalar e Universitário de Coimbra e da Área de Medicina Dentária da Faculdade de Medicina da Universidade de Coimbra.

Material e Métodos: Realizou-se um estudo observacional com a análise das seguintes variáveis: número de consultas; referência pelos cuidados de saúde primários; faltas injustificadas a consultas; número de cirurgias em bloco operatório; número de biópsias; número de doentes admitidos pelo serviço de urgência e indicadores epidemiológicos; durante dois períodos de 18 meses, de setembro de 2018 a agosto de 2021: pré-COVID-19 e durante a COVID-19, com o último a subdividir-se em quatro fases. Posteriormente, realizou-se a análise estatística dos dados, descritiva e inferencial, com um nível de significância determinado de 5% e aplicação de testes paramétricos, do teste *t*-Student para uma amostra e amostras independentes e do teste *One-Way* ANOVA para análise de variância.

Resultados: Os resultados mostraram um declínio generalizado em todos os indicadores, entre os períodos pré-COVID-19 e COVID-19, com uma redução de 50,61% no número de consultas, 44,06% na referência, 24,41% nas cirurgias, 26,30% nas biópsias, 32,33% nos doentes admitidos nos Serviços de Urgência e um aumento de 181,82% nas faltas injustificadas. Todas as variações revelaram diferenças estatisticamente significativas ($p < 0,05$). A análise das fases individuais da COVID-19, quando comparada à referência pré-COVID-19, e da variância destes, mostraram igualmente existência de diferenças estatisticamente significativas ($p < 0,05$ e $p < 0,001$), exceto para o número de biópsias durante a terceira e quarta fases.

Conclusão: Os resultados deste estudo sugerem que a pandemia por SARS-CoV-2 tem tido um impacto considerável nos cuidados de saúde oral. Os resultados obtidos demonstraram que as medidas implementadas se refletiram na melhoria dos cuidados prestados e sua evolução favorável ao longo de todo o período COVID-19.

Palavras-chave: Acesso aos Serviços de Saúde; COVID-19; Cuidados Dentários; Pandemia; Portugal; SARS-CoV-2

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INTRODUCTION

The Clinical and Academic Center of Coimbra (CACC), which integrates the Coimbra Hospital and University Centre (CHUC) and the University of Coimbra (UC), is responsible for providing healthcare services to the Centre Region of Portugal.¹ Apart from being a member of the M8 Alliance (a network of 30 leading health centers and research institutions in 20 countries, dedicated to global health improvement and development of science based solutions to global health challenges),² the CACC is recognized nationally and internationally for having within its structure eighteen Reference Centers for the treatment of a multitude of specific conditions, such as cystic fibrosis, congenital cardiopathies and hepatobiliary/pancreatic cancer.^{3,4}

In this center, oral healthcare services are provided through a partnership between the Stomatology Department of CHUC and the Dentistry Department, which is part of the Faculty of Medicine of the University of Coimbra (FMUC).¹ It reaches over two million people ranging from zero to over 99 years old, and integrates several areas such as surveillance, diagnosis and treatment of a multitude of oral conditions, as well as a differentiated surgical activity

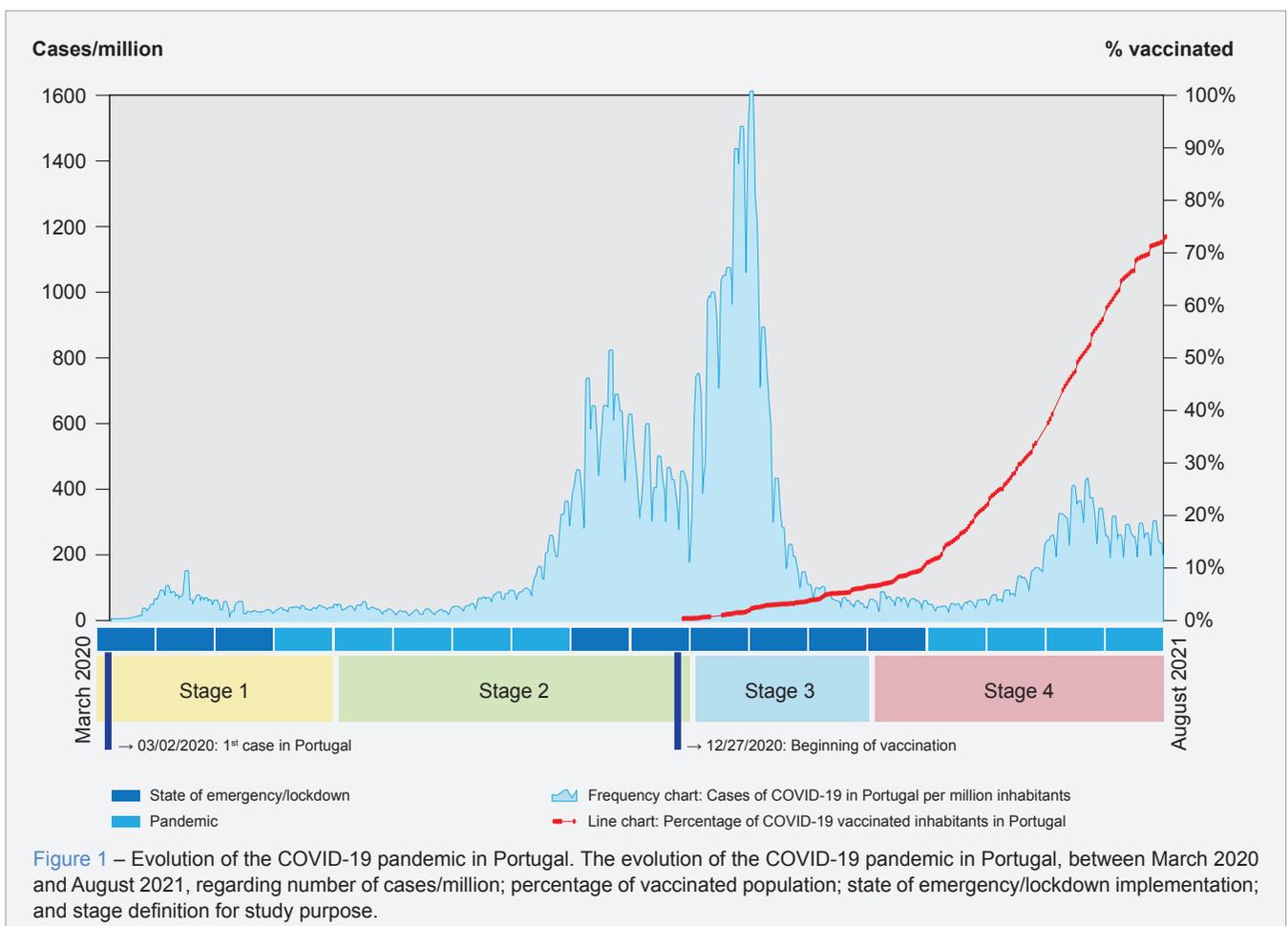
and an Emergency Department (ER).^{5,6}

Like many centers around the globe, for the past two years, it has had to deal with the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) pandemic. SARS-CoV-2 is a virus from the *Coronaviridae* family, responsible for the COVID-19 disease.^{7,8}

Among humans, it is transmitted directly through air droplets and aerosol particles or indirectly by contact with contaminated surfaces, and is responsible for causing symptoms like fever, cough, dyspnea, fatigue, anosmia and dysgeusia.⁷

It is estimated that, without vaccination, as much as 81% of COVID-19 patients have mild to moderate disease, 14% could develop a serious disease requiring hospital care and 5% present with critical disease requiring admission to an Intensive Care Unit (ICU).⁹ Thankfully, the effectiveness of vaccines against SARS-CoV-2 and its variants brought a new hope, reducing transmissibility, risk of serious illness, hospitalizations and deaths.¹⁰

The first cases of COVID-19 were reported on the 29th of December 2019 in Wuhan, China.^{7,8,11} By the 30th of January



2020, the World Health Organization (WHO) declared the state of Public Emergency and on the 11th March 2020 a Global Pandemic was acknowledged.¹¹⁻¹³

In Portugal, the first patient was diagnosed with SARS-CoV-2 on the 2nd of March 2020 and a peak number of infections were registered between October 2020 and December 2020, January 2021 and March 2021 and from December 2021.^{14,15} The first state of emergency declared by the Portuguese Government lasted from the 19th of March, until the 2nd of May 2020 and the second occurred between the 9th of November 2020 and the 30th of April 2021.^{16,17} These periods were marked by important limitations of individual rights, mainly by enforcing variable and evolving types of lockdowns, which had significant impact on commerce, services as well as leisure activities (Fig. 1).¹⁸

From the 16th of March to the 4th of May 2020, by governmental order, oral health practitioners, such as Stomatologists and Dentists, had their professional activity restricted to emergency appointments.¹⁹ During this period, the Directorate-General of Health, as well as professional associations and societies, published guidelines that guided all clinical activity involving oral healthcare and still regulate clinical practice to this date.²⁰⁻²²

With an expectation of an increasing number of new infections, during the first wave, the CACC also put in practice its own strategy to deal with the pandemic by implementing teleconsultations for non-urgent patients and restricting surgical activity. To reduce cross-contamination between healthcare workers, schedules were reorganized, and fixed teams were created. These measures were put in practice or suspended according to the direct impact of the pandemic, predominantly assessed by the number of hospital beds occupied and patients admitted to the ICU.

The next big step for trying to control the pandemic was the start of the Portuguese COVID-19 vaccination program on the 27th of December 2020, which followed predefined criteria of eligibility, starting with healthcare professionals, followed by risk groups.²³ By the 31st of August 2021 approximately 85% of all population had already received the second dose of the vaccine, thus making the Portuguese vaccination program as one of the most successful worldwide (Fig. 1).^{14,15}

The COVID-19 pandemic has had a tremendous impact across the globe and has created catastrophic financial and logistical challenges for healthcare systems and facilities.²⁴ For healthcare workers, the pandemic caused a heightened risk of occupational exposure to a new fast spreading disease and created the need to adapt new roles and responsibilities for a wide range of tasks and professional settings, which led to anxiety, depression, sleep problems, and distress among professionals.^{25,26} Other dimensions of healthcare such as initial screening, referral to specialists, diagnosis, treatment initiation, surgery and ongoing care were

also affected. However, its full effect is still being studied, with the impact it took on oral healthcare yet to completely be assessed.^{24,27-29}

Therefore, the aim of this study was to understand if and how the COVID-19 pandemic affected the demand and performance of oral healthcare services provided to the Portuguese population, using the CACC as an example, more precisely the Department of Stomatology of the Coimbra Hospital and University Centre and the Dentistry Department of Faculty of Medicine of the University of Coimbra.

MATERIAL AND METHODS

A longitudinal observational retrospective study was designed for collecting the data of key oral healthcare indicators from the CACC database, and epidemiologic parameters, over a 36-month period (from September 2018 to August 2021). This study was assigned the number CE-135/2021 and approved by the Ethics Committee of the Faculty of Medicine of the University of Coimbra.

For study assessment purposes, the 36 months were analyzed in two continuous 18 month-periods: a pre-COVID-19 period, between September 2018 and February 2020, and a COVID-19 period, between March 2020 and August 2021.

The authors considered the start of the COVID-19 period on March 2020, after the first patients were diagnosed in Portugal on the 2nd of March.^{14,15} The COVID-19 period was then divided in four stages according to the following parameters: (a) beginning of the pandemic, (b) peak infection rates in Portugal, (c) states of emergency/lockdown, (d) vaccination onset and percentage of immunized population. The first stage, from the 1st of March 2020 to the 30th of June 2020 was marked by the first state of emergency and restriction of activity in Stomatology and Dental Medicine.^{16,19} The second stage, from the 1st of July 2020 to the 31st of December 2020, comprised a normalization period after the first lockdown.^{21,22} The third stage, from the 1st of January 2021 to the 31st of March 2020, represented the second state of emergency and a peak in infection rates and overload of healthcare services.^{14,15,17} The fourth stage, from the 1st of April 2021 to the 31st of August 2021, was characterized by the reduction of cases and significant increase in vaccination with approximately 75% of the Portuguese population with two doses and 85% with one dose by the end of this stage (Fig. 1).^{14,15,18}

For every stage, the variables that were studied and considered representative of the clinical workload of oral healthcare were: total number of appointments (first and follow-up) performed in all areas and specialties; referrals from primary healthcare; missed appointments; number of surgeries performed in the operating room (OR); number of biopsies; and patients admitted through the ER.

After collecting the data, the information was uploaded

to a database for subsequent statistical analysis which included descriptive and inferential procedures, utilizing IBM SPSS Statistics Version 28.0.1.0 (142)®.

Descriptive statistics were used considering the most adequate statistical parameters for the study variables, like distribution of frequencies (absolute and relative), central tendency measures [mean (\bar{x}), median and mode] and dispersion measures [standard deviation (sd) and range of variation]. With the goal of analyzing oral healthcare demand and performance evolution during the different COVID-19 stages and comparing them to the pre-COVID-19 period, the authors considered as reference the values that preceded the pandemic, as well as the equivalent number of months for each specific stage.

The distribution of variables was verified for symmetry through the ratio between the skewness (Sk) value and standard error (SE), flattening, kurtosis [(K), ratio of K and the standard error]. Due to the heterogeneous sample size for each key indicator both Kolmogorov-Smirnov e Shapiro-Wilk tests were used to assess the normality of variables.

For inferential statistics, the significance level of 5% was established and parametric tests, t-Student test for a sample and for independent samples, and One-Way ANOVA for the variance analysis were used.

RESULTS

For comparison purposes, the results were organized in two continuous 18-month periods – a pre-COVID-19 period (1st of September 2018 to 28th of February 2020) and a COVID-19 period (1st of March 2020 to 31st of August 2021) (Table 1). The latter was then divided in 4 stages (1st of March 2020 to 30th of June 2020; 1st of July 2020 to 31st of December 2020; 1st January 2021 to 31st of March 2021; 1st of April 2021 to 31st of August 2021) (Table 2).

Pre-COVID-19 period

Between the 1st of September 2018 and the 28th of February 2020, a total of 18 months, 58 601 consultations were made (\bar{x} = 3255.61 per month; sd = 89.21), 11 687 of which were first time appointments (\bar{x} = 649.28 per month; sd = 24.31), and 46 914 were follow-up appointments (\bar{x} = 2606.33 per month; sd = 72.78) of which 4769 (\bar{x} = 264.94 per month; sd = 13.64) resulted from primary care referral. Missed appointments accounted for a total of 2200 consultations (\bar{x} = 122 per month; sd = 6.23) not carried out. During the same period, 1102 patients were surgically treated in the OR (\bar{x} = 61.22 per month; sd = 4.56), 3774 patients were seen in the ER (\bar{x} = 209.67 per month; sd = 9.56) and 327 diagnostic biopsies were made (\bar{x} = 18.17 per month; sd = 6.3).

Table 1 – Oral healthcare performance: pre-COVID-19 versus COVID-19

Key oral healthcare indicators	pre-COVID-19			COVID-19			t-test	p-value
	Total	\bar{x}	Sd	Total	\bar{x}	Sd		
Appointments	58 601	3255.61	89.21	28 944	1608	716.17	-50.61%	< 0.001
First app.	11 687	649.28	24.31	6465	359.17	151.56	-44.68%	< 0.001
Follow-up app.	46 914	2606.33	72.78	22 479	1249.83	569.74	-52.61%	< 0.001
Referrals	4769	264.94	13.64	2668	148.22	45.80	-44.06%	< 0.001
Missed appointments	2200	122.22	6.23	6200	344.44	36.00	181.82%	< 0.001
Surgeries	1102	61.22	4.56	833	46.28	20.83	-24.41%	0.008
Biopsies	327	18.17	6.30	241	13.39	5.23	-26.30%	0.018
Emergencies	3774	209.67	9.56	2554	141.89	26.82	-32.33%	< 0.001

\bar{x} : monthly mean; sd: standard deviation; %: variation; app.: appointments; referrals: primary healthcare referrals
Key oral healthcare indicators comparison between pre-COVID-19 and COVID-19 selected periods, through descriptive statistical analysis and t-Student test application. Based on the data of the CACC.

Table 2 – Oral healthcare performance: pre-COVID-19 versus COVID-19 stages

Key oral healthcare indicators	Pre-COVID-19			COVID-19 Stage 1			COVID-19 Stage 2			COVID-19 Stage 3			COVID-19 Stage 4		
	\bar{x}	sd	%	\bar{x}	sd	%	\bar{x}	sd	%	\bar{x}	sd	%	\bar{x}	sd	%
Appointments	3255.61	89.21		594	35.55	-81.75%	1331.17	43.14	-59.11%	2226.67	26.58	-31.61%	2380.20	24.39	-26.89%
First app.	649.28	24.31		150.50	9.88	-76.82%	307.33	18.84	-52.67%	419	9.85	-35.47%	552.40	14.22	-14.92%
Follow-up app.	2 606.33	72.78		443.50	25.70	-82.98%	1023.83	27.93	-60.72%	1807.67	17.62	-30.64%	1827.80	11.42	-29.87%
Referrals	264.94	13.64		78.75	4.65	-70.28%	148.67	7.42	-43.89%	146.33	7.64	-44.77%	204.40	5.32	-22.85%
Missed app.	122.22	6.23		367	27.39	200.27%	350	16.30	186.36%	382.67	11.50	213.09%*	296.80	7.66	142.84%
Surgeries	61.22	4.56		18.25	2.22	-70.19%	41.67	3.33	-31.94%	47.33	6.51	-22.69%	73.60	7.30	20.22%
Biopsies	18.17	6.30		7.75	1.71	-57.34%	11	2.61	-39.45%	16.67	3.22	-8.26%	18.80	3.90	3.49%
Emergencies	209.67	9.56		124.25	8.26	-40.74%	148.17	8.01	-29.33%	100.67	5.51	-51.99%	173.20	6.34	-17.39%

\bar{x} : monthly mean; sd: standard deviation; %: variation; app.: appointments; referrals: primary healthcare referrals
 Key oral healthcare indicators comparison between the selected COVID-19 stages and the equivalent pre-COVID-19 period. Based on the data of the CACC. All variations showed statistically significant differences ($p < 0.05$) on t-Student test application, except for the number of biopsies performed in the 3rd ($p = 0.547$) and 4th ($p = 0.670$) stages.

COVID-19 period

In the COVID-19 period, between the 1st of March 2020 to the 31st of August 2021, a total number of 28 944 appointments were made (\bar{x} = 1608 per month; sd = 716.17), 6465 of which were first appointments (\bar{x} = 359.17 per month; sd = 151.56) and 22 479 follow-up appointments (\bar{x} = 1249.83 per month; sd = 569.74). There were 2668 (\bar{x} = 148.22 per month; sd = 45.80) and 6200 (\bar{x} = 344.44 per month; sd = 36) referrals from primary healthcare and missed appointments, respectively.

During the same period, 833 patients were surgically treated in the OR (\bar{x} = 46.28 per month; sd = 20.83), 241 diagnostic biopsies were carried out (\bar{x} = 13.39 per month; sd = 5.23), and 2554 patients were admitted through the ER (\bar{x} = 141.89 per month; sd = 26.82).

COVID-19 stages

The individual analysis of each selected stage was also performed (Table 2 and Fig. 2).

In the first stage, comprising the period between the 1st of March and the 30th of June 2020 (four months), 2376 appointments were made (\bar{x} = 594 per month; sd = 35.55), 73 surgeries were performed (\bar{x} = 18.25 per month; sd = 2.22) and 31 biopsies were taken (\bar{x} = 7.75 per month; sd = 1.71). The total number of patients seen in the ER was 497 (\bar{x} = 124.25 per month; sd = 8.26) and 315 patients were referred from primary healthcare (\bar{x} = 78.75 per month; sd = 4.65). The number of missed appointments was 1468 (\bar{x} = 367 per month; sd = 27.39).

During the second stage, between the 1st of July 2020 and the 31st of December 2020 (six months), 7987 consultations were carried out (\bar{x} = 1331.17 per month; sd = 43.14), 250 surgeries were performed (\bar{x} = 18.25 per month; sd = 2.22) and 31 biopsies were taken (\bar{x} = 41.67 per month; sd = 3.33). The total number of patients seen in the ER was 889 (\bar{x} = 148.17 per month; sd = 8.01) and 892 patients were referred from primary healthcare (\bar{x} = 148.67 per month; sd = 7.42). The number of missed appointments was 2100 (\bar{x} = 350 per month; sd = 16.30).

In the third stage considered, between the 1st of January 2021 and the 31st of March 2021 (three months), 6680 consultations were carried out (\bar{x} = 2226.67 per month; sd = 26.58), 142 surgeries were performed (\bar{x} = 47.33 per month; sd = 6.51) and 50 biopsies were taken (\bar{x} = 16.67 per month; sd = 3.22). The total number of emergencies was 302 (\bar{x} = 100.67 per month; sd = 5.51) and 439 patients were referred from primary healthcare (\bar{x} = 146.33 per month; sd = 7.64). The number of missed appointments was 1148 (\bar{x} = 382.67 per month; sd = 11.50).

In the last stage, between the 1st of April 2021 and the 31st of August 2021 (five months), 11 901 consultations were carried out (\bar{x} = 2380.20 per month; sd = 24.39), 368

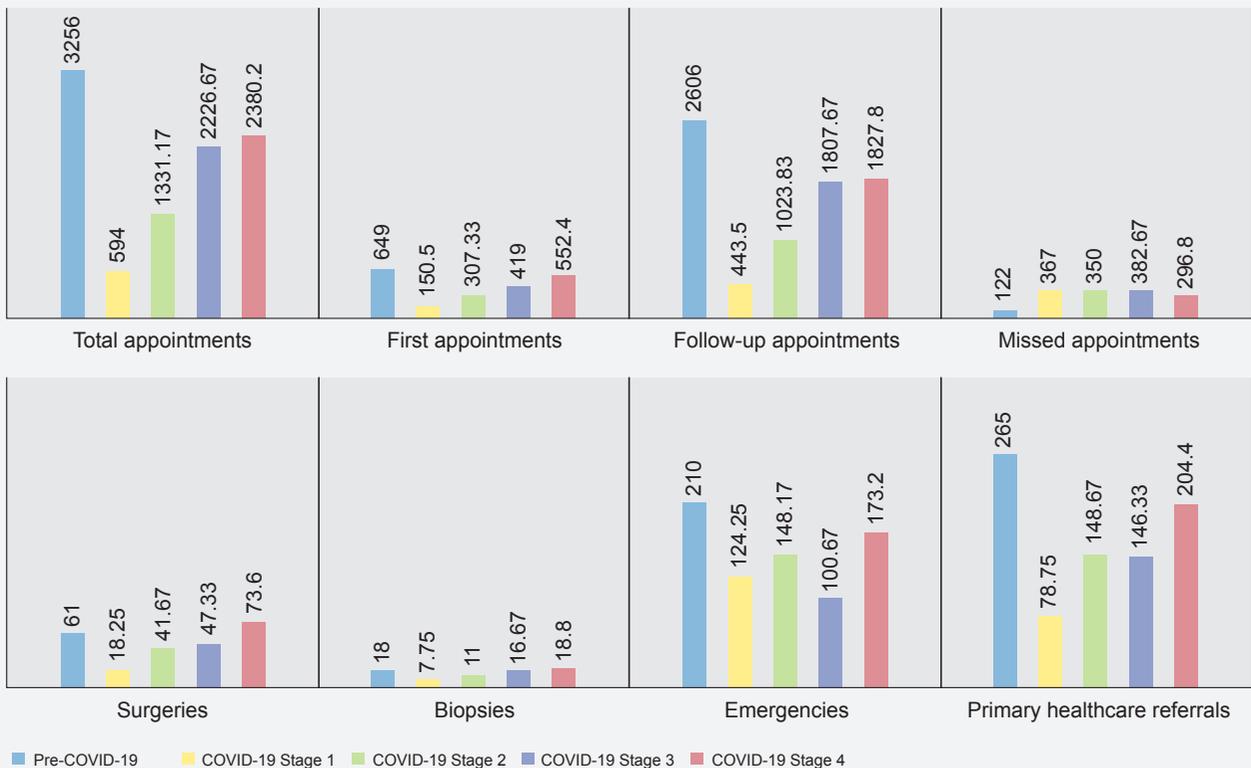


Figure 2 – Oral healthcare performance: pre-COVID-19 versus COVID-19 Stages. Key oral healthcare indicators monthly mean comparison bar charts between the selected COVID-19 stages and pre-COVID-19 period. Based on the data of the CACC.

surgeries were performed (\bar{x} = 73.60 per month; sd = 7.30) and 94 biopsies were performed (\bar{x} = 18.80 per month; sd = 3.90). The total number of emergencies was 866 (\bar{x} = 173.20 per month; sd = 6.34) and 1022 patients were referred from primary healthcare (\bar{x} = 204.40 per month; sd = 5.32). The number of missed appointments was 1484 (\bar{x} = 296.80 per month; sd = 7.66).

Pre-COVID-19 versus COVID-19

When comparing the COVID-19 period to the pre-COVID-19 period, the data analysis revealed the existence of statistically significant differences ($p < 0.05$) for all the parameters, with a decrease of 50.61% in the total number of appointments carried out and an increase of 181.82% in missed appointments. There was also a 44.06% reduction in the number of referrals from primary healthcare and of 24.41% in the number of surgeries performed in the OR. The number of diagnostic biopsies was also reduced by 26.30% and there was a decrease of 32.33% in the number of patients admitted through the ER (Table 1).

When examining the results of the different COVID-19 stages, compared with the pre-COVID-19 equivalent period, there was also a clear decline within most variables,

except for the number of biopsies during the third (-8.26%) and fourth (3.49%) stages and the number of surgeries (20.22%) in the fourth stage. In addition, the data analysis revealed statistically significant differences ($p < 0.05$) for the great majority of parameters, in all stages, except for the number of biopsies during the third and fourth stages ($p > 0.05$) (Table 2 and Fig. 2).

Furthermore, individual stage assessment shows a clear tendency for a greater severity of the effects of the pandemic during the first stage, with 81.75% less appointments in total, 70.28% fewer primary healthcare referrals and an increase over 200.27% in the number of missed appointments. During this time, the number of patients surgically treated in the OR, biopsies performed, and patients admitted through the ER were also reduced by 70.19%, 57.34%, and 40.74%, respectively.

The opposite can be observed in the fourth stage, with a less significant impact being observed across all variables.

However, outliers for this trend can be identified in the third stage, specifically the number of missed appointments (213%) and patients admitted through the ER (-52%).

Variance analysis between the different stages of the defined parameters was also considered. Therefore, by per-

Table 3 – One-way ANOVA variance analysis of the COVID-19 selected stages

		Sum of Squares	df	Mean square	Z	Sig.
Appointments	Between groups	8 702 313.7	3	2 900 771.23	2404.67	< 0.001
	Within groups	16 888.3	14	1206.31		
	Total	8 719 202	17			
First app.	Between groups	387 722.97	3	129 240.99	650.03	< 0.001
	Within groups	2783.53	14	198.82		
	Total	390 506.5	17			
Follow-up app.	Between groups	5 510 893.2	3	1 836 964.4	3517.5	< 0.001
	Within groups	7311.3	14	522.236		
	Total	5 518 204.5	17			
Referrals	Between groups	35 097.16	3	11 699.05	287.37	< 0.001
	Within groups	569.95	14	40.71		
	Total	35 667.11	17			
Missed app.	Between groups	17 952.98	3	5984.33	20.55	< 0.001
	Within groups	4077.47	14	291.25		
	Total	22 030.44	17			
Surgeries	Between groups	7005.66	3	2335.22	88.85	< 0.001
	Within groups	367.95	14	26.28		
	Total	7373.61	17			
Biopsies	Between groups	340.06	3	113.35	12.78	< 0.001
	Within groups	124.21	14	8.87		
	Total	464.28	17			
Emergencies	Between groups	11 480.73	3	3826.909	71.72	<.001
	Within groups	747.05	14	53.36		
	Total	12 227.78	17			

App.: appointments; referrals: primary healthcare referrals.

Variance analysis between the COVID-19 selected stages regarding selected key oral healthcare indicators. Based on the data of the CACC.

forming one-way ANOVA (Table 3), statistically significant differences were encountered across all studied variables ($p < 0.001$) (Table 2).

DISCUSSION

As an important part of the Portuguese national healthcare system, the CACC ensures the care of over two million people.^{1,6} With a pre-pandemic monthly average of approximately 3256 oral healthcare appointments, 265 referrals from primary healthcare, 61 patients surgically treated in OR and 3774 patients seen in the ER, this center may represent the only oral healthcare unit available to thousands of patients. The CACC also plays an important role in the diagnosis and treatment of oral cancer by performing a monthly average of 18 biopsies.

The SARS-CoV-2 pandemic dates back to the 29th of December 2019 in Wuhan, China,^{7,8,11} and has had a tremendous effect on healthcare systems around the world, leading to various restrictive measures and reorganization of human and material resources to accommodate the in-

creasing number of COVID-19 patients.^{30,31}

During this time, several articles exposing the diverse impacts of COVID-19 on the multiple dimensions of healthcare and oral health were published.^{21,24,29,32} An Australian study analyzed a four-month period from March to June 2020 and saw a substantial decrease in healthcare activity in New-South Wales, compared with the same period in 2019. For example, primary care face-to-face consultations decreased by 22.1%, breast cancer screening activity by 51.5%, emergency department visits by 13.9% and public hospital planned surgical activity by 32.6%.²⁹

Another study conducted in China explored the impact of the COVID-19 pandemic on the use of emergency dental services in two equivalent 10-day periods, one in January 2020, pre-COVID-19 and another in February 2020 during the pandemic. The authors found that 38% fewer patients visited the ER and that the distribution of dental problems had changed significantly: dental and oral infections raised from 51.0% to 71.9% during COVID-19, and dental trauma decreased from 14.2% to 10.5%.³²

However, there is a lack of similar studies, reflecting the concrete influence of COVID-19 on parameters like the ones that were analyzed in this study. Therefore, the authors consider this article directly relevant, by exposing the concrete effects of the pandemic on the Portuguese population's oral healthcare demand and performance, and indirectly, for drawing attention to possible future consequences, such as a growing number of patients with undiagnosed, or advanced oral cancer.

Taking CACC as an example, for the considered eighteen-month period of pandemic, a clear and statistically significant impact ($p < 0.05$) was observed in all the analyzed parameters, characterized by a sharp reduction in oral healthcare performance and demand (Table 1).

However, as shown in the results, the encountered differences between each stage and the compared pre-COVID-19 period were highly variable (Table 2). Nevertheless, for almost every parameter, a statistically significant difference ($p < 0.05$) was present. The variance analysis among the different stages also showed statistically significant differences ($p < 0.001$) (Table 3).

The major variations occurred in the first stage, in which, for example, the total number of appointments, surgeries and biopsies was tremendously reduced, leaving many potential oncological patients undiagnosed or having their diagnosis delayed, thus limiting the possible therapeutic intervention. The enormous reduction of the number of patients being referred from primary healthcare, 70.28% in this stage, is another concerning result that could translate the impact primary care services suffered by stopping their activities, and then being overwhelmed with the diagnosis and surveillance of ambulatory COVID patients. When compared to the pre-COVID period, in the first stage, the number of patients admitted through the ER also dropped by 40.74%, for reasons still to be clarified.

Stage two was a period of normalization after the first lockdown, with a significant reduction of COVID-19 cases and the relief of most of the restrictive measures. Consequently, as expected, these alleviated the healthcare system and professionals, allowing for an improvement on all parameters, that was, however, still distant from pre-pandemic numbers.

Stage three was marked by the second state of emergency. The results show that despite having a similar impact on most parameters, as seen previously on stage one, the percentual decrease compared to the pre-COVID-19 period was lower. This could be explained by the measures taken after the first wave, allowing the healthcare system and professionals to better cope with the impact of the COVID-19 pandemic.

By contrast, in the fourth stage a smaller variation among all stages was seen, a clear sign of success of the

vaccination process, the decrease in total number of cases and the relief of restrictive measures.

Therefore, the obtained results suggest that the empirical selection of the stages under study, based on legislative, epidemiological and sanitary factors, was adequate and essential for correct analysis of how the pandemic has evolved and in direct correlation with the burden inflicted by COVID-19 on the healthcare system, which affected clinical practice directly and substantially.

The outliers ($p > 0.05$) we encountered were the number of biopsies performed during the third and fourth stages approaching pre-pandemic values. Another exception, although statistically significant ($p < 0.05$), was the number of surgeries in the fourth stage, which surpassed the pre-COVID-19 levels by 20%. Therefore, these portray the exceptional effort from the professionals involved in order to overcome the impact of the first three stages, as well as a normalization of the healthcare system activity and the implementation of productivity programs which include of carrying out additional surgeries and consultations. The reinforcement of these programs could also be a valuable measure to counteract the healthcare impact of future waves and other pandemics, serving as a proved and successful experience.

However, although these results are encouraging, the emergence of new variants like Alpha, Beta, Gamma, Delta and Omicron, as well as the discovery of new lineages, like BA.4 and BA.5 from Omicron, prove that viral transmissibility, virulence and rate of reinfection, by escaping natural and vaccine-induced immunity, are highly susceptible to modifications.³³⁻³⁵ Therefore, the recovery of pre-pandemic clinical activity levels and oral healthcare performance can still be endangered, and future vaccination programs, regarding the need of administering booster doses, remain to be fully improved pending further analysis of new relevant data.

One important limitation of this study is related with the number of referrals, one of the parameters under analysis. First appointments result from four types of referrals: primary care; internal (same institution); other public institutions (excluding primary care); and private sector. However, in this article the authors focused only on primary care referrals, as a way to indirectly evaluate the oral healthcare demand in the general population. This information also explains the number of first and missed appointments when consultations were restricted to urgent care and emergencies by government decree.

The authors also felt that results like the substantial decrease in the number of patients seen in the ER, especially during stage one and three are susceptible to multiple interpretations and lack a clear explanation, thus constituting another limitation. Speculation and common sense could point to the motives like a natural reduction in false

emergencies and the avoidance of going to the hospital, during periods of rising number of cases. However, further studies need to be conducted so concrete explanations can be given.

CONCLUSION

Taking CACC as an example, the findings suggest that there was a negative preliminary impact of COVID-19 on oral healthcare demand and performance, which appeared not only to be directly associated with epidemiological factors, but also with the implementation of restrictive and sanitary measures.

This study also raises concerns about the possible impact of COVID-19 on oral cancer patients, with the number of biopsies representing just the tip of the iceberg in the characterization of the problem, leaving elements like cancer staging at the time of diagnosis unknown.

Therefore, it intends to be a valid contribution to foster further studies within the area of oral sciences and COVID-19, as well as contribute the creation of more effective and responsible health policies that could guide future public health emergencies.

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AUTHOR CONTRIBUTIONS

All authors were involved and contributed equally during the design of this study, data collection and result interpreta-

tion. All authors read and approved the final manuscript.

JMA, IC, MIB, AQ, TN: Major contributors in writing the manuscript.

FV, FM, JF: Responsible for the revision of the written manuscript.

PROTECTION OF HUMANS AND ANIMALS

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the Helsinki Declaration of the World Medical Association updated in 2013.

DATA CONFIDENTIALITY

The authors declare having followed the protocols in use at their working center regarding patients' data publication. All data supporting the findings of this study was procured from the Clinical and Academic Centre of Coimbra (CACC) (Coimbra, Portugal) and used under the license for the current study. Public availability must be accessed upon reasonable request and with permission of CACC and in compliance with the national database protection legislation.

COMPETING INTERESTS

All authors report no conflicts of interest.

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