






# Contextual and local determinants associated with the achievement of goals in the endodontics specialty in Brazilian dental speciality centres: A multilevel analysis

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## Funding information

The PMAQ-CEO study that originated the database used in this article was funded by the National Health Fund (FNS)

## Abstract

**Objectives:** To assess which factors were associated with the achievement of endodontic goals.

**Methods:** Cross-sectional study using secondary data from the second cycle of the Program for the Improvement of Access and Quality in the dental speciality centres—in Portuguese PMAQ-CEO. The independent variables extracted from this database were related to dental speciality centres (CEO in Portuguese). In addition, variables referring to the CEO host city were incorporated into the model. The outcome variable was the number of endodontic goals achieved calculated from the production of the CEO available in the Ambulatory Health Information System in 2018. Descriptive analyses and multilevel Poisson regression were performed with the software SPSS 23.0 and STATA 14.0.

**Results:** CEOs with more than 20% of patients' absenteeism were 26% less likely to reach the goals of the endodontics specialty; CEOs with availability of endodontists for more than 40 hours a week were two times more likely to reach the goals than those with less than 40 hours in endodontics specialty. CEOs with a waiting time for endodontic procedures greater than 45 days achieved a number of goals 31% lower than those with a waiting time up to 45 days. CEO type I and CEO type II showed 2.10 and 1.20 higher likelihood to reach the number of goals of the endodontics specialty than CEO type III. The number of endodontic instruments in sufficient number was positively associated with the achievement of goals. CEOs located in municipalities that reached more than 5% in the supervised brushing indicator had 2.26 greater likelihood to achieve the goals than those that did not reach this percentage.

**Conclusion:** Contextual and local determinants are associated with the achievement of goals in the endodontic specialty in the dental speciality centres in Brazil.

## KEYWORDS

delivery of health care, dental health services, endodontics, public health, secondary care

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## 1 | INTRODUCTION

Since 1988, Brazil established a Unified Health System ('Sistema Único de Saúde'—SUS), which was based on the principles of universality, integrality, and social participation and conceived to assure access to health actions and services, including oral health. Fifteen years later, the National Oral Health Policy was instituted and proposed a reorientation of the healthcare model, supported by an adaptation of the working system of oral health teams so that they include health promotion actions, treatment provision and rehabilitation. The intention was to rationally increase access to integrated oral health care, where 'care lines' (since childhood through adolescence, adulthood and old age) may have a centralized flow that includes the stages of welcoming, information giving, attendance and referral (including referral and contra-referral), in order to reach resolute outcomes for dental problems.<sup>1,2</sup>

The implementation of the dental speciality centres (CEO) is one of the actions of the National Oral Health Policy that are financed by the Ministry of Health. The CEOs offer dental clinical treatment complementary to procedures provided in primary care units, including periodontal surgery, endodontic treatment, minor oral surgeries, diagnosis and treatment support of oral lesions, and dental treatment for individuals with different types of disabilities.<sup>1,2</sup> According to the current legislation that regulates CEOs,<sup>3,4</sup> there are three models of CEO. CEO type I (three dental chairs); CEO type II (four to six dental chairs); and CEO type III (seven dental chairs or more). The CEOs must offer dental care 40 hours a week where the number of professionals vary according to the type of CEO. The CEOs must achieve the following production goals per month according to the type of CEO: Type I—35 endodontic procedures, 60 periodontal procedures, 80 oral surgery procedures and 80 basic procedures for people with disabilities; type II—these goals are 60, 90, 90 and 110 procedures respectively; and type III—95, 150, 170 and 190 procedures according to the listed specialties.

There has been an improvement in access to specialized dental treatments in Brazil in recent years though remarkable inequalities in dental services use persist between cities.<sup>5</sup> Access to dental care at CEOs is immediate in some cities though the waiting time can reach more than 1 year in other cities.<sup>5,6</sup> Currently, there are more than a thousand CEOs throughout the country<sup>7</sup> and endodontics is the most in demand specialized service in the dental speciality centres. This is because dental pain is one of the main reasons for seeking dental treatment.<sup>8</sup> Endodontic treatment is expensive in private dental practice, and this type of treatment was not offered in public services in the majority of cities until recently. Therefore, the great pent-up demand for endodontic procedures has generated long waiting lists at CEOs. Even so, there are large dropout rates of those patients undergoing endodontic treatment.<sup>8</sup> CEO organizational factors such as availability of dental instruments and equipment, waiting time, patient absenteeism and professional qualifications have been studied.<sup>5,9,10</sup> Also, contextual characteristics, such as Human Development Index (HDI),<sup>6,11–16</sup> *per capita* GDP<sup>17</sup> and organization of primary health care (PHC)<sup>12,13,15,16</sup> have been pointed out as

relevant factors associated with the performance of the CEOs. For example, municipalities with low HDI and small populations were less likely to achieve the goals set by the Ministry of Health. This was probably due to the difficulties related to the scarcity of resources faced by these municipalities. Likewise, municipalities with higher average income showed higher rates for dental procedures, demonstrating the inequalities in access to dental services in Brazil.<sup>13</sup>

The identification of the factors that influence CEO's productivity may generate relevant information favouring the reorganization of secondary dental care in Brazil. Thus, the aim of this study was to investigate organizational and structural factors, socioeconomic indicators, and CEO and PHC work processes that influence the achievement of CEO endodontic goals recommended by the Ministry of Health.

## 2 | METHODS

The Program for the Improvement of Access and Quality (PMAQ-CEO) is a national program with all CEOs in Brazil instituted by the Ministry of Health whose CEO census is conducted by partner universities. It is a national study of evaluation of dental units of secondary care aiming to induce the expansion of access and the improvement of quality in the dental speciality centres through the standardization of quality in these establishments so that they all become comparable nationally, regionally and locally. This program has four phases: agreement, development, external evaluation and re-contractualization.<sup>18</sup> In our study, data from the external evaluation carried out in 2018 were used. Eighty-five trained external evaluators interviewed health professionals of the CEOs (CEO coordinator, dentists or the municipal health manager) using standardized questionnaires and made on-site observation in the Brazilian CEOs that adhered to the proposal ( $N = 1042$ ) distributed by the regions of the country as follows form: 66 (6.3%) in the North, 410 (39.3%) in the Northeast, 364 (34.9%) in the Southeast, 131 (12.6%) in the South and 71 (6.8%) in the Midwest.

The dependent variable was the number of endodontics goals fulfilled per month by each CEO in the year 2018. The following thresholds regarding the number of endodontic procedures per month were used to ascertain whether the CEO reached the goals regulated by the Ministry of Health<sup>4</sup>:  $\geq 35$  endodontic procedures (CEO type I),  $\geq 60$  endodontic procedures (CEO type II) and  $\geq 95$  endodontic procedures (CEO type III) endodontic procedures. The list of endodontic procedures related to the goal is presented in the Appendix. The endodontic production per month in the year 2018 at each CEO was initially tabulated on TABWIN 4.14 Program. The endodontic production of each month was transformed into a dichotomous variable on whether each type of CEO was able to meet the pre-established goals. Finally, the number of months in which the goals were achieved was added up, resulting in the outcome measure ranging from 0 to 12.

The independent variables are described according to two levels and the respective dimensions in Table 1. The level 1 measures

TABLE 1 Dimensions and variables of independent variables

| Dimensions  | Variables                                       | Analysis  | Data source  |
|---|---|---|--|
| <b>1st Level – Dental Speciality Center (CEO)-level</b> |   |   |  |
| Access  | CEO area of coverage                            | Municipal or Regional   | PMAQ-CEO   |
|   | Access to CEO dental appointment                | Demand-led model and mixed-demand model or Exclusive referral model   | PMAQ-CEO   |
| Organization  | Protocol for endodontic procedures available    | Yes or No   | PMAQ-CEO   |
|   | Endodontic retreatment offered                  | Yes or No   | PMAQ-CEO   |
|   | Percentage of patients' absenteeism             | Up to 20%; More than 20%; Didn't know   | PMAQ-CEO   |
|   | Workload for endodontic procedures              | Number of hours available for endodontic procedures<br>Up to 40 h per week; More than 40 h per week.  | PMAQ-CEO   |
|   | Waiting time for endodontic treatment           | Number of days waiting for endodontic appointment.<br>Up to 45 days; More than 45 days  | PMAQ-CEO   |
|   | Sessions for endodontic treatment               | Number of days to complete endodontic treatment   | PMAQ-CEO   |
|   | Structure                                       | Type of CEO   | Type I; Type II; Type III<br>Based on the number of dental chairs and endodontic goals |
| Number of endodontic equipments/dentist                 |   | Number of specific endodontic equipments (apex locators and rotating instruments) divided by the number of dentists in the endodontics specialty.   | PMAQ-CEO   |
| Number of endodontic instruments                        |   | Presence of a sufficient number of instruments and with good quality. Sum of the answers yes for the following instruments: arch for absolute isolation, endodontic cement for filling, gutta percha cone, staples for endodontics, rubber sheet, endodontic files, sheet perforator rubber, clamp holder). Yes or No | PMAQ-CEO   |
| Proportion of qualified dentists in Endodontics (%)     |   | Proportion of dentists with training or specialization in endodontics in relation to the total number of dentists providing endodontic treatment.   | PMAQ-CEO   |
| <b>2nd Level—Municipality level</b>                     |   |   |  |
| Organization of Primary Health Care                     | Coverage of first dental appointment            | Proportion of the populational coverage of the first dental appointment in primary care. Greater coverage indicates a higher access to primary dental care.<br>Up to 15%; More than 15%   | DATASUS  |
|   | Proportion of tooth extraction                  | Proportion of tooth extraction in relation to primary dental care procedures. Greater proportion indicates a less preventive approach. Up to 8%, More than 8%   | DATASUS  |
|   | Coverage of supervised toothbrushing            | Average supervised toothbrushing (expresses the proportion of people who had access to toothbrushing with fluoride dentifrice under guidance / supervision of a health professional aiming at the prevention of oral diseases, mainly dental caries and periodontal disease)<br>Up to 5%, More than 5%                | DATASUS  |
| Sociodemographic indicators                             | Human Development Index (HDI)                   | Composite index using life expectancy, education and income to assess social development. Ranges from 0 to 1.   | PNUD   |
|   | Gini Index                                      | Assess the level of income inequality. Ranges from 0 to 1.  | PNUD   |
|   | Gross Domestic Product (GPD) <i>per capita</i>  | Total market value of goods and services per person   | IBGE   |
|   | Population                                      | Number of inhabitants   | IBGE   |
|   | Region of the country                           | North, Northeast, South, Southeast, Midwest   | IBGE   |
| <b>Dependent variable</b>                               |   |   |  |
|   | Number of achieved goals in endodontics in 2018 | Ranges from 0 to 12   | DATASUS  |

included 12 variables organized into three dimensions: access, organization and structure. The level 2 measures referred to eight contextual variables of organization of primary health care and sociodemographic indicators of the municipality where the CEO is located.

The variables were described through proportions and means (standard variation). First, Poisson regression was used to test the association between the independent variables at level 1 and the number of endodontics goals fulfilled per month using SPSS 23.0 (IBM Corp.). Multivariate multilevel Poisson regression analysis<sup>19</sup> was used to estimate prevalence ratios (PR) and 95% CI of variables related to dental speciality centres (CEO) (first-level variables) and municipal factors (second-level variables) with the outcome. Initially, the null model was assessed to verify the relevance of using multilevel analysis. The first model included the first-level variables with  $p$ -values  $<.20$  in the crude analysis. They were included and retained in the multivariate statistical modelling. The second-level variables were inserted in model 2 using the same statistical criteria ( $p$ -value  $<.20$ ). The final model consisted of the CEO and municipal variables with  $p$ -values  $<.05$  in model 2. The percentage of variance explained by the contextual level (partition coefficient of variance) was calculated by comparing the variance of the final model with the null model. Multilevel statistical analysis was performed on STATA 12.0 (College Station, TX, USA).

The PMAQ-CEO Project<sup>18</sup> was approved by the Research Ethics Council of the Federal University of Pernambuco (Registration 23458213.0.1001.5208).

### 3 | RESULTS

Overall, the dental speciality centres (CEO) achieved the endodontic goals in less than 4 months of the year (3.63 months SD = 4.14). Most of the CEOs provided dental treatment for the population of the city (68.6%), book dental appointments by referral (61.1%), have a protocol for endodontic procedures (85.7%), offer endodontic retreatment (78.3%) and have patients' absenteeism rate less than 20% (49.9%). Nearly 60% of the CEOs provided less than 40 h per week for the specialized endodontic treatment (59.7%) and their users waited less than 45 days for endodontic treatment (59.1%). The endodontic treatments were completed in 1.8 days (SD = 1.0) on average. Most of CEOs were type II (46.8%). The average number of endodontic equipment per dentist was 0.8 (SD = 0.8), and 89.4% of the CEOs had all listed instruments in sufficient number. In addition, a proportion of 0.8 (SD = 0.3) dentists registered at CEOs had training in endodontics (Table 2).

The multilevel Poisson regression (Table 3) showed the number of endodontics goals fulfilled per month was associated with variables related to the dental speciality center level (first level) and one variable of the organization of primary health care. CEOs with more than 20% of patient absenteeism achieved 26% lower number of goals than those with patient absenteeism rate lower than 20%. CEOs who have availability of endodontists for more than 40 h a

week were 1.95 times more likely to reach the goals than those with less workload in endodontics specialty. CEOs with a waiting time for procedures greater than 45 days achieved a number of goals 31% lower. CEO type I and CEO type II showed 2.10 and 1.20 higher likelihood to reach the number of goals of the endodontics specialty than CEO type III. The number of endodontic instruments in sufficient number was positively associated with the achievement of goals.

Municipalities that achieved more than 5% in the supervised toothbrushing indicator reached 2.29 times more goals than those with 5% or less coverage of supervised toothbrushing.

The comparison between the null model and the final regression multilevel model indicates an increase in explaining the variance of the result. The difference of the variances between the null model and the final model was approximately 17%.

### 4 | DISCUSSION

This study evaluated the impact of different factors related to the specialty dental services and to the context at municipality level in fulfilling the goals of endodontics procedures in public secondary dental care services in Brazil. The patients' absenteeism rate, the number of hours of dentist providing endodontic treatment, the type of CEO, the number of instruments and the average of supervised toothbrushing were associated with the number of fulfilled goals in endodontic specialty within the dental specialty centres.

Patients' absenteeism was negatively associated with the achievement of endodontic goals. Missing appointments in health-care facilities creates inefficiencies and loss of clinical productivity, which can affect the achievement of goals related to number of procedures.<sup>20</sup> Higher absenteeism may be associated with the fact that users referred to endodontics spent more time in the waiting list when compared with other dental specialties. Moreover, endodontics is the dental specialty with the highest frequency of no-shows.<sup>21</sup> One possible explanation of patient's absenteeism is the overlapping between the opening hours of the CEOs and the working hours of the users, as already reported in primary health care.<sup>22</sup> Besides, one possible reason for avoiding treatment may be the long time to finish the endodontic treatment and because dental pain frequently finishes in the first session.<sup>8</sup> Dental appointment confirmation in advance is the most used strategy to reduce patient's absenteeism in the CEOs across all Brazilian regions. Dental appointment overbooking (scheduling an excess number of patients) to compensate possible absences is relatively uncommon, and some CEOs do very little to prevent patients' absenteeism.<sup>5</sup> Other strategies to reduce absenteeism reported in different countries, regardless of the type of health service, include team embracement as a demand management strategy and phone call in advance on the day of appointment as a reminder to confirm the appointment,<sup>20,23,24</sup> in addition to an intense patient involvement in solving the problem.<sup>25</sup> One possible approach to reduce patients' absenteeism is to revise the CEO's regulations in order to plan the supply to meet the demand for health

TABLE 2 Descriptive analysis

|  |  | N (%)                                     | PR (IC95%)       | p                |
|--|--|---|------------------|------------------|
| <b>Independent variables (1st level)</b> |  |   |                  |                  |
| Access                                   | <i>CEO area of coverage</i>                            |   |                  |                  |
|  | Municipal  | 715 (68.6)                                | 1                |                  |
|  | Regional   | 327 (31.4)                                | 1.10 (0.95–1.27) | .190             |
| Organization                             | <i>Access to CEO dental appointment</i>                |   |                  |                  |
|  | Demand-led model and mixed demand                      | 405 (38.9)                                | 1                |                  |
|  | Exclusively referenced demand                          | 637 (61.1)                                | 1.31 (1.13–1.52) | <.001            |
|  | <i>Protocol for endodontic procedures available</i>    |   |                  |                  |
|  | Yes  | 893 (85.7)                                | 1                |                  |
|  | No   | 149 (14.3)                                | 0.79 (0.63–0.99) | .037             |
|  | <i>Endodontic retreatment offered</i>                  |   |                  |                  |
|  | Yes  | 816 (78.3)                                | 1                |                  |
|  | No   | 226 (21.7)                                | 0.82 (0.68–0.98) | .030             |
|  | <i>Percentage of patients' absenteeism</i>             |   |                  |                  |
| Up to 20%                                | 520 (49.9)   | 1   |                  |                  |
| More than 20%                            | 252 (24.2)   | 0.87 (0.73–1.02)                          | .091             |                  |
| Didn't know how to answer                | 270 (25.9)   | 0.66 (0.55–0.80)                          | <.001            |                  |
| Structure                                | <i>Workload for endodontic procedures</i>              |   |                  |                  |
|  | Up to 40 hours per week                                | 622 (59.7)                                | 1                |                  |
|  | More than 40 hours per week                            | 420 (40.3)                                | 1.44 (1.26–1.65) | <.001            |
|  | <i>Waiting time for endodontic treatment</i>           |   |                  |                  |
|  | Up to 45 days  | 577 (59.1)                                | 1                |                  |
|  | More than 45 days                                      | 400 (40.9)                                | 0.91 (0.78–1.05) | 0.197            |
|  | <b>Mean (SD)</b>                                       |   |                  |                  |
|  | <b>PR (IC95%)</b>                                      |   |                  |                  |
|  | <b>p</b>   |   |                  |                  |
|  |  | <i>Sessions for endodontic treatment*</i> | 1.8 (1.0)        | 0.81 (0.69–0.95) |
|  | <b>N (%)</b>   |   |                  |                  |
|  | <b>PR (IC95%)</b>                                      |   |                  |                  |
|  | <b>p</b>   |   |                  |                  |
|  | <i>Type of CEO</i>                                     |   |                  |                  |
|  | Type III   | 136 (13.1)                                | 1                |                  |
|  | Type II  | 488 (46.8)                                | 0.87 (0.70–1.10) | .243             |
|  | Type I   | 418 (40.1)                                | 1.17 (0.94–1.46) | .149             |
|  | <i>Sufficient number of instruments</i>                |   |                  |                  |
|  | Não  | 110 (10.6)                                | 1                |                  |
|  | Sim  | 932 (89.4)                                | 1.21 (0.93–1.57) | .166             |
|  | <b>Mean (SD)</b>                                       |   |                  |                  |
|  | <b>PR (IC95%)</b>                                      |   |                  |                  |
|  | <b>p</b>   |   |                  |                  |
|  | <i>Proportion of qualified dentists in Endodontics</i> | 0.8 (0.3)                                 | 1.00 (0.99–1.00) | .371             |
|  | <i>Number of endodontic equipment/dentist</i>          | 0.8 (0.8)                                 | 1.07 (1.00–1.15) | .063             |
| <b>Dependent variable</b>                | <b>Mean (SD)</b>                                       |   |                  |                  |
|  | Number of achieved goals in endodontics in 2018        | 3.6 (4.1)                                 |                  |                  |

\*Loss higher than 20%. Not included in the multilevel analysis.

services. On the contrary, the CEOs that did not have information on the percentage of absenteeism had an even lower achievement of goals. This may be related to the inefficiency of the CEO's management and the absence of an effective information system in order to

improve the access according to the user's risk classification, defined rules and agreed in healthcare protocols through a system specifically for that purpose.<sup>26</sup> The workload of dentists in endodontics specialty was directly associated with the number of goals of the

**TABLE 3** Poisson multilevel regression analysis for the number of achieved goals in endodontic treatment in Dental Specialty Centers, according to individual and contextual variables

| Variables                           |  | Model 1          | Model 2          | Final Model      |
|-------------------------------------|--|------------------|------------------|------------------|
|                                     |  | PR (95%CI)       | PR (95%CI)       | PR (95%CI)       |
| <b>1<sup>st</sup> Level (CEO)</b>   |  |                  |                  |                  |
| Access                              | CEO area of coverage                         |                  |                  |                  |
|                                     | Municipal                                    | 1                |                  |                  |
|                                     | Regional                                     | 1.00 (0.84–1.21) |                  |                  |
|                                     | Access to CEO dental appointment             |                  |                  |                  |
|                                     | Demand-led model or mixed demand             | 1                |                  |                  |
|                                     | Exclusively referenced demand                | 0.97 (0.81–1.17) |                  |                  |
| Organization                        | Protocol for endodontic procedures available |                  |                  |                  |
|                                     | Yes  | 1                |                  |                  |
|                                     | No   | 1.20 (0.90–1.58) |                  |                  |
|                                     | Endodontic retreatment offered               |                  |                  |                  |
|                                     | Yes  | 1                |                  |                  |
|                                     | No   | 0.88 (0.70–1.10) |                  |                  |
|                                     | Percentage of patients' absenteeism          |                  |                  |                  |
|                                     | Up to 20%                                    | 1                | 1                | 1                |
|                                     | More than 20%                                | 0.77 (0.64–0.93) | 0.74 (0.61–0.90) | 0.74 (0.62–0.90) |
|                                     | Didn't know how to answer                    | 0.57 (0.45–0.72) | 0.61 (0.47–0.78) | 0.61 (0.48–0.79) |
|                                     | Workload for endodontic procedures           |                  |                  |                  |
|                                     | Up to 40 h per week                          | 1                | 1                | 1                |
|                                     | More than 40 h per week                      | 2.12 (1.77–2.54) | 1.99 (1.64–2.43) | 1.95 (1.61–2.37) |
|                                     | Waiting time for endodontic treatment        |                  |                  |                  |
|                                     | Up to 45 days                                | 1                | 1                | 1                |
|                                     | More than 45 days                            | 0.78 (0.65–0.93) | 0.70 (0.58–0.86) | 0.69 (0.57–0.84) |
| Structure                           | Type of CEO                                  |                  |                  |                  |
|                                     | Type III                                     | 1                | 1                | 1                |
|                                     | Type II                                      | 1.10 (0.90–1.35) | 1.20 (0.96–1.50) | 1.20 (0.96–1.50) |
|                                     | Type I                                       | 1.94 (1.50–2.50) | 2.07 (1.56–2.74) | 2.10 (1.60–2.77) |
|                                     | Sufficient number of instruments             |                  |                  |                  |
|                                     | Não  | 1                | 1                | 1                |
|                                     | Sim  | 1.51 (1.14–2.01) | 1.44 (1.09–1.91) | 1.46 (1.10–1.93) |
|                                     | Number of endodontic equipments/dentist      | 1.08 (0.97–1.22) | 1.05 (0.93–1.19) |                  |
| <b>2nd Level (municipal)</b>        |  |                  |                  |                  |
| Organization of Primary Health Care | Coverage of first dental appointment         |                  |                  |                  |
|                                     | Up to 15%                                    |                  | 1                |                  |
|                                     | More than 15%                                |                  | 0.83 (0.59–1.17) |                  |
|                                     | Proportion of tooth extraction               |                  |                  |                  |
|                                     | More than 8%                                 |                  | 1                | 1                |
|                                     | Up to 8%                                     |                  | 1.37 (1.04–1.81) | 1.28 (0.98–1.68) |
|                                     | Coverage of supervised toothbrushing         |                  |                  |                  |
|                                     | Up to 5%                                     |                  | 1                | 1                |
|                                     | More than 5%                                 |                  | 2.19 (1.02–4.73) | 2.29 (1.07–4.93) |

TABLE 3 (Continued)

| Variables                             |                       | Model 1                | Model 2                | Final Model            |
|---------------------------------------|-----------------------|------------------------|------------------------|------------------------|
|                                       |                       | PR<br>(95%CI)          | PR<br>(95%CI)          | PR<br>(95%CI)          |
| Sociodemographic indicators           | HDI                   |                        | 0.15 (0.01–2.85)       |                        |
|                                       | GINI index            |                        | 1.79 (0.14–22.76)      |                        |
|                                       | GDP per capita        |                        | 1.00 (1.00–1.00)       |                        |
|                                       | Population            |                        | 1.00 (1.00–1.00)       |                        |
|                                       | Region of the country |                        |                        |                        |
|                                       | Midwest               |                        | 1                      | 1                      |
|                                       | South                 |                        | 1.11 (0.62–1.98)       | 1.03 (0.59–1.80)       |
|                                       | Southeast             |                        | 0.73 (0.44–1.21)       | 0.71 (0.43–1.17)       |
|                                       | Northeast             |                        | 0.54 (0.30–0.95)       | 0.62 (0.37–1.04)       |
|                                       | North                 |                        | 0.89 (0.46–1.74)       | 1.00 (0.53–1.91)       |
| <b>Random effects</b>                 | <b>Null Model</b>     |                        |                        |                        |
| Variance (95%CI)                      | 2.055 (1.749–2.413)   | 1.823<br>(1.565–2.157) | 1.689<br>(1.408–2.026) | 1.707<br>(1.424–2.046) |
| Changes in variation (%) <sup>1</sup> |                       | 11.2                   | 17.8                   | 16.9                   |
| LR test ( $\chi^2$ . <i>p</i> -value) | 2390.66 (<.001)       | 1950.87 (<.001)        | 1548.76 (<.001)        | 1608.33 (<.001)        |

Abbreviations: CI, confidence interval; LR, Likelihood Ratio; PR, prevalence ratio.

<sup>1</sup>in relation to the null model.

endodontics specialty. In a previous mixed-methods study in Brazil, the underutilization of dental services was meaningful despite achieving the goals of procedures in the specialty of endodontics. Some hypotheses to explain the underutilization of dental services are the lack of compliance of the contracted working hours of professionals, non-replacement of patients who miss appointments and difficulties in the referral system.<sup>27</sup> In addition, the difficulty in accessing secondary dental care services seems to be due to the insufficient number of professionals as a result of the high demand for endodontic treatment, thus contributing to a cycle of inefficiency in the provision of dental services.<sup>28</sup> All the above-mentioned factors can also impact on the waiting time for the endodontic procedures.

Small dental speciality centres (CEO type I) were more efficient in achieving the endodontic goals than the large dental centres (CEO type III). The latter have almost 3 times higher number of dental chairs and goals than the former. In previous research conducted with CEOs located in the southeast region of the country, no association was found between the type of CEO and their performance in achieving goals.<sup>15</sup> However, when evaluating CEOs across the country, CEOs type II achieved more goals when all specialties were evaluated.<sup>18</sup> In the case of the endodontic goals, another study did not find association between the type of CEO and the achievements of goals.<sup>29</sup> The number of endodontic instruments was associated with the achievement of goals in endodontics. A previous study carried out in the South region of the country did not find such association.<sup>29</sup> Another study found that 30.4% of dentists working in CEOs reported that they did not provide dental treatment due to lack of dental materials and dental instruments, and 38.6% informed problems with dental equipment as the reason for not treating patients.

The adequate availability of dental instruments is essential for the completion of endodontic treatments in a timely and efficient way.

Among the contextual characteristics investigated related to the organization of primary health care and the sociodemographic variables of the municipality where the CEO is located, the coverage of supervised toothbrushing was the only one that remained associated with the number of goals of the endodontics specialty. Higher coverages indicate the municipal oral health services provide preventive dental activities. Thus, these activities may have a positive impact on the population's oral health. Severe dental caries is one of the most common causes of endodontic treatment needs,<sup>30,31</sup> and toothbrushing is fundamental to prevent dental caries and gingivitis.<sup>32,33</sup> The lower use of individual preventive procedures at both levels of care reveals the predominance of the curative model of care.<sup>34</sup> Toothbrushing is an important procedure for establishing oral hygiene habits and reduces the levels of dental biofilm.<sup>35</sup> It has already been found that the factors related to the organization of primary health care were the same factors responsible for a lower need of dental treatment at the secondary level.<sup>36</sup> Despite the lack of association between contextual variables and the number of achieved goals in endodontic treatment in this study, population size and HDI have been associated with the performance of CEOs in previous studies. The smaller the municipality and the lower the human development index, the worse the CEO performance in different regions of Brazil.<sup>11–13,15,17</sup> Possibly, low HDI follows the poor levels of education and income at city level, which might increase the burden of dental needs in a population. The search for health services occurs according to the user's values and perceptions of needs. This, in turn, influences

the performance of the services due to misuse of resources and lack of opportunity to intervene in time.<sup>13</sup> On the contrary, associations of coverage of first dental appointment of the Unified Health System, proportion of tooth extraction and Gini Index with the performance of secondary dental care services were reported. However, GINI index was not associated with the performance of Brazilian Oral Health Teams in primary care.<sup>37</sup> In this study, the average number of months in which the endodontic goal was met was less than four. Some authors have reported among other variables analysed from 1st PMAQ cycle (2013/2014) an association between self-evaluation and meeting service production targets with planning process of the dental speciality centres.<sup>38</sup> In addition, it is known that there was an increased tendency of these services to meet goals related to secondary dental assistance compared with those from primary dental care; however, this tendency was not uniform for all regions in the country and either for all specialties.<sup>39</sup> Therefore, within the literature, there are not studies regarding the factors associated with the achievement of endodontic goals to help a better planning for these services and consequently an expected increase on endodontic care offer. Previous studies showed the need to review the legal framework for the implementation of CEO. This should involve the reassessment of the criteria and norms, as well as the revision when defining new standards and achievement of goals of these services for evaluation and monitoring purposes.<sup>16</sup>

This is a cross-sectional study that used secondary data from public electronic databases and systems. Therefore, the data is subject to bias and inaccuracies that may influence the validity of the present findings. In addition, causal interpretation of the relationships between variables should be avoided due to the cross-sectional study design. However, the large sample size and robustness of the statistical analysis may be considered the strengths of the study.

The understanding of the factors that may interfere in the achievement of goals in endodontic services in public health units must be considered during the planning and monitoring processes. Consequently, they can contribute to improve the amount and quality of dental services in secondary care. Strategies to prevent patients' absenteeism, maintenance of dental equipment and securing the financial resources to purchase the essential materials and instruments for endodontic treatments may enhance the capacity to provide endodontic treatment. Furthermore, improvement on professional career paths and supervision of compliance concerning dentist's working hours are some actions that may contribute to the improve endodontic dental services.

## ACKNOWLEDGMENT

Collaborating Center of the Ministry of Health of the Federal University of Pernambuco - CECOL/UFPE; and the financing of the National Health Fund (FNS).

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in Ministério da Saúde—Secretaria de Atenção Primária à Saúde at <https://aps.saude.gov.br/ape/pmaq/ciclo2ceo/>.


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**How to cite this article:** Pinto RDS, Lucas SD, Goes PSAD, et al. Contextual and local determinants associated with the achievement of goals in the endodontics specialty in Brazilian dental speciality centres: A multilevel analysis. *Community Dent Oral Epidemiol*. 2022;50:74–82. doi:[10.1111/cdoe.12722](https://doi.org/10.1111/cdoe.12722)

## APPENDIX

List of procedures (the codes presented are those provided by the SUS Unified Table of Procedures):

0307020037 concluded endodontic treatment of deciduous tooth  
 0307020045 concluded endodontic treatment of permanent bi-radicular tooth  
 0307020053 concluded endodontic treatment of permanent tooth with three or more roots  
 0307020061 concluded endodontic treatment of permanent uni-root tooth  
 0307020088 concluded endodontic retreatment in permanent biradicular tooth  
 0307020096 concluded endodontic retreatment in permanent tooth with 3 or more roots  
 0307020100 concluded endodontic retreatment in permanent uni-root tooth  
 0307020118 root perforation sealing