









Restorative procedures and extractions of permanent teeth in Brazil's public dental services (2008–2024)

Procedimentos restauradores e extrações de dentes permanentes nos serviços públicos de saúde bucal do Brasil (2008–2024)

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Abstract

Objective: to assess the proportion between restorative procedures and extractions of permanent teeth (R:E) in Brazil's public dental services from 2008 to 2024. **Method:** a time series was constructed within this timeframe using data from the ambulatory productivity reports. Restorative procedures included direct restorations of anterior and posterior teeth, as well as pulpectomies (including retreatments). The ratio was calculated in relation to the number of extractions (per permanent tooth). The significance level was set at 5% for all inferential analyses. **Results:** throughout the entire period, the R:E ratio was approximately 2.49, with 1.37 as the lowest and 3.33 as the highest value. The person-year incidence of restorations was 150,427 per 100,000; of pulpectomies was 5,394 per 100,000; and of extractions was 62,695 per 100,000. Moreover, there was a significant reduction in the R:E ratio between 2008 and 2024 (p-value = 0.011; APC = -2.95% [95% CI: -4.94%, -0.46%]). When comparing the pre-pandemic interval, the R:E ratio was lower during each of the first four years following the onset of the COVID-19 outbreak (all p-values <0.05). Furthermore, the person-year incidence in the Central-West region was significantly higher than the national estimate (p-value <0.001), with no significant differences observed between the other regions and this parameter. **Conclusion:** it was possible to conclude that the R:E ratio declined over the last 17 years in Brazil's public dental services, indicating changing treatment patterns.

Keywords: dental care; public health dentistry; tooth extraction; dental restoration; permanent; delivery of health care.

Resumo

Objetivo: avaliar a proporção entre procedimentos restauradores e extrações de dentes permanentes (R:E) nos serviços públicos de saúde bucal do Brasil no período de 2008 a 2024. **Método:** foi construída uma série temporal nesse intervalo a partir dos relatórios de produtividade ambulatorial. Os procedimentos restauradores incluíram restaurações diretas em dentes anteriores e posteriores, bem como pulpectomias (incluindo retratamentos). A razão foi calculada em relação ao número de extrações (por dente permanente). O nível de significância adotado foi de 5% para todas as análises inferenciais. **Resultados:** em todo o período, a razão R:E foi de aproximadamente 2,49, com valor mínimo de 1,37 e máximo de 3,33. A incidência pessoa-ano de restaurações foi de 150.427 por 100.000; de pulpectomias, 5.394 por 100.000; e de extrações, 62.695 por 100.000. Além disso, houve redução significativa na razão R:E entre 2008 e 2024 (p-valor = 0,011; APC = -2,95% [IC95%: -4,94%, -0,46%]). Ao comparar o período pré-pandemia, a razão R:E foi menor em cada um dos quatro primeiros anos após o início do surto de COVID-19 (p-valor <0,05). Ademais, a incidência pessoa-ano na região Centro-Oeste foi significativamente maior que a estimativa nacional (p-valor <0,001), não sendo observadas diferenças significativas entre as demais regiões para esse parâmetro. **Conclusão:** foi possível concluir que a razão R:E diminuiu nos últimos 17 anos nos serviços públicos de saúde bucal do Brasil, indicando mudanças nos padrões de tratamento.

Palavras chave: assistência Odontológica; odontologia em saúde pública; exodontia; restauração dentária permanente; atenção à saúde.

INTRODUÇÃO

Tooth loss in Brazil has asserted itself throughout history as a public health problem. In fact, partial or total tooth loss can undermine a number of key functions of the oral cavity, including mastication, speech, and facial aesthetics. From an epidemiological viewpoint, tooth loss may also reflect both access and efficiency in the supply of oral health care and existing social inequalities. Hence, it is interesting to analyze the dynamics of this phenomenon, particularly in the hope of creating efficient public policies to combat it¹⁻³.

It is important to highlight that dental caries is one of the

primary causes of edentulism in Brazil. In this context, the results of the most recent national epidemiological survey on oral health (SB Brasil 2023) show that more than one-third of individuals aged 65 to 74 years are edentulous (approximately 36.3%). Although this represents progress compared to previous years (approximately 53.3% in 2003 and 53.4% in 2010), the reduction occurred unevenly, being more prominent among white individuals and those with higher levels of education⁴. This outcome may indicate enduring challenges in the control of dental caries in Brazil, particularly those associated with limitations in the availability and accessibility of public oral

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health services. Such barriers suggest a structural weakness in care provision that persists across the life course of the Brazilian population^{4,5}.

From a clinical standpoint, Restorative Dentistry has achieved numerous advancements that enable the treatment of carious lesions and the functional preservation of teeth within the oral cavity⁶. Nevertheless, various clinical situations render such preservation unfeasible, making tooth extraction the only viable therapeutic option (e.g., extensively decayed teeth, crown-root fractures, failed endodontic treatments, or irreversible periodontal compromise)^{3,7}. Compounding these challenges is the limited availability of resources and technologies necessary for restorative dental procedures, particularly within the public health services, which underscores the urgent need for effective strategies that prioritize prevention and reduce the likelihood of tooth extractions^{1,8}.

From a collective health perspective, Brazil's public health system (Sistema Único de Saúde – SUS) has faced challenges in controlling dental caries, as evidenced by the burden this disease imposes on both the population and oral healthcare services^{4,5}. In parallel, tooth extraction as an immediate solution for pain, infections, or extensive coronal destruction caused by caries has been a longstanding practice in the country, particularly in contexts with limited access to restorative treatments. Although effective in the short term, this approach overlooks the functional, aesthetic, and psychosocial impacts of tooth loss^{1,8,9}.

In light of this evidence, it becomes pertinent to question whether the changes in the epidemiological landscape truly reflect the performance of Brazil's public health system. Thus, the following research question arises: are more restorative procedures being performed in place of tooth extractions? Therefore, the aim of this study was to assess the proportion between restorative procedures and extractions of permanent teeth (R:E) in Brazil's public dental services from 2008 to 2024. Three alternative hypotheses were tested: (H₁) There was a decrease in the number of extractions and an increase in the number of restorations and pulpectomies in permanent teeth; (H₂) There were regional disparities in the R:E values across Brazilian regions; and (H₃) COVID-19 pandemic onset significantly impacted the R:E values.

METHOD

Approach

A 17-year time series was constructed to achieve the proposed objective, based on records from the ambulatory productivity of Brazil's public dental services from 2008 to 2024 (ecological assessment). Therefore, a longitudinal, retrospective, and quantitative study design was outlined, in alignment with consistent research reports employing register-based approaches^{5,10,11}. All evaluated records correspond to dental services provided within Brazil's public healthcare system, with

no restrictions regarding the type of outpatient dental service or the professional performing it. Geographically, the analysis covered Brazil and its five regions, including the Federal District.

Source

The data source was the Ambulatory Information System (Sistema de Informações Ambulatoriais - SIA), linked to Brazil's public health services. All dental procedures of interest were monthly recorded through the Ambulatory Productivity Reports (*Boletins de Produtividade Ambulatorial* - BPAs), made available online by DATASUS. Data access was carried out through the TabNet tool¹². Additionally, it was also necessary to obtain population projections (number of inhabitants) from the Brazilian Institute of Geography and Statistics (IBGE)¹³.

Variables

The primary outcome of this study was the proportion (ratio) between restorative procedures and extractions of permanent teeth (R:E), with restorative procedures defined as direct restorations of anterior and posterior teeth (all restorative materials), as well as pulpectomies of single-, double-, and multi-rooted teeth (including both initial root canal treatments and retreatments). Extractions were counted per tooth, excluding supernumerary teeth and multiple extractions performed in a single procedure, to allow for a fair ratio between procedures. In addition, the annual quantity of each dental procedure was expressed as person-year incidence (per 100,000 Brazilian inhabitants). Secondarily, R:E values were obtained annually for each region of Brazil. To assess the impact of the onset of the COVID-19 pandemic, a pre-pandemic interval was designed (12 months, from April 2019 to March 2020), along with the first four subsequent years within the same interval.

Acquisition

Data were acquired on March 27, 2025, by the same researcher. All steps applied were the same as those used in previous approaches^{10,11}. The records of dental procedures of interest to this study were retrieved from DATASUS, accessible via the official website (<https://datasus.saude.gov.br/>). The TabNet tool was used by selecting the categories 'assistência à saúde' (healthcare assistance) and '*produção ambulatorial*' (ambulatory care). Next, the reports were filtered by location (territory) where the dental procedures were performed, adjusting the geographic scope to Brazil and its five regions. Moreover, the timeframe was adjusted using the corresponding filter, and the content (BPAs) was set to include all ambulatory productivity approved.

After these preliminary adjustments, all relevant dental procedures were filtered using their corresponding codes through the TabNet tool: direct restorations of anterior and posterior teeth (all restorative materials – #0307010031, #0307010120, #0307010139, and #0307010040), pulpectomies of single-, double-, and multi-rooted teeth (including both

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initial root canal treatments and retreatments – #0307020061, #0307020045, #0307020053, #0307020100, #0307020088, and #0307020096), and tooth extraction (#0414020138). The numbers were registered in a spreadsheet for subsequent processing and statistical analysis.

Analysis

Statistical analysis was conducted using both descriptive and inferential approaches. The descriptive analysis involved calculating person-year incidence rates (per 100,000 inhabitants) as well as absolute and relative frequencies of the variables. Inferential analysis was performed with a significance level of 5% ($\alpha = 0.05$). The temporal trend analysis was based on the Annual Percent Change (APC), following the statistical procedures previously described^{5,14}. For this approach, the PAST software (version 4.03, Oslo, Norway) was used. Each dependent variable was log-transformed (\log_{10}) before estimating the slope coefficients (β_1) using the Prais–Winsten regression model. The 95% confidence interval (95% CI) was calculated using the formula: $[(\beta_1) \pm \{t\text{-critical value} \times \beta_1 \text{ standard error}\}]$. Subsequently, the β_1 values were used to calculate the APC and its 95% CI by substituting them into the formula: $[-1 + 10^{(\beta_1)}] \times 100$. In cases of statistical significance, a positive β_1 value indicated an increasing trend, while a negative β_1 value indicated a decreasing trend over time. When the p-value was not statistically significant, the trend was considered stationary.

Moreover, Generalized Linear Models (GLMs) were used to compare person-year incidence rates across variables. Variance analysis revealed a quasi-Poisson distribution, indicating

overdispersion. Therefore, rate ratios were obtained using the Poisson regression model with robust variance adjustment (to account for overdispersion), employing a logarithmic link-function. All model parameters were estimated using the maximum likelihood method (*log*-likelihood approach). When the p-value was <0.05 , all coefficients were expressed as percentage differences relative to the reference category. The JAMOV software (version 2.5.4, Sydney, Australia) was used.

Ethics

There was no need for ethical approval for this study, as it was based on secondary and aggregated data available online in the open-access public domain. Hence, there was no direct or indirect contact with individuals linked to the dental procedures of interest (population-level approach), nor access to any information that could identify or locate them. Therefore, an Informed Consent Form was not required. This perspective is ethically supported by Resolution 510/2016 of the Brazilian National Health Council – Ministry of Health¹⁵.

RESULTS

Table 1 presents the descriptive analysis of restorative procedures and extractions of permanent teeth. It was observed that direct restorations were more frequent compared to pulpectomies (treatment or retreatment) and extractions during the evaluated period. The proportion of restorative procedures (direct restorations and pulpectomies) per extraction of permanent teeth (R:E) was approximately 2.49, ranging from 1.37 (2021 – lowest value) to 3.33 (2010 – highest value).

Table 1. Descriptive analysis of restorative procedures and extractions of permanent teeth in the Brazilian public dental services from 2008 to 2024 (2025).

Variable	n	%	Incidence per 100,000 inhabitants
Restoration	308,702,279	68.8	150,427
Pulpectomy	11,066,955	2.5	5,394
Extraction	128,623,518	28.7	62,695

n: absolute frequency. %: relative frequency.

Table 2 shows the comparison of the incidence per 100,000 inhabitants among restorations, pulpectomies, and extractions of permanent teeth. Compared to restorations on permanent teeth (the reference level), the incidence of pulpectomies was 96.5% lower (95% CI: 91.6–98.9%), and that of extractions

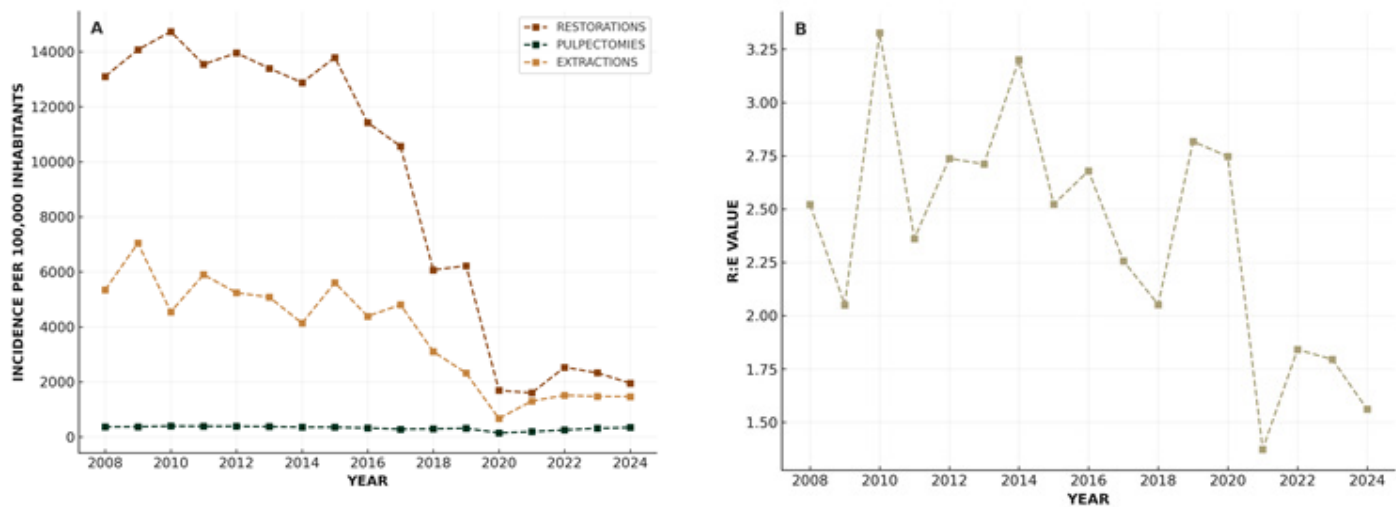
was 58.5% lower (95% CI: 41.9–70.7%). Figure 1 shows the temporal variation in the incidence per 100,000 inhabitants of restorations, pulpectomies, and extractions of permanent teeth, as well as the R:E values over time.

Table 2. Comparison of the incidence per 100,000 inhabitants among restorations, pulpectomies, and extractions of permanent teeth in the Brazilian public dental services from 2008 to 2024 (2025).

Comparison	Ratio	Limits		p-value
		Lower	Upper	
Procedures				
Intercept	2,215	1,476	3,010	<0.001*
Restoration	ref			
Pulpectomy	0.035	0.011	0.084	<0.001*
Extraction	0.415	0.293	0.581	<0.001*

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Figure 1. A – Temporal variation of the incidence per 100,000 inhabitants among restorations, pulpectomies, and extractions of permanent teeth. B – Temporal variation of the proportion of restorative procedures (direct restorations and pulpectomies) per extraction of permanent teeth (R:E values) over time.



Also addressing temporal variations, Table 3 presents the trends in the incidence per 100,000 inhabitants of restorations, pulpectomies, and extractions of permanent teeth, as well as R:E values over time. It was observed that all incidences significantly decreased between 2008 and 2024, including the R:E ratio. Moreover, Table 4 shows the comparison of R:E across Brazilian regions. Compared to the national estimate, only the Central-West region showed a significant difference in R:E values, being 117.3% higher (95% CI: 52.3–319.7%). The other regions did not differ significantly.

Ultimately, Table 5 shows the comparison of R:E among COVID-19 pre-pandemic and pandemic intervals. Compared to the pre-pandemic, all subsequent years after the SARS-CoV-2 outbreak showed a significant reduction in R:E values. In the first year of the pandemic, the R:E proportion was 69.6% lower (95% CI: 50.2–82.3%), followed by a 59.5% reduction in the second year (95% CI: 36.4–74.9%), 41.5% in the third year (95% CI: 12.4–61.5%), and 53.8% in the fourth year (95% CI: 28.8–70.7%).

Table 3. Trend analysis of restorative procedures and extractions of permanent teeth in the Brazilian public dental services from 2008 to 2024 (2025).

Variable	β_1	R_2	p-value	APC	Trend
Restoration	-0.060 [-0.046, -0.085]	0.767	0.001*	-12.9 [-10.1, -17.8]	Decreasing
Pulpectomy	-0.011 [-0.002, -0.021]	0.358	0.008*	-2.50 [-0.46, -4.72]	Decreasing
Extraction	-0.047 [-0.033, -0.062]	0.704	<0.001*	-10.3 [-7.32, -13.3]	Decreasing
R:E	-0.013 [-0.002, -0.022]	0.329	0.011*	-2.95 [-0.46, -4.94]	Decreasing

R:E proportion of restorative procedures (direct restorations and pulpectomies) and extractions of permanent teeth. β_1 : angular coefficient. R_2 : coefficient of determination. APC: Annual Percent Change (%). *: p-value <0.05 (statistically significant outcome). []: 95% confidence interval.

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Table 4. Comparison of the proportion of restorative procedures (direct restorations and pulpectomies) per extraction of permanent teeth in the Brazilian public dental services from 2008 to 2024 (2025).

Comparison	Ratio	Limits		p-value
		Lower	Upper	
Region				
Intercept	2.94	2.62	3.29	<0.001*
Brazil	ref			
North	1.435	0.974	2.134	0.073
Northeast	0.676	0.417	1.078	0.107
Southeast	1.208	0.807	1.820	0.362
South	1.396	0.945	2.079	0.099
Central-West	2.173	1.523	4.197	<0.001*

*: p-value <0.05 (statistically significant outcome). ref: reference level for adjustment (ratio = 1).

Table 5. Impact of the COVID-19 pandemic onset on the proportion of restorative procedures (direct restorations and pulpectomies) per extraction of permanent teeth in the Brazilian public dental services from 2008 to 2024 (2025).

Comparison	Ratio	Limits		p-value
		Lower	Upper	
Period				
Intercept	2.61	2.21	3.06	<0.001*
Pre-pandemic	ref			
First year	0.304	0.177	0.498	<0.001*
Second year	0.405	0.251	0.636	<0.001*
Third year	0.585	0.385	0.876	0.013*
Fourth year	0.462	0.293	0.712	0.001*

*: p-value <0.05 (statistically significant outcome). ref: reference level for adjustment (ratio = 1).

DISCUSSION

This study assessed the proportion between restorative procedures and extractions of permanent teeth (R:E) in Brazilian public dental services from 2008 to 2024. The first alternative hypothesis (H1) was partially accepted: although the number of restorations and pulpectomies in permanent teeth decreased during this timeframe, the number of tooth extractions also followed a similar temporal variation pattern (Table 3). The second alternative hypothesis (H2) was accepted: there was a regional disparity in relation to the national estimate involving the Central-West region (Table 4). Ultimately, the third alternative hypothesis (H3) was also accepted: the onset of the COVID-19 pandemic significantly reduced the R:E values (Table 5).

To better understand this scenario, it is important to emphasize that the significant reduction observed in outpatient productivity was not an expected outcome of such magnitude, especially with regard to restorations and extractions. The hypothesis that this decline was solely the result of cyclical variations in demand is not supported, as the identified pattern was consistent and heterogeneous throughout nearly the entire

time series, as demonstrated in Figure 1. Moreover, no changes were identified in procedural coding that could justify potential underreporting. On the other hand, between 2018 and 2021, a period during which the decline intensified, the quality of care provided by public dental services progressively deteriorated. This deterioration began prior to the pandemic and was further exacerbated during the COVID-19 crisis, as previously evidenced by Santos et al. (2023)¹⁶.

In this context, it is essential to recognize that public dental care has achieved notable advances while also facing persistent challenges. Facchini, Tomasi, and Dilélio (2018) discussed the expansion of access to dental appointments, particularly among socially vulnerable populations, while highlighting ongoing structural and managerial difficulties, including limited coordination with complementary oral health services¹⁷. In parallel, Casotti et al. (2014), in their evaluation of the National Program for Access and Quality Improvement in Primary Care (PMAQ-AB), found that less than half of users were able to schedule a dental appointment in 2012 (45.1%), and only 62.1% left with a follow-up appointment scheduled⁸. Together, these

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findings support the idea that declining productivity may be partly explained by persistent barriers to service provision and user access.

Despite the overall decrease in productivity across all evaluated dental procedures, the ratio between restorative procedures and extractions (R:E annual values) also declined, suggesting a proportional increase in extractions relative to restorative procedures in public dental services in recent years. When considering the relevant literature from Brazil, this outcome may be attributed to several factors, including population-specific caries experience (which can influence the demand for tooth extractions), delayed care-seeking behavior (often triggered by pain), and the persistence of a mutilating model of care in public dental services, which tends to favor extractions over restorative procedures due to both cultural perspectives and structural limitations^{5,10,18,19}.

Furthermore, Litaiff et al. (2024) demonstrated a significant decline in endodontic retreatments in public dental services between 2008 and 2022¹⁰. As a reflection of the relationship between restorative procedures and extractions, the reduction in retreatments may reinforce the increased prevalence of extractions in permanent teeth. Lima et al. (2023) also emphasized regional disparities in access to Endodontics and pointed out that the high cost of such procedures can limit their availability within the public system¹⁹. These limitations are consistent with the broader challenges previously described by Facchini, Tomasi, and Dilélio (2018) and Casotti et al. (2014)^{8,17}. Taken together, shifts in R:E values are unlikely to stem from a single factor, but instead reflect broader systemic issues related to geographic disparities, service availability, and health system management. These factors may help explain the discrepancies observed in the Central-West region.

It is important to emphasize that these discrepancies are not unique to Brazil. Studies conducted in other countries, such as England (Europe) and Taiwan (Asia), also highlight significant territorial differences in access to and quality of oral health services. Indeed, regional disparities within a single country are expected, particularly given the uneven distribution of resources, which is a crucial factor for ensuring accessibility and quality of care. This aspect is essential for understanding the outcomes of the present study^{20,21}.

Moreover, studies conducted within Brazil's public health system indicate that outpatient productivity may be associated with the high prevalence of tooth extractions and edentulism in specific populations, as well as emphasize how disparities in resource allocation continue to reinforce structural inequalities in oral health across the country^{22,23}. Therefore, it is reasonable to state that variations in R:E values should be understood through the lens of territory as a determining factor in the provision of dental care within the public health network.

Expanding the analysis of the results, it is critical to acknowledge the immediate and long-term impacts of the

COVID-19 pandemic on these outcomes, which exacerbated existing limitations. The decline in R:E values indicates that the proportion of extractions relative to restorative procedures was lower prior to the pandemic, increasing after the onset of SARS-CoV-2. The observed pattern suggests that full restoration of dental service provision has been constrained by structural and operational barriers. First, public dental care prioritized urgent procedures and those with lower aerosol generation, which significantly restricted elective interventions such as restorations and endodontic therapies. Second, these types of procedures were already exhibiting a downward trend prior to the onset of the COVID-19 pandemic, raising uncertainty as to whether the observed reduction would have occurred regardless, perhaps with less intensity^{5,19,24}.

Regarding the applicability of these findings, several limitations must be acknowledged. First, because this was a population-level analysis based on aggregated secondary data, no clinical information was available regarding the procedures, particularly the extent or severity of dental involvement, which would justify the indication of restoration, pulpectomy, or extraction. Second, the databases used do not allow assessment of the quality or clinical outcomes of the treatments, such as therapeutic success, retreatment needs, or systemic complications. Lastly, there is a recognized possibility of underreporting or inconsistencies in how dental procedures are recorded across regions and time periods, which may compromise the accuracy of some variables, even though the methodology applied is widely established in the literature.

In light of the findings, future studies should prioritize *in loco* investigations to better understand the contextual factors that influence the preference for extractions over restorative or endodontic procedures, particularly in areas with limited access to specialized public dental services. It is also relevant to analyze how dental practice has been reorganized in the post-pandemic setting, including changes in service priorities and care pathways. Moreover, studies exploring oral health profiles and service demands in Primary Health Care could contribute to more effective, territory-oriented planning by identifying whether the observed productivity aligns with the actual needs of the population. Finally, future research should deepen the analysis of distinctions between general and specialized care, especially concerning access mechanisms, referral systems, and the effectiveness of integrated care strategies across service levels.

CONCLUSION

Over the past 17 years, from 2008 to 2024, there was a significant shift in the proportion between restorative procedures and extractions of permanent teeth in the Brazilian public dental services, with the number of extractions increasing relative to the number of restorative procedures (restorations and pulpectomies), suggesting changes in treatment patterns. It was also concluded that the ratio between these dental treatment modalities (R:E values) continued to decline after the onset

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of the COVID-19 pandemic and was not homogeneous across Brazilian regions, with notable disparity in the Central-West.

version 4.0, OpenAI, California, USA) to review orthographic and semantic aspects of the manuscript.

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