



# Endodontic Continuing Education of Dental Practitioners in Croatia: A Nationwide Survey

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## Abstract

**AIM:** This study aims to assess the state of endodontic continuing education (ECE) among dental practitioners in Croatia and identify factors influencing participation in such education.

**METHODS:** A questionnaire was sent to all dental offices in Croatia, yielding 819 responses. The data were analyzed descriptively and statistically modeled.

**RESULTS:** Most respondents had participated in some form of ECE during their careers. However, in the past 5 years, only about 78% had engaged in such education, with participation decreasing by 2% for each additional year of practice. Male practitioners had significantly less continuing education in the past 5 years, particularly in private clinics, dental clinics with concession contracts, and certain regions. Practitioners who performed more endodontic treatments reported higher levels of continuing education. The endometer was the only modern technique consistently used by about 60% of practitioners with continuing dental education.

**CONCLUSION:** Continuing education in endodontics should be more strongly promoted among practitioners with longer careers, particularly men.

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**Keywords:** Continuing professional development; Continuing dental education; Dental education; Endodontics; Rubber dam

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## Introduction

Continuing professional development (CPD) is mandatory for dental practitioners in Croatia, as well as in most European countries [1], [2], [3], [4], [5] and the U.S. [6]. The primary goal of CPD is to ensure high standards of patient care by continuously updating dentists' knowledge and skills [7], [8], [9], [10], [11], [12], [13]. Moreover, CPD has been linked to important secondary outcomes, such as reducing opioid-related mortality through improved pain management practices [14], [15].

Globally, the effectiveness of CPD programs has been questioned, with several studies investigating the real impact of educational interventions [16], [17], including the growing role of online continuing dental education [18]. A significant body of literature addresses the status of endodontic practices among general dental practitioners [19], [20], [21], [22], [23], [24], with research focusing on knowledge gaps, skill development, and the need for updated training. In addition, collegial feedback within clinical settings has been explored as a means to enhance CPD outcomes [25].

In Croatia, previous research has mainly focused on the prescribing practices of dental professionals, including their contribution to national medication consumption [26], [27], as well as the patterns of antibiotic use in endodontic treatments (ET) [28], [29], [30], [31], [32]. Other studies have examined referrals for surgically managed endodontic cases [33], the preparedness of dentists to handle medical emergencies [34], and the knowledge of pediatricians in managing dental trauma [35]. Occupational injuries in dental practices [36] and dental students' awareness of oncology patient care [37] have also been researched. In addition, research has highlighted the adoption of new endodontic techniques in Croatian dental practices [38], as well as the need for further CPD on maintaining dental records for forensic purposes [39].

CPD plays a vital role in ensuring that dental practitioners stay informed about emerging knowledge, technologies, and procedures and that they integrate these advances into clinical practice to provide optimal patient care. This study aims to assess the current state of endodontic continuing education (ECE) among dental practitioners in Croatia, identifying the factors that

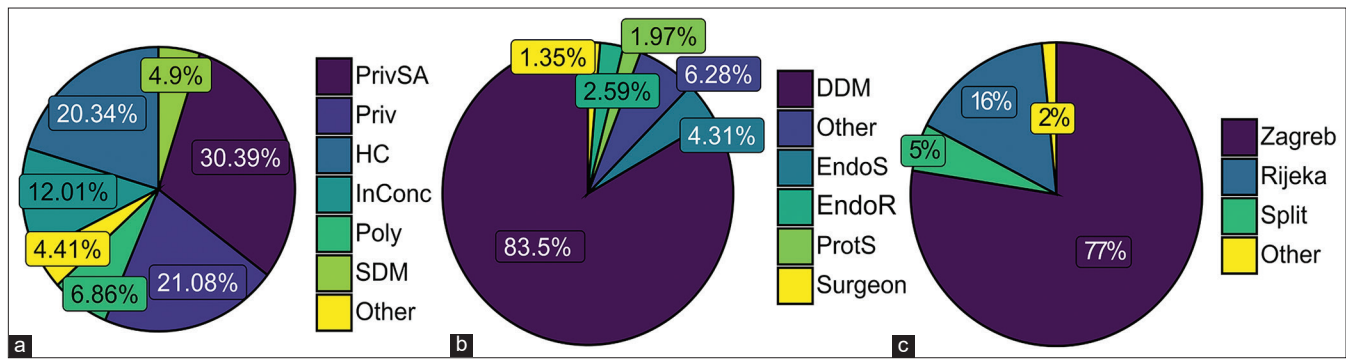


Figure 1: Percentage of responders per (a) Office type, (b) Degree in clinical education, (c) University

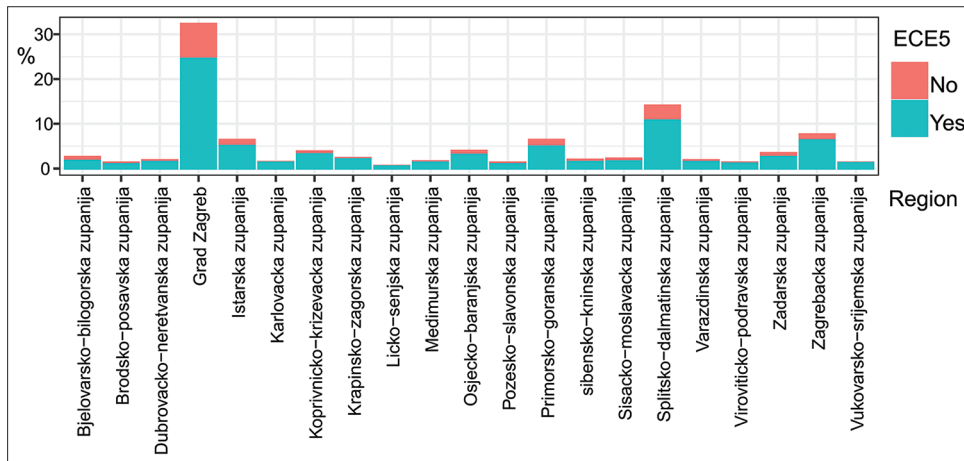


Figure 2: Percentage of responders per region and endodontic continuing education in the past 5 years

influence participation in such programs. The ultimate goal is to enhance ECE programs and, consequently, the quality of care provided by Croatian dental professionals.

## Materials and Methods

### Questionnaire

A questionnaire was distributed to approximately 3000 dental practitioners in Croatia. The number of respondents was estimated using data from the Croatian Institute of Public Health and the Croatian Health Statistics Yearbook. A total of 819 responses were collected, representing a 27% response rate. The questionnaire can be accessed at <https://forms.gle/nmUeQizSoN2U5SNYA>.

Participants provided demographic information, including sex (female - F and male - M), years of practice, and educational qualifications (Doctor of Dental Medicine [DDM], Specialist in Endodontics [EndoS], Resident in Endodontics [EndoR], Prosthetics Specialist [ProtS], Oral Surgeon [Surgeon], and Other). In addition, participants indicated the type of dental office where they practiced, including Health Center (HC), Dental Clinic with Concession Contract (InConc), Private Clinic (Priv), Private Clinic with State Health

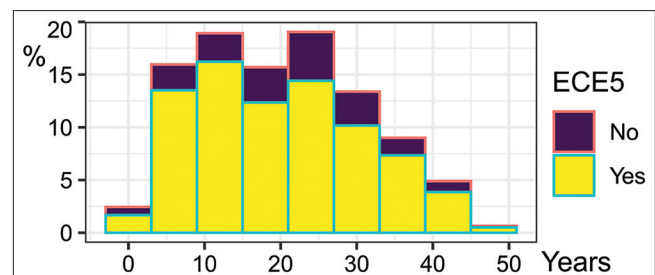


Figure 3: Histogram of responders' years of practice and endodontic continuing education in the past 5 years

Fund Contract (PrivSA), Dental Polyclinic (Poly), and School of Dental Medicine (SDM).

The questionnaire distinguished between practitioners who had received ECE at any point in their careers and those who had participated in ECE in the past 5 years (ECE5). Further questions covered various aspects of endodontic clinical practices, such as the use of endometers and rubber dams, the use of X-ray imaging and cone-beam computed tomography (CBCT), and preferences for manual, mechanical, or combined instrumentation methods.

### Statistical methods

The statistical analysis was conducted using the R Project for Statistical Computing (version 4.3.0)

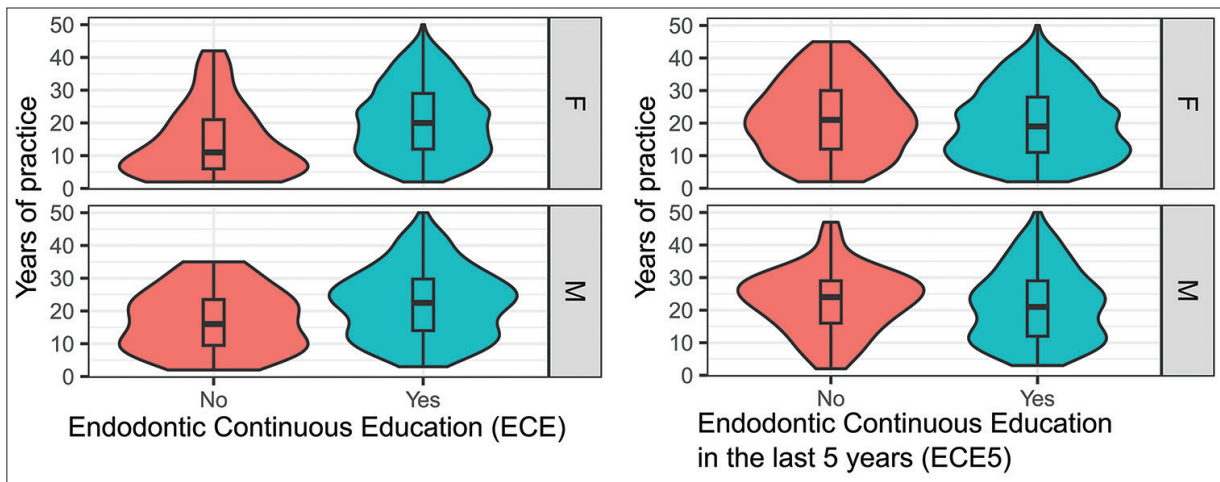


Figure 4: Endodontic continuing education (left) and endodontic continuing education in the past 5 years (right) per sex and years of practice

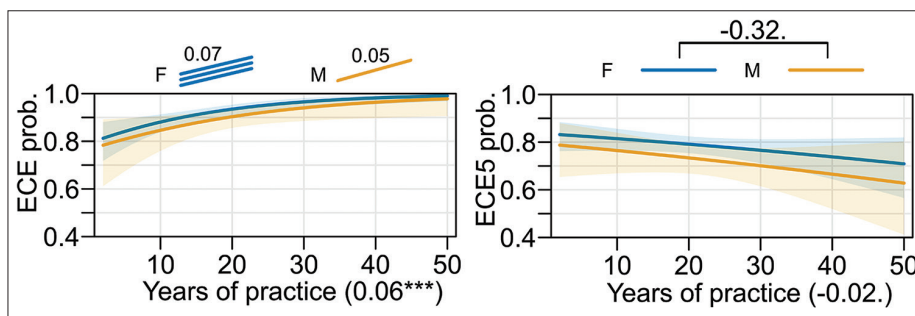


Figure 5: Effects of sex and years of practice on continuing education (left Endodontic continuing education; right endodontic continuing education in the past 5 years)

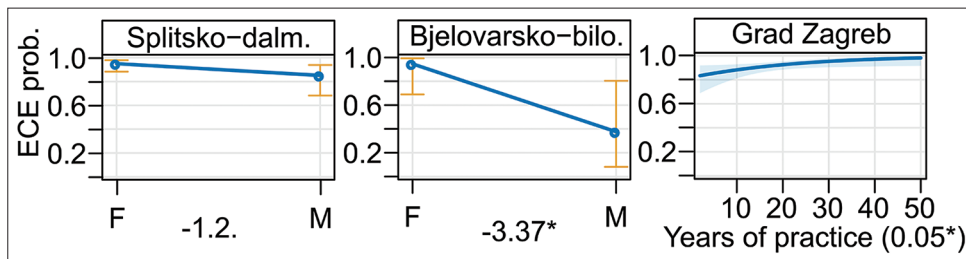


Figure 6: Regions and endodontic continuing education

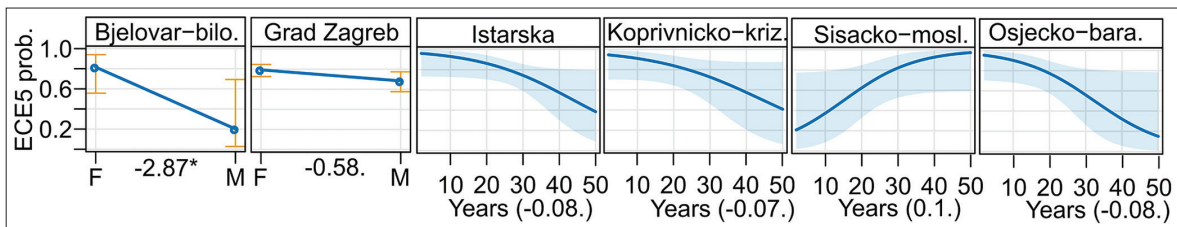


Figure 7: Regions and endodontic continuing education in the past 5 years

along with its Survey package. The use of the specialized Survey package was necessary due to the relatively large sample size in comparison to the total population, making the finite population correction factor significant.

First, the distribution of practitioners by sex, years of practice, region, and ECE participation was examined. The  $\chi^2$  test was applied to assess relationships between categorical variables,

while Analysis of Variance was used to examine relationships between continuous and categorical variables. Logistic regression models were developed to identify factors influencing ECE participation. All regression models were adjusted for sex and years of practice. For all categorical variables except sex, sum contrasts were used, meaning that the categories were contrasted with the overall mean.

Results are reported as log odds (logit), with significance levels indicated as follows: \*\*\*p < 0.001, \*\*p < 0.01, \*p < 0.05, and dot for p<0.1. Slopes in the regression analysis are denoted by the corresponding number of stripes, with a dotted stripe representing a significance level of 0.1. Error bars or bands in the plots represent 95% confidence intervals.

## Results

### Characteristics of practitioners and population parameter estimates

Table 1 provides general data about the respondents, while Figures 1-3 describe variables with more than two levels. Figure 4 shows violin plots of ECE and ECE5 based on sex and years of practice. There does not appear to be a significant effect of sex or years in practice on ECE5, although there is a slight decrease with years of practice for both sexes. However, male respondents are slightly older, necessitating regression analysis correction for years in practice.

**Table 1: Responders' characteristics**

Characteristics	Quantity	
	Mean (%)	SE
Sex		
Male	29.2	0.01
Female	70.8	0.02
Years of practice		
ECE	20.8	0.32
No	8.3	0.01
Yes	91.7	0.01
ECE5		
No	22.2	0.01
Yes	77.8	0.01
Office status		
Polyvalent	87.7	0.01
Specialist	12.3	0.01
Performing endo treatments	96.2	0.006
Number of doctors per office	2.4	0.33

SE: Standard error, ECE: Endodontic continuing education, ECE5: Endodontic continuing education in the past 5 years

### Regression analysis

Figures 5-12 present the regression analysis results. All relevant predictor variables were tested against ECE and ECE5.

As expected, the probability of having ECE significantly increases with years of practice for both males and females (Figure 5). However, ECE5 drops with each additional year of practice by approximately 2% ( $e^{-0.02}-1 = -0.02$ ). There is slight evidence suggesting that males have significantly less ECE5 than females, with 27% lower odds ( $e^{-0.32}-1 = -0.27$ ).

Although some variation in ECE5 is observed between regions (Figure 2), no significant differences between regions were found overall (Figure 7). However, significant drops in ECE5 with years of practice were observed in three regions, except in Sisacko-Moslovacka, where a significant increase in ECE5 with years was detected. In Figure 6, the effect of sex on ECE is significant in two regions, while an increase with years of practice is only significant in the Grad Zagreb region (the capital of Croatia).

No significant differences were found among degrees in clinical education (Figure 8). DDMs demonstrated high ECE levels and a significant increase with years of practice.

There is slight evidence that PrivSA offices have more ECE than other office types (Figure 9). Both PrivSA and Priv clinics have shown a significant increase in ECE over the years. Poly and PrivSA clinics have significantly higher ECE5 rates than other office types, while SDM (School of Dental Medicine) shows a significantly lower probability of ECE5. Interestingly, male practitioners in InConc have significantly higher ECE5, while in Priv clinics, females are more likely to have ECE5. Polyvalent offices exhibit a significant increase in ECE over the years, while male specialists are less likely to have ECE5 (Figure 10).

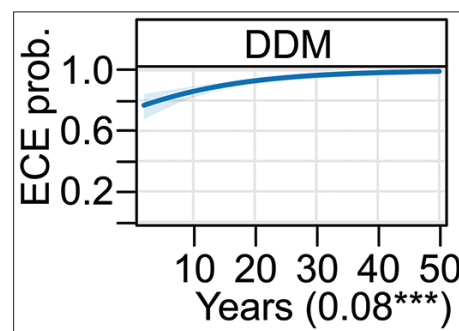


Figure 8: Degree in clinical education and endodontic continuing education

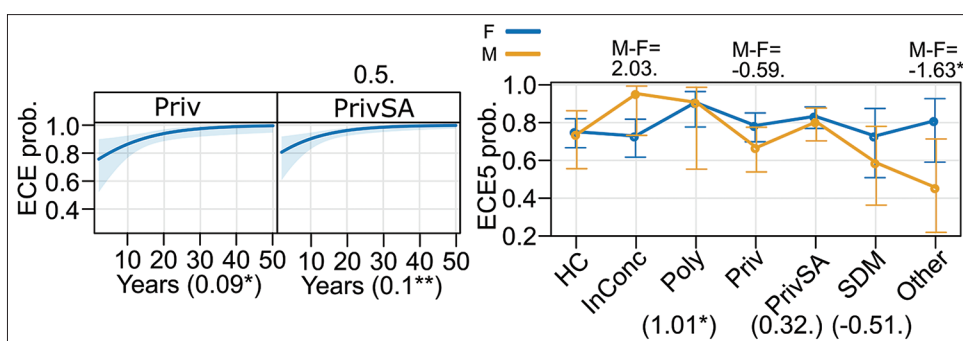


Figure 9: Office organization and endodontic continuing education (left endodontic continuing education; right endodontic continuing education in the past 5 years)

No significant differences were observed among practitioners from different universities (Figure 11). For major Croatian universities (Zagreb, Split, Rijeka), the probability of ECE increases with years, though ECE5 significantly decreases for practitioners from Zagreb as they gain years of practice. Among Split University graduates, males are less likely to have ECE.

Practitioners who perform more ET per month tend to have more ECE and ECE5, although the increase is not significant for males with ECE (Figure 12). However, the probability of males having ECE is still quite high (~0.9 or greater).

### Relationship between ECE and novel endodontic methods

Figure 13 shows the percentage of practitioners with ECE or ECE5 per their usage of various endodontic technologies. Endometer stands out as the only technique showing consistent usage of 60% by practitioners with ECE or ECE5. CBCT usage is rare, while most respondents with ECE rarely use XR imaging 12–24 months after treating teeth with significant periradicular lesions. About 30% of respondents with ECE5 never use a rubber dam, and around 20% never use rotary instrumentation.

## Discussion

As shown in Table 1 and Figure 3, the distribution of respondents by sex and years of practice is uneven.

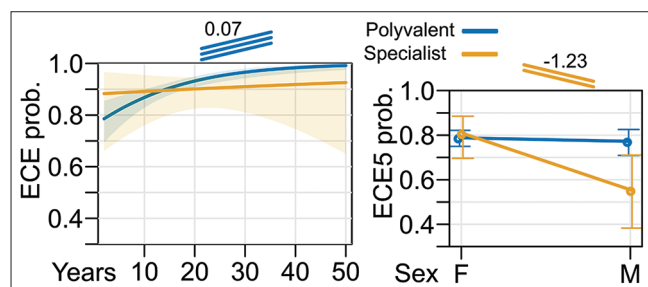


Figure 10: Office status and endodontic continuing education (left endodontic continuing education; right endodontic continuing education in the past 5 years)

Therefore, all regression models were adjusted for these two variables. The larger number of female respondents aligns with the greater representation of women among practitioners. The smaller number of respondents at the extremes of the years-of-practice histogram (Figure 3) indicates that both newer and more experienced practitioners were less likely to participate in the survey, a trend also observed in previous studies [40].

According to Table 1, nearly all respondents perform ETs, with approximately 92% having some form of ECE, and 78% having had ECE5. For comparison, in 2003 in New Zealand, 76% of respondents had ECE in the prior 3 years. Most respondents (88%) work in polyvalent offices. Figure 1 shows that over 50% of respondents work in Priv and PrivSA offices, followed by HC (20%), InConc (12%), Poly (7%), and SDM (5%). Among educational qualifications (Figure 1b), DDM is the most prominent, while EndoS, EndoR, ProtS, and Surgeon share smaller proportions in decreasing order. In addition, 77% of respondents studied in Zagreb (panel C), Croatia's largest university.

Figure 4 highlights the influence of sex and years on ECE and ECE5. For both males and females, ECE increases with years of practice, but the opposite is true for ECE5. This trend is confirmed by regression analysis (Figure 5). The decline in ECE5 with age may suggest that older practitioners feel that they need less CPD due to greater knowledge, but it could also mean that they are less informed about recent advances. Conversely, younger respondents, likely influenced by recent university studies and clinical practice, may have more ECE5. The COVID-19 pandemic could also have disproportionately affected ECE5 among older practitioners [41], [42].

We observed a slight but significant reduction in ECE5 among males (Figure 5), a finding that contrasts with a previous UK study that found less CPD among females [43]. Therefore, it may be beneficial to target males in Croatia for increased CPD participation, particularly in regions such as Grad Zagreb, Splitsko-dalmatinska, and Bjelovarsko-bilogorska, where significant differences were detected (Figures 6 and 7).

Interestingly, no significant differences in ECE5 were found across degrees of clinical education,

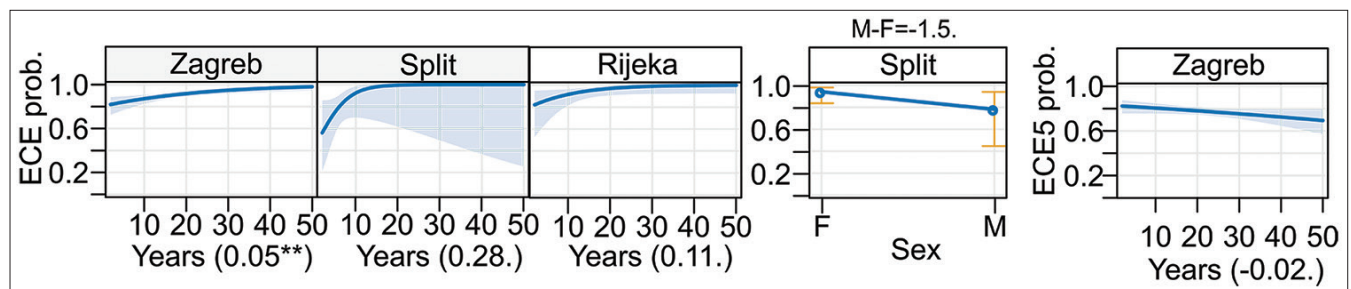


Figure 11: Universities and endodontic continuing education

although DDMs show a high ECE rate and an increase with years (Figure 8). PrivSA offices slightly outperform other types in terms of ECE, with Poly and PrivSA clinics showing significantly higher ECE5. SDM shows significantly lower probability of ECE5, which could be because EndoS responders in SDM interpreted ECE5 as education intended for non-specialists. In addition, male specialists and male Split graduates were less likely to have ECE5 (Figures 9-11).

It is encouraging that practitioners who perform more ET per month are more likely to have ECE, suggesting that more qualified practitioners are treating a larger number of cases (Figure 12).

It is important to recognize the limitations of this study. One major limitation is the distinction only between ECE and ECE5, without considering other potential variables such as personal motivation and interest in continuing education. In addition, the study does not account for time spent reading professional or scientific journals, which could also influence a practitioner's knowledge. Future research could explore different forms of CPD and include these aspects for a more nuanced understanding of continuing education practices among dental practitioners.

### Conclusions

This study investigates the influence of sex, years of practice, region, office type, clinical education, university attended, and modern techniques on ECE and ECE5 among dental practitioners in Croatia. After

20 years of practice, about 90% of practitioners had some form of ECE, but within the past 5 years, this number is around 78% and it drops with age. The findings suggest that ECE programs should focus on male practitioners, particularly in regions such as Splitsko-dalmatinska, Grad Zagreb, and Bjelovarsko-bilogorska, as well as those in private offices or who studied at Split University. ECE generally increases with years of practice, while ECE5 decreases. Furthermore, practitioners who perform more ETs tend to have more education. Finally, the use of modern endodontic techniques, apart from endometers, is not nearly as high as it should be among practitioners with ECE or ECE5.

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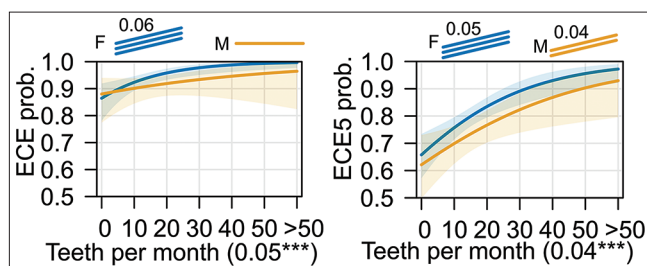


Figure 12: Number of endodontic treatments per month and endodontic continuing education (left endodontic continuing education; right endodontic continuing education in the past 5 years)

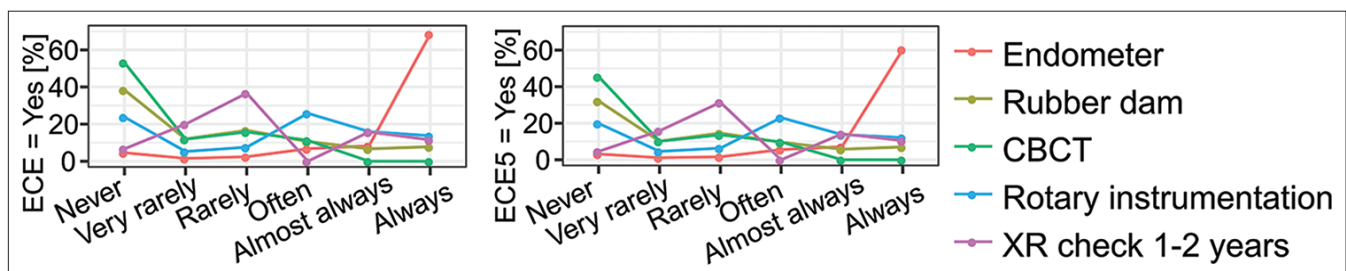


Figure 13: Continuing education and modern endodontic techniques (percentage of practitioners who responded yes to endodontic continuing education (left) and endodontic continuing education in the past 5 years (right), per different method)

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