

# Dentists' Attitudes towards the Dental Ceramic Choice for Metal-Free Restorations: a Questionnaire Survey

## Atitudes de Dentistas Frente à Escolha de Cerâmicas Dentárias para Restaurações Livres de Metal: uma Pesquisa de Questionário

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### Abstract

A wide variety of dental ceramics is launched every year. Therefore, clinicians should constantly study and update themselves to correctly indicate these materials. This cross-sectional study aimed to assess the association of dentists' academic aspects with their knowledge and the indication of dental ceramics for metal-free restorations. All the dentists from private clinics who affirmed to perform prosthetic treatments on their patients in a Southern Brazilian city were personally invited to this research to avoid dropouts. Participants answered questions related to their knowledge of different dental materials, their information sources and usage frequency of ceramic materials, and related to their academic training/education. Chi-square tests were performed to evaluate the association among the outcomes (knowledge of different materials, information sources considered for material selection and their frequencies of use) and exposure variables (time since graduation and post-graduation degree). Significant associations were also submitted to Chi-square residual analysis. A response rate of 73.3% was reached. The most known and used materials were Y-TZP and porcelain veneered zirconia, respectively, whereas the least known was leucite-based ceramic. The majority of the professionals with at least 25 years since graduation claimed not to know lithium disilicate or leucite-based ceramics, and a significant number of these professionals allow the laboratory prostheses technician to choose the restorative material. In addition, most of dentists with no post-graduation said they did not have knowledge about leucite and lithium disilicate. It was evidenced that continuing education plays an important role in the dentists' attitudes regarding ceramic materials.

**Keywords:** Surveys and Questionnaires. Ceramics. Prosthodontics.

### Resumo

*Uma grande variedade de cerâmicas é lançada no mercado a cada ano. Portanto, os clínicos devem se manter em constante estudo e atualização para indicar corretamente o uso desses materiais. Assim, este estudo transversal teve por objetivo avaliar a associação entre aspectos acadêmicos de dentistas com seus conhecimentos e as indicações de cerâmicas dentárias para uso em restaurações livres de metal. Para isso, todos os dentistas de clínicas privadas que afirmaram realizar tratamentos protéticos em seus pacientes em uma cidade do sul do Brasil foram pessoalmente convidados a participar desta pesquisa para evitar desistências. Os participantes responderam a questões relacionadas ao seu conhecimento sobre diferentes materiais dentários, suas fontes de informação, a frequência de uso de materiais cerâmicos, e, também, sobre sua formação acadêmica. Testes qui-quadrado foram realizados para avaliar a associação entre os desfechos (conhecimento de diferentes materiais, fontes de informação consideradas para a seleção do material e sua frequência de uso) e as variáveis de exposição (tempo desde a graduação e grau de pós-graduação). As associações significativas foram submetidas à análise de resíduos do qui-quadrado. A taxa de resposta obtida foi de 73,3%. O material mais conhecido e usado foi a Y-TZP e zircônia recoberta por porcelana, respectivamente, enquanto que o material menos conhecido foi a cerâmica a base de leucita. A maioria dos profissionais com pelo menos 25 desde a graduação afirmaram não conhecer as cerâmicas a base de dissilicato de lítio ou leucita, e um significativo número desses profissionais permitem que o técnico em prótese dentária escolha o material restaurador. Ainda, a maioria dos dentistas sem pós-graduação disseram não conhecer as cerâmicas a base de dissilicato de lítio ou leucita. Concluiu-se que a educação continuada é um fator determinante nas atitudes de dentistas em relação aos materiais cerâmicos.*

**Palavras-chave:** Pesquisas e Questionários. Cerâmicas, Prótese Dentária

## 1 Introduction

The wide demand for esthetic and natural restorations has led to the improvement and development of metal-free ceramic systems which have been constantly launched in the dental market. Previous literature has described satisfying properties of ceramic materials popularized in dental clinics such as zirconia,<sup>1-3</sup> lithium disilicate,<sup>4</sup> feldspathic,<sup>5</sup> and leucite reinforced dental ceramics.<sup>6</sup>

In this sense, factors such as tooth location, esthetic

demands, mechanical requirements, occlusal factors, dental substrate color and parafunction habits must be considered in the restorative ceramic material choice. Single and multiple fixed dental prostheses (FDPs) are commonly fabricated using a high crystalline content material as substructure, which provides strength, and veneered with a predominantly glass ceramic, which provides highly esthetics.<sup>7</sup> Nevertheless, some dental ceramics such as lithium disilicate,<sup>8</sup> leucite-<sup>9,10</sup> and zirconia-based<sup>11</sup> are also indicated for monolithic FDPs.

Despite all the produced knowledge in the ceramics field, it is not known how much of the new information reaches dental clinicians. These indication possibilities and the introduction of new materials on the dental market require studying and training by the dentists in order to ensure the best indication for each case.<sup>12,13</sup> In addition, factors such as continuing education<sup>14</sup> and clinical experience<sup>15</sup> have been reported as influencing professional clinical choices.

Studies that aimed to analyze the dentists' preferences and attitudes regarding material and technique choices have been previously performed in different countries.<sup>14,16-20</sup> Previous surveys have evaluated several aspects such as confection techniques for implant-supported prostheses,<sup>18</sup> use of denture adhesives,<sup>19</sup> and the preference of using posts to restore endodontically treated teeth.<sup>14</sup> Makhija, et al.<sup>20</sup> evaluated the recommendations of dentists from the United States regarding single crowns through questionnaires. These studies help to identify possible deficiencies in clinical academic education and to suggest adjustments in the dental schools and post-graduation courses curricula.

To the best of our knowledge, there is no available evidence associating the dentists' attitudes toward novel ceramic material for metal-free FDPs with their academic education aspects. Thus, this cross-sectional study aimed to evaluate the association of time since graduation and post-graduation degree on the dentists' attitudes toward selecting and indicating dental ceramics for metal-free restorations in a southern Brazilian city.

## 2 Material and Methods

This study was approved by the Ethics in Research Committee of Federal University of Santa Maria, RS, Brazil (CAAE: 63077216.0.0000.5346) and signed informed consent forms were obtained from all the participants.

This cross-sectional study was performed between March and June/2017 in Santa Maria, Rio Grande do Sul, Brazil, a middle-sized city which had approximately 278,445 inhabitants at the time of the study. Lists provided by the City hall and the Regional Council of Dentistry showed a total of 880 dentists registered and attending the municipality. The authors identified the clinicians who had private practices and affirmed performing prosthodontic treatments through phone calls, which constituted the sample inclusion criteria. All the dentists who met these inclusion criteria were invited in person to attend the study (n = 206). This approach was chosen to avoid low response rates. Dentists only working in public health services that (in Brazil) do not include this kind of prosthodontic treatment (ceramic restorations) were excluded from the sample, as well as Dentistry professors who did not work in private practice.

All the 206 professionals were visited by the researchers in their dental offices. Those who accepted to participate in the study received a self-reported questionnaire, and the

researchers returned seven days later to collect the answered document with the signed informed consent form. If the dentist did not return the questionnaire after 3 visits, his/her participation was excluded. After signing the consent form and answering the questionnaires, the clinicians then received explanatory material on the indications, confection techniques and commercial brand examples of the main ceramic materials currently available in the market which had been elaborated by the researchers. The questionnaires and informed consents of each participant were identified only by number and kept in separate envelopes to ensure data confidentiality.

The following information was gathered through the questionnaire: social-demographic characteristics (age and gender), academic education (time since Dentistry graduation, post-graduation degree and area), clinical experience (number of metal-free restorations performed during the last month), and information sources considered for the selection (manufacturer's instructions, scientific literature, colleagues' suggestions, dental prostheses technician suggestions, allow the dental prosthesis technician to choose), frequency of use, and knowledge on dental ceramics.

A pilot study was performed prior to this survey to test the questionnaire reliability. The questionnaire was pre-tested in a group of 30 dentists from another southern Brazilian city (São Miguel do Oeste, SC). After a period of ten days, ten randomly selected clinicians who answered the questionnaire were invited to answer the questionnaire again in order to test its reliability by calculating the Kappa coefficient of agreement. Questions identified as having some kind of misinterpretation (Kappa < 0.8) were discussed by the authors and modified in the final version with the purpose to make them clearer and easier to answer.

Statistical analysis was carried out using the Stata 13.0 software program (SataCorp., College Station, USA). Descriptive analysis was performed to identify the sample characteristics. Chi-square tests were performed to verify associations between exposure (time since graduation and post-graduation degree) and outcome variables (known ceramic materials, information sources considered for selection, and frequency of use). When associations were significant, Chi-square residual analyses were performed to evaluate which observed frequencies were statistically different from the expected frequencies if the variables were not associated. Chi-square residual analysis was performed using the BioEstat 5.0 software program (Mamiraua Institute, Tefé, Brazil). The significance level was set at 5% in all analyses.

## 3 Results and Discussion

A total of 151 dentists answered the questionnaire (73.3% response rate). Within the 55 excluded participations, 3 refused to participate and 52 did not return the questionnaire after the third retrieval attempt. Some participants did not answer all the questions, which led to variations in response

numbers on each question.

Most of the participants were men (60.9%), and mean sample age was 39.8 (SD 13.6) years. Mean time since graduation was 15.8 (SD 13.1) years and the average of metal-free restorations performed by these clinicians in the last month was 7.9 (SD 7.9). Furthermore, most of the participants (99.3%) had graduated from local universities (State of Rio Grande do Sul, Brazil).

Table 1 presents the sample time since graduation, post-graduation degree, knowledge on dental ceramics and attitude characteristics. Almost 47% of the participants were post-graduated in areas other than Prosthodontics, and 66.6% of the dentists who have Master's/PhD degrees in Prosthodontics are also a Prosthodontic specialist.

**Table 1** - Time since graduation, post-graduation degree, and known dental ceramics characteristics of the participants. Santa Maria, RS, Brazil

	n	%	CI95%
<b>Time Since Graduation in Dentistry*</b>			
≤6 years	42	27.8	0.2 – 0.4
6 - 25 years	71	47.0	0.4 – 0.6
≥25 years	38	25.2	0.2 – 0.3
<b>Post-Graduation Degree</b>			
No post-graduation	18	12.7	0.1 – 0.2
Specialization in Prosthodontics	40	28.2	0.2 – 0.4
Master or PhD degree in Prosthodontics	18	12.7	0.1 – 0.2
Specialization/ Master/ PhD in other areas	66	46.5	0.4 – 0.6
<b>Known Dental Ceramics</b>			
<b>Yttria-stabilized tetragonal zirconia polycrystal (YTZP)#</b>			
Yes	123	82.0 <sup>A</sup>	0.8 – 0.9
No	27	18.0	0.1 – 0.2
<b>Feldspathic ceramic<sup>#</sup></b>			
Yes	117	78.0 <sup>A</sup>	0.7 – 0.8
No	33	22.0	0.2 – 0.3
<b>Leucite reinforced ceramic<sup>#</sup></b>			
Yes	77	51.3	0.4 – 0.6
No	73	48.7	0.4 – 0.6
<b>Lithium disilicate ceramic<sup>#</sup></b>			
Yes	114	76.0 <sup>A</sup>	0.7 – 0.8
No	36	24.0	0.2 – 0.3
<b>Information Sources Considered for the Material Selection</b>			
<b>Manufacturer's instructions<sup>#</sup></b>			
Yes	103	76.3 <sup>A</sup>	0.7 – 0.8
No	32	23.7	0.2 – 0.3
<b>Scientific literature<sup>#</sup></b>			
Yes	140	97.2 <sup>A</sup>	0.9 – 1.0
No	4	2.8	0.0 – 0.1
<b>Colleagues' suggestions<sup>#</sup></b>			
Yes	100	75.7 <sup>A</sup>	0.7 – 0.8
No	32	24.2	0.2 – 0.3
<b>Dental prosthesis technician's suggestions<sup>#</sup></b>			
Yes	99	72.3 <sup>A</sup>	0.6 – 0.8

	n	%	CI95%
No	38	24.7	0.2 – 0.4
<b>Allows the technician to choose the material<sup>#</sup></b>			
Yes	23	18.1	0.1 – 0.3
No	104	81.9 <sup>A</sup>	0.7 – 0.9
<b>Frequency of Use of Dental Ceramics</b>			
<b>Porcelain veneered zirconia<sup>#</sup></b>			
Never/ Hardly ever	29	19.6	0.1 – 0.3
Sometimes/ Frequently	119	80.4 <sup>A</sup>	0.7 – 0.9
<b>Monolithic zirconia<sup>#</sup></b>			
Never/ Hardly ever	99	71.7 <sup>A</sup>	0.6 – 0.8
Sometimes/ Frequently	39	28.3	0.2 – 0.4
<b>Monolithic lithium disilicate<sup>#</sup></b>			
Never/ Hardly ever	77	57.5	0.5 – 0.7
Sometimes/ Frequently	57	42.5	0.3 – 0.5
<b>Porcelain veneered lithium disilicate<sup>#</sup></b>			
Never/ Hardly ever	78	59.5	0.5 – 0.7
Sometimes/ Frequently	53	40.5	0.3 – 0.5
<b>Lithium disilicate veneered zirconia<sup>#</sup></b>			
Never/ Hardly ever	90	70.9 <sup>A</sup>	0.6 – 0.8
Sometimes/ Frequently	37	29.1	0.2 – 0.4
<b>Monolithic leucite<sup>#</sup></b>			
Never/ Hardly ever	117	92.9 <sup>A</sup>	0.9 – 1.0
Sometimes/ Frequently	9	7.1	0.0 – 0.1
<b>Monolithic Feldspathic<sup>#</sup></b>			
Never/ Hardly ever	86	65.2 <sup>A</sup>	0.6 – 0.7
Sometimes/ Frequently	46	34.8	0.3 – 0.4

\*Data collected as continuous variable and categorized according to median and/or 25% and 75% percentiles.

<sup>#</sup>Missing data. N<sup>A</sup>Significant greater proportion (confidence intervals do not overlap).

**Source:** Research data.

All the clinicians affirmed knowing the majority of dental ceramics contemplated in this study. The most known material was Y-TZP (82.0%), and the least known was leucite reinforced ceramic (51.3%). Regarding the information sources considered to select the dental ceramic material, most of the participants pointed out scientific literature (97.2%), and only 18.1% said they allow the dental prosthesis technician to choose i. Porcelain veneered zirconia was the system which most of the dentists (80.4%) affirmed using sometimes/ frequently, while 92.9% of them said they never/hardly ever use monolithic leucite restorations in their patients.

Association between time since graduation and each known material are described in Table 2. Time since graduation was associated to leucite and lithium disilicate-based ceramics knowledge. Chi-square residual analysis showed there were more dentists with 6-25 years since graduation who knew these materials than those who did not know, and more dentists with ≥25 years since graduation who did not know the materials than those who knew.

**Table 2** - Association between Time since graduation and each known dental ceramic (Chi-square test)

Known Dental Ceramics	Time Since Graduation			P
	≤6 years	6 – 25 years	≥25 years	
<i>Y-TZP</i>				0.461
Yes	37 (88.1%)	56 (78.9%)	30 (81.1%)	
No	5 (11.9%)	15 (21.1%)	7 (18.9%)	
<i>Feldspathic</i>				0.196
Yes	35 (83.3%)	57 (80.3%)	25 (67.6%)	
No	7 (16.7%)	14 (19.7%)	12 (32.4%)	
<i>Leucite</i>				0.004
Yes	19 (45.2%)	46 (64.8%)*	12 (32.4%)#	
No	23 (54.8%)	25 (35.2%)#	25 (67.6%)*	
<i>Lithium disilicate</i>				0.000
Yes	35 (83.3%)	62 (87.3%)*	17 (46.0%)#	
No	7 (16.7%)	9 (12.7%)#	20 (54.0%)*	

\*Observed frequencies that are higher than the expected frequencies if the variables were not associated (Chi-square residual analysis). #Observed frequencies that are lower than the expected frequencies if the variables were not associated (Chi-square residual analysis).

Source: Research data.

Analysis on association between time since graduation and information sources for dental ceramic selection (Table 3) shows that manufacturer's instructions, scientific literature, colleagues' suggestions, and dental prostheses lab technician's suggestions are equally considered by all participants, regardless of time since graduation.

**Table 3** - Association between Time since graduation and information sources that clinicians consider selecting dental ceramics materials (Chi-square test)

Information Sources	Time Since Graduation			P
	≤6 years	6 – 25 years	≥25 years	
<i>Manufacturer instructions</i>				0.859
Yes	32 (78.0%)	49 (74.2%)	22 (78.6%)	
No	9 (22.0%)	17 (25.8%)	6 (21.4%)	
<i>Scientific literature</i>				0.983
Yes	41 (97.6%)	66 (97.1%)	33 (97.1%)	
No	1 (2.4%)	2 (2.9%)	1 (2.9%)	
<i>Colleagues' suggestions</i>				0.351
Yes	35 (83.3%)	44 (71.0%)	21 (75.0%)	
No	7 (16.7%)	18 (29.0%)	7 (25.0%)	
<i>Dental prosthesis technician's suggestions</i>				0.197
Yes	26 (61.9%)	49 (76.6%)	24 (77.4%)	
No	16 (38.1%)	15 (23.4%)	7 (22.6%)	
<i>Allows the technician to choose the material</i>				0.023
Yes	6 (14.3%)	7 (12.3%)	10 (35.7%)*	
No	42 (85.7%)	50 (87.7%)	18 (64.3%)#	

\*Observed frequencies that are higher than the expected frequencies if the variables were not associated (Chi-square residual analysis). #Observed frequencies that are lower than the expected frequencies if the variables were not associated (Chi-square residual analysis)

Source: Research data.

Nevertheless, the frequency of dentists with ≥25 years since graduation who allow the technician to choose the dental ceramic (35.7%) are significantly higher than those who said

they do not. Time since graduation was also associated to the frequency of using porcelain veneered zirconia: most of the clinicians with 6-25 years since graduation sometimes/frequently use this system, and most of clinicians with ≥25 years since graduation said never/hardly ever use it (Table 4). The frequency using other dental ceramic materials was not associated to the time since graduation.

**Table 4** - Association between Time since graduation and dental ceramics frequency of use (Chi-square test)

Frequency of Use	Time Since Graduation			P
	≤6 years	6 – 25 years	≥25 years	
<i>Porcelain veneered zirconia</i>				<b>0.000</b>
Never/ Hardly ever	10 (23.8%)	5 (7.1%)#	14 (38.9%)*	
Sometimes/ Frequently	32 (76.2%)	65 (92.9%)*	22 (61.1%)#	
<i>Monolithic Zirconia</i>				0.109
Never/ Hardly ever	33 (80.5%)	48 (72.7%)	18 (56.1%)	
Sometimes/ Frequently	8 (19.5%)	18 (27.3%)	13 (41.9%)	
<i>Monolithic lithium disilicate</i>				0.172
Never/ Hardly ever	27 (65.8%)	32 (49.2%)	18 (64.3%)	
Sometimes/ Frequently	14 (34.2%)	33 (50.8%)	10 (35.7%)	
<i>Porcelain veneered lithium disilicate</i>				0.736
Never/ Hardly ever	24 (61.5%)	36 (56.2%)	18 (64.3%)	
Sometimes/ Frequently	15 (38.5%)	28 (43.8%)	10 (35.7%)	
<i>Lithium disilicate veneered zirconia</i>				0.739
Never/ Hardly ever	26 (68.4%)	44 (69.8%)	20 (76.9%)	
Sometimes/ Frequently	12 (31.6%)	19 (30.2%)	6 (23.1%)	
<i>Monolithic leucite</i>				0.887
Never/ Hardly ever	35 (94.6%)	58 (92.1%)	24 (92.3%)	
Sometimes/ Frequently	2 (5.4%)	5 (7.9%)	2 (7.7%)	
<i>Monolithic feldspathic</i>				0.965
Never/ Hardly ever	25 (65.8%)	41 (64.1%)	20 (66.7%)	
Sometimes/ Frequently	13 (34.2%)	23 (35.9%)	10 (33.3%)	

\*Observed frequencies that are higher than the expected frequencies if the variables were not associated (Chi-square residual analysis). #Observed frequencies that are lower than the expected frequencies if the variables were not associated (Chi-square residual analysis)

Source: Research data.

Table 5 presents the association between post-graduation degree and knowledge on dental ceramics. The results showed that most of Master's/PhDs in Prosthodontics significantly knew leucite reinforced ceramic, while most of the dentists with no post-graduation did not know the material.

**Table 5 - Association between Post-graduation degree and each known dental ceramic (Chi-square test)**

Known Dental Ceramics	Post-Graduation Degree				P
	No post-graduation	Specialization in prosthodontics	Master/ PhD in prosthodontics	Post-graduation in other areas	
<i>Y-TZP</i>					0.730
Yes	15 (83.3%)	30 (75.0%)	15 (83.3%)	55 (83.3%)	
No	3 (16.7%)	10 (25.0%)	3 (16.7%)	11 (16.7%)	
<i>Feldspathic</i>					
Yes	13 (72.2%)	33 (82.5%)	16 (88.9%)	50 (75.8%)	
No	5 (27.8%)	7 (17.5%)	1 (5.6%)	15 (24.2%)	
<i>Leucite</i>					0.004
Yes	4 (22.2%) <sup>#</sup>	22 (55.0%)	15 (83.3%)*	36 (54.6%)	
No	14 (77.8%)*	18 (45.0%)	3 (16.7%) <sup>#</sup>	30 (45.4%)	
<i>Lithium disilicate</i>					0.000
Yes	7 (38.9%) <sup>#</sup>	34 (85.0%)	17 (94.4%)	54 (81.8%)	
No	11 (61.1%)*	6 (15.0%)	1 (5.6%)	12 (18.2%)	

\*Observed frequencies that are higher than the expected frequencies if the variables were not associated (Chi-square residual analysis). <sup>#</sup>Observed frequencies that are lower than the expected frequencies if the variables were not associated (Chi-square residual analysis)

Source: Research data.

Regarding lithium disilicate-based ceramic, the frequency of non-post-graduated dentists who did not know this dental ceramic was significantly higher than those who knew it. There were no associations among post-graduation degree and sources considered to select dental ceramics. On the other hand, post-graduation degree was associated to usage

frequency of porcelain veneered lithium disilicate, as the frequency of dentists without post-graduation who never/hardly ever use this ceramic system was significantly higher than those who sometimes/frequently use it (Table 6). In addition, post-graduation degree was not associated to the usage frequency of other dental ceramics.

**Table 6 - Association between Post-graduation degree and dental ceramics frequency of use (Chi-square test)**

Frequency of Use	Post-Graduation Degree				P
	No post-graduation	Specialization in prosthodontics	Master/ PhD in prosthodontics	Post-graduation in other areas	
<i>Porcelain veneered zirconia</i>					0.082
Never/ Hardly ever	6 (33.3%)	4 (10.5%)	1 (5.6%)	14 (21.2%)	
Sometimes/ Frequently	12 (66.7%)	34 (89.5%)	17 (94.4%)	52 (78.8%)	
<i>Monolithic Zirconia</i>					0.436
Never/ Hardly ever	13 (76.5%)	23 (62.2%)	13 (72.2%)	47 (77.0%)	
Sometimes/ Frequently	4 (23.5%)	14 (37.8%)	5 (27.8%)	14 (23.0%)	
<i>Monolithic lithium disilicate</i>					0.154
Never/ Hardly ever	13 (81.2%)	17 (47.2%)	10 (55.6%)	34 (56.7%)	
Sometimes/ Frequently	3 (18.8%)	19 (52.8%)	8 (44.4%)	26 (43.3%)	
<i>Porcelain veneered lithium disilicate</i>					0.042
Never/ Hardly ever	13 (81.2%)*	18 (48.6%)	7 (41.2%)	38 (65.5%)	
Sometimes/ Frequently	3 (18.8%) <sup>#</sup>	19 (51.4%)	10 (58.8%)	20 (34.5%)	
<i>Lithium disilicate veneered zirconia</i>					0.682
Never/ Hardly ever	13 (81.2%)	24 (68.6%)	10 (62.5%)	41 (71.9%)	
Sometimes/ Frequently	3 (18.8%)	11 (31.4%)	6 (37.5%)	16 (28.1%)	
<i>Monolithic leucite</i>					0.735
Never/ Hardly ever	15 (93.8%)	31 (88.6%)	16 (94.1%)	53 (94.6%)	
Sometimes/ Frequently	1 (6.2%)	4 (11.4%)	1 (5.9%)	3 (5.4%)	
<i>Monolithic feldspathic</i>					0.211
Never/ Hardly ever	10 (71.4%)	19 (54.3%)	14 (82.4%)	41 (68.3%)	
Sometimes/ Frequently	4 (28.6%)	16 (45.7%)	3 (17.6%)	19 (31.7%)	

\*Observed frequencies that are higher than the expected frequencies if the variables were not associated (Chi-square residual analysis). <sup>#</sup>Observed frequencies that are lower than the expected frequencies if the variables were not associated (Chi-square residual analysis)

Source: Research data.

Knowledge about the indications of dental ceramics, careful diagnosis and planning taking into account the oral condition, patient’s necessities, esthetics and mechanical

requirements for the restoration, as well as a good dental prostheses technician is the necessary combination for achieving the best clinical result in each case.

Results of the present study showed that the clinicians' academic education were associated with their attitudes regarding selection, knowledge and usage frequency of different dental ceramics for metal-free restorations. Time since graduation in Dentistry and post-graduation degree were associated to knowledge and usage frequency of some materials.

Leucite-based ceramic was the least known material among the participants, which led to leucite restorations presenting the lowest usage frequency (7.1%). In contrast, the results presented a considerably greater usage frequency of lithium disilicate ceramic (42.5%), which is suitable for clinical cases that can be restored with leucite. These findings suggest that clinicians are not familiar with leucite reinforced ceramic, and also suggest the possible preference for lithium disilicate, maybe due to the superior mechanical properties and to the number of indication possibilities.

Y-TZP was the most known material and porcelain veneered zirconia was the ceramic system that these dentists use sometimes or frequently. In the same way, in addition to familiarity with the material, other factors could also influence these findings such as the tendency of local dental prosthesis laboratories to charge less for porcelain veneered zirconia than for machined monolithic restorations.

Previous studies have shown that clinical experience time influences CAD/CAM technology use,<sup>24</sup> and the selection of dental ceramics for anterior restorations.<sup>20</sup> In the current study, time since graduation equal or higher than 25 years was associated with a lower number of professionals who know and use some dental ceramics, and a higher percentage of those who allow the technician to choose the material. The first CAD/CAM system was developed in the early 1980s,<sup>25</sup> and the use of this technology and metal-free ceramic restorations was not popular or easily available 25 years ago. For instance, the first pressed lithium disilicate ceramic (Empress 2) was launched in the early 1990s. Thus, it is very unlikely that these dentists had studied such topics in dental school or post-graduation if they were in university soon thereafter.

Post-graduation degree was related to the knowledge of some dental ceramics. Most of the post-graduated dentists affirmed knowing materials such as lithium disilicate, whereas those with no post-graduation degree said the opposite. It was also observed that the majority of dentists with Master's/PhD degrees in prosthodontics know leucite-based ceramic (the least known material in the overall analysis). In contrast, most of the professionals with no post-graduation answered they did not know this dental ceramic. This fact points to a possible lack of teaching on dental ceramics in some dental schools' curricula. In addition, the fact that dentists who have post-graduation degrees know and use a greater variety of ceramic materials suggests that Master's/PhD/Specialization courses somehow fill this knowledge gap. Sarkis-Onofre, et al.<sup>14</sup> carried out a study to evaluate the dentists' preference to restore endodontically treated teeth and observed that

continuing education was an influencing factor on decisions of the research participants.

Post-graduation degree had no association with the sources considered to choose dental ceramics for restorations. However, it was associated to the usage frequency of porcelain veneered lithium disilicate. Most professionals with no post-graduation affirmed never or hardly ever using this ceramic system, which seemed to happen due to the unfamiliarity with lithium disilicate-based ceramic. Nascimento, et al.<sup>13</sup> evaluated the dentists' preferences regarding restorative materials for the posterior region. They also observed an association of time since graduation and post-graduation on the studied outcomes. Nevertheless, the authors did not distinguish among the post-graduation degrees (i.e. Master's degree or specialization). The present results did not point out differences among post-graduation degrees in all the study outcomes. However, it is in agreement with previous studies, since it evidenced the prevalence of using dental ceramic by dentists with no post-graduation differing from those by dentists with post-graduation in different degrees.

The present study has some limitations such as the use of a non-validated self-reported questionnaire in a sample composed of dentists from only one city. A self-reported questionnaire easily allows the participant to answer a low number of questions; however, conducting interviews would be difficult as the professionals were met in their dental offices during work days. On the other hand, the researchers went to the dental offices to deliver and to get the questionnaires, which led to a great response rate. An online questionnaire certainly could include professionals from other places, however, previous online questionnaire studies only achieved response rates of 39%<sup>18</sup> and 20.2%,<sup>24</sup> which are way lower than the response rate achieved in the present study (73.3%). Moreover, as there is no validated questionnaire to be used in this research area, a pilot study was conducted to ensure data reliability and to provide important information regarding attitudes, opinions, decisions towards treatments, and socio-demographic data, as all questionnaire surveys do.<sup>26</sup>

The presented results evidence the importance of clinicians constantly learning/updating their knowledge. It also brings up a reflexive point about dentists' knowledge regarding dental ceramics, which can be compared to other samples worldwide. In spite of all the dental industry development, the excellent restorative materials available, and all the studies published about them, it is imperative that this knowledge reaches the clinicians in order to benefit patients with the best treatment options. Dental schools and post-graduation courses that encourage dentists to seek knowledge and provide a broader approach about dental ceramics play an important role in approximating the clinicians to the advances in the dental ceramics field.

#### 4 Conclusion

Time since graduation and post-graduation degree are

associated to knowledge and usage frequency of dental ceramics systems. The results of the present study pointed out the importance of continuing education and the preparation of dental school students regarding dental ceramics for metal-free restorations.

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