Brazilian undergraduates' and dentists' knowledge on preventing, diagnosing and managing dentin hypersensitivity: a cross-sectional questionnaire study

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ABSTRACT

Objectives: To analyze the knowledge of dental undergraduates and dentists on the prevention, diagnosis and management of dentin hypersensitivity (DH); to compare their knowledge scores; and to understand the related variables using a regression model. ***Methods:*** An original online questionnaire investigated the attitudes, self-reported knowledge ("how much they thought they knew") and real knowledge ("how much they really knew") of 132 students and 338 dentists. Data were analyzed descriptively, both knowledge scores were compared using Mann-Whitney and Wilcoxon tests, and data were subjected to two multiple linear regression analyses considering real knowledge scores as the dependent variable ($\alpha<0.05$). ***Results:*** The self-reported knowledge on DH was higher than the real knowledge for both students and dentists, but dentists presented the highest scores. Gingival recession and acidic diet were reported as the main predisposing factors for DH by undergraduates and dentists. Students normally managed DH with dietary and hygiene instructions followed by a desensitizing agent application, whilst dentists managed with occlusal adjustments. The mechanism of glutaraldehyde/HEMA and bioactive fillers on DH is widely unknown by students and dentists. The majority of the questioned individuals cannot differentiate DH from sensitivity of caries or molar-incisor hypomineralization. ***Conclusion:*** Both students and dentists overestimate their knowledge of DH, revealing deficiencies in prevention, diagnosis, and management. Students' knowledge improves towards the end of the Dentistry course, whilst younger dentists and PhD holders are more knowledgeable. Institutions should implement ongoing DH education for undergraduates and conduct interventions for experienced professionals, especially older ones.

Keywords: Dentin sensitivity. Health Knowledge, Attitudes, Practice. Observational study. Regression analysis. Surveys and questionnaires.

INTRODUCTION

Dentin hypersensitivity (DH) is defined as a short, sharp pain arising from thermal, evaporative, tactile, osmotic, or chemical stimuli which cannot be attributed to any other dental defect or disease.[1-6] Thus, by definition, DH is a diagnosis of exclusion.[1] A recent study has shown that 18.6% of Brazilians do not know DH can be treated[7] and, on its early onsets, some patients find it not to be a relevant problem, so they do not seek professional assistance.[8-9] However, in advanced cases, patients with DH often limit their eating, drinking and oral hygiene habits, thus, substantially impairing their oral health-related quality of life,[10] indicating the importance of dentists to properly manage this condition.

Because of its significance, Dental Schools have included DH in their curricula. Yet, published studies have reported a knowledge gap of dentists around the world on managing DH, especially in controlling its predisposing factors and in understanding the mechanisms of desensitizing agents.[8,9,11-15] In Brazil, a study pointed out that dentists are observant of the predisposing factors of DH, but there is still lack of knowledge on the mechanism of desensitizing products.[14] Yet, in another Brazilian study, a knowledge gap was detected for professionals and students on this subject.[15]

There is also studies investigating the factors associated with the knowledge of dentists on DH with conflicting results.[13,14.]A previous investigation evidenced that age and number of years in practice were associated with a higher knowledge on managing DH,[13] whilst another did not find any significant association between the number of years in practice with proper management of DH.[14] Therefore, it is also essential to understand what are the variables related to this knowledge gap, so educational strategies can be developed to solve this problem.

Additionally, it is important to investigate the knowledge of undergraduate students and to analyze what are their associated factors, especially when considering that only one study evaluated the knowledge of Brazilian undergraduate students,[15] but it was restricted to a single Brazilian Dental School. Therefore, the aims of this study were 1) to analyze the knowledge (self-reported and real knowledge values) of undergraduate students and dentists on the prevention, diagnosis and management of DH; 2) to compare their self-reported and real knowledge scores; and 3) to understand what variables could explain the scores of both undergraduate students and dentists using a multiple linear regression model. The tested null hypotheses were that 1) there is no difference between undergraduate students' and dentists' knowledge scores (both self-reported and real knowledge); 2) there is no difference between self-reported and real knowledge scores for both undergraduate students and dentists.

METHODOLOGY

Study design

The STROBE[16] and CHERRIES[17] checklists were used to report this cross-sectional, observational study. This study was an open voluntary online survey, in which the sample answered a questionnaire applied through Google Forms.

Ethical aspects and informed consent

This study was carried out after approval by the local Human Research Ethics Committee (CAAE: 33627920.3.0000.5417).

When the questionnaire was accessed, the participants were informed the mean time required to complete the questionnaire, the name of the investigators and the purpose of the study. An email account was necessary to prevent duplicate entries (no cookies nor IP checks were used). In case of duplicate entries, the first response was considered. The participants were asked to give their consent only after reading these statements. No incentives were offered to the participants of this study and the data were password-protected and could only be accessed by the investigators in this study.

Sample size calculation and acquisition

Sample size was estimated using G*Power and based on a multiple linear regression model[18] considering f^2=0.2, α error=0.05 and power (1-β)=0.95. The estimated sample size was n=122 for 8 independent variables (for dentists), and n=127 for 9 independent variables (for undergraduate students).

The dissemination of the questionnaire for all regions of Brazil was conducted using social media. In total, 470 people (132 students; 338 dentists) completely answered the questionnaire between August and October of 2021.

Eligibility criteria

The inclusion criteria consisted of dentists (clinical practitioners, academics and/or graduate students) who are registered with a Regional Council of Dentistry; and undergraduates in Dentistry (from the third to the last semester) with a minimum of 18 years old enrolled in Dental schools from all regions of Brazil. Dentists or undergraduates in institutions abroad and/or retired dentists were excluded.

Questionnaire development, testing and application

The questionnaire was developed by two specialized researchers and revised by independent experts (content validity analysis). The questionnaire was modified until all questions were unanimously considered clear and relevant by the experts.

A pre-test was conducted with a small sample (n=5, both undergraduates and dentists) and used to estimate the time required to complete the questionnaire (15 min). The data from this test sample

were discarded before the commencement of the study and these participants did not answer the final questionnaire.

The questionnaire was structured with multiple-choice questions in four main pages (the unvalidated English version of the questionnaire is available online as Appendix 1). The order of the questions and the alternatives were kept constant for all participants. The first page asked if the participant was an undergraduate student or a professional. The participants had access to the second page based on their answer (adaptive questioning). All participants were able to review and alter their answers, if necessary, before submitting the form. Only complete forms were analyzed.

For undergraduates, these questions on the second page were divided into demographic questions (1-gender, 2-age and 3-region in which their school was located) and educational questions (4-semester in which the student was enrolled, 5-if the school was public/private, 6-how long was the course in years, 7-if they did any extra-curricular activity, 8-when was the last meeting/congress they attended, 9-if DH was a topic discussed in any subject, 10-and how much they thought they knew about DH on a scale of 0 to 10 (self-reported knowledge on DH).

For dentists, the same questions were asked, except for questions 4, 6, 7 and 9. Instead, they were asked if they had a master's, PhD or post-doctoral degree, if they had a specialist degree, how many years had passed since their graduation and if they worked as a clinician in the public or private sector or as a professor in a Dental School.

After answering all questions on the second page, students and dentists had access to the same third page, with 7 questions. The participants were asked: 1-the prevalence of DH they assisted during their practice, 2-in which situations patients reported most frequent episodes of DH, 3-what were the predisposing factors of DH in their patients, 4-what age group was most affected by DH, 5-how they diagnosed DH in their patients, 6-how they treated those who complained about DH, and 7-how they chose what desensitizing agent to have in their office.

Then, on the forth page, the participants answered five questions regarding the mechanism of action of different treatment agents: 1-sodium fluoride varnish, 2-glutaraldehyde/HEMA (hydroxyethyl methacrylate)-based product, 3-potassium nitrate product, 4-potassium oxalate product, and 5-varnish containing Surface Pre-Reacted Glass (S-PRG) fillers. Thereafter, five clinical cases with different conditions were presented for them to diagnose DH and differentiate from molar-incisor hypomineralization and dental caries. All ten questions were multiple-choice with one correct answer, except for the question 4, for which two answers were correct, and if the participant answered only one correctly, half the points were considered. The number of points scored by each patient were summed in a final score entitled "real knowledge on DH" that ranged from 0 to 10. Values below 7 were considered as a gap in knowledge.

Statistical analyses

A descriptive quantitative analysis was conducted using percentages, means and absolute numbers. All statistical tests were conducted using the Jamovi software (version 1.6) with a significance level of 5%.

Both the self-reported knowledge score and the real knowledge on DH score failed normality analyses (Shapiro-Wilk test, $p < 0.05$), therefore these scores were compared between undergraduates and dentists using the Mann-Whitney test. The self-reported knowledge score was compared to the real knowledge score for both undergraduates and dentists using the Wilcoxon test.

Then, two multiple linear regression analyses were conducted (backward method) in which the dependent variable was the "real knowledge on DH" score (score between 0 and 10).

For undergraduate students, the independent variables included in the regression model were age, gender, region, if the school was public or private, length of the Dentistry course, % of the course that was completed, presence of any extracurricular activity, when was the last attendance in a meeting/congress and if the subject was taught during the Dentistry course.

For dentists, the independent variables included in the regression model were age, gender, region, if the school was public or private, number of years since graduation, possession of a post-graduate degree, possession of a specialist degree, and when was the last attendance in a meeting/congress.

RESULTS

One participant did not consent to participate in this study, hence the participation rate was calculated to be 99.79%. Nonetheless, all the participants who gave their consent completely answered the questionnaire, thus the completion rate was estimated to be 100%.

Undergraduate students

The students were from all Brazilian regions and the majority were aged between 18-30 years (95.5%). Their demographic characteristics are displayed in Table 1, and their educational characteristics in Table 2.

Most students reported that the prevalence of patients with DH they assisted was between 21%-30% (17.4%) and 31%-40% (16.7%) (Table 3). Gingival recession (93.9%), erosive diet (87.1%) and inappropriate hygiene habits (80.3%) were the most frequent etiological factors of DH. The most affected age group was between 18 and 35 years old (52.3%) and the most frequent method they used to diagnose DH was the evaporative stimulus (82.6%). Dietary and hygiene instructions associated with

the application of a desensitizing agent was the preferred method of managing DH (67.4%). Also, scientific papers (63.6%) were the source they used to choose what desensitizing agent to have.

The undergraduates' answers regarding the mechanism of action of different desensitizing products and the clinical cases are also displayed in Table 3. Over 47.7% did not know the mechanism of fluoride on DH. Most students (95.5%) could diagnose DH associated with a non-carious cervical lesion, but 57.6% could not differentiate from molar-incisor hypomineralization.

The student's self-reported DH knowledge values were not categorized as a gap in knowledge and were statistically higher than their real knowledge values ($p<0.001$) (Table 4).

Regarding the multiple linear regression, multicollinearity (tolerance value=1.0; VIF value<1.0) and outliers were not detected, and the residuals were independent (Durbin-Watson=2.02). The multiple linear regression resulted in a statistically significant final model ($F [2,128] = 3.75$; $p = 0.026$; $R^2 = 0.0554$) with the % of completed graduation course as the only remaining independent variable (Table 5).

Dentists

Dentists were also from all five regions of Brazil. The demographic characteristics of the dentists' sample are displayed in Table 1 and their educational characteristics are displayed in Table 2.

Most dentists reported that the prevalence of patients with DH was between 21%-30% (21.3%) and 31%-40% (19.8%) (Table 3). Gingival recession (96.7%), erosive diet (88.2%) and inappropriate hygiene habits (85.2%) were also the main etiological factors of DH. The most affected age group was between 36-50 years old (49.4%). Occlusal adjustment was the most frequent method to manage DH (78.7%). Scientific papers (47.9%) were also their main source of information.

The dentists' answers regarding the mechanism of action of different desensitizing products and the clinical cases are displayed in Table 3. Most dentists (97.3%) could diagnose DH associated with a non-carious cervical lesion, but 34.6% could not differentiate from molar-incisor hypomineralization (Table 3).

For dentists, the self-reported DH knowledge values were statistically higher than the real knowledge values ($p<0.001$), which were categorized as a knowledge gap. When their self-reported knowledge values and real knowledge values were compared to those of undergraduate students, both values were higher for dentists than for undergraduates ($p=0.002$ for self-reported knowledge; $p<0.001$ for real knowledge values) (Table 4).

Regarding the multiple linear regression, multicollinearity (tolerance values>0.738; VIF values<1.36) and outliers were not detected, and the residuals were independent (Durbin-Watson<1.71). The multiple linear regression resulted in a statistically significant final model ($F [11,326] = 6.21$;

$p<0.001$; $R^2 = 0.173$) with gender, age, years since graduation and post-graduation degree as possible predictors of the dependent variable (Table 5).

DISCUSSION

This study identified that undergraduate students and dentists presented different self-reported and real knowledge on DH, with the latter being the group with slightly higher knowledge. Therefore, both null hypotheses were rejected. For undergraduates, the percentage of completion of the Dentistry course was the only predicting variable that remained in the final regression model. However, for dentists, the predicting variables that remained in the final regression model were 1) gender, 2) age, 3) post-graduation degree and 4) number of years since graduation.

In this present study, most students and dentists reported the prevalence of DH in their patients to be between 21%-30% and 31%-40%. This is in accordance with a clinical study in the Brazilian population (33.4% diagnosed by air, and 34.2% diagnosed by probe)[19] but higher than what was reported in a systematic review with meta-analysis (11.5%).[20] However, there is great heterogeneity in the prevalence of DH around the world due to differences in the population and in the diagnostic criteria.[20-22]

The two most common methods of diagnosing DH reported by dentists in this present study were the air blast and the use of an exploratory probe. This is in agreement with the published literature.[1,2,4,14,23] Stimuli using heat have been shown to cause a flow of the dentinal fluid towards the pulp, whereas cold stimuli causes an outward flow, which produces a much stronger nerve response.[1,23] This justifies the reason for cold stimuli (air blast) being used over heat in the clinics. Moreover, as previously stated, DH cannot be attributed to any other dental defect or disease and, thus, should be diagnosed by exclusion.[1-6] Therefore, given that 18.9% and 57.6% of students and 14.8% and 34.6% of professions could not differentiate the sensitivity from caries and molar-incisor hypomineralization from DH, respectively, it is safe to suppose that some of them still assume that any sensitivity would be classified as DH, so the prevalence of patients with actual DH might be lower than that found in this study.

The majority of students also reported that the most affected age group was between 18 and 35 years old, while, for dentists, the most affected by DH were between 36 and 50 years old. This is similar to what was reported by Teixeira et al.,[24] who evidenced that DH was more prevalent in patients older than 30 years old, and by Ramlogan et al.,[22] where patients aged 40-49 presented the highest number of sensitive teeth. Nonetheless, other study has reported that DH might occur in any age group, but reaches its peak between 30 and 40.[25] This occurs because of secondary, tertiary and/or sclerotic dentin deposition over the years, which reduces the symptoms of DH.[20,24] Also, young patients might not present a high prevalence of DH because it occurs upon the exposure of dentin, so either the soft tissues from the periodontium or the enamel must be disturbed, and these processes take time to occur.[26]

Nonetheless, for both undergraduates and dentists, gingival recession and acidic diet were the most frequent predisposing factors associated with the development of DH, followed by inappropriate hygiene habits (e.g. overzealous toothbrushing) and parafunctional habits. The use of hard-bristled toothbrushes, gingival recession and acidic diets were pointed out as associate factors for DH previously.[22,23] The reason for these factors to be associated with DH is because they might increase the incidence of gingival recession and/or promote wear of enamel and dentin.[26] As reported in a study in Brazilians, depending on the age group, the prevalence of gingival recession varied from 29.5% to 100%.[27] In that study, the prevalence of recession >1mm in people between 40-49 years old was 99%, and in people ≥50 years old was 100%. Other studies have reported that gingival recession seems to be closely related to the presence of DH,[1,28] and inappropriate hygiene habits have also been previously pointed out as a predisposing factor for DH.[1,22,23]

In the present study, an acidic diet was also reported as one of the main reasons for the presence of DH. This is in agreement with the study of O'Toole and Bartlett,[29] in which a higher prevalence of DH was observed for patients with erosive eating habits. Parafunctional habits, such as bruxism, were also reported to cause wear by attrition, which might lead to dentin exposure and DH.[30] Moreover, brushing with hard-bristled toothbrushes or with abrasive toothpastes might also increase the rates of gingival recession and wear, leading to DH.[23,30-33]

Therefore, it is logical to state that the management of DH should consider controlling the predisposing factors and the symptoms.[1] In this current study, the majority of undergraduates reported that they conducted dietary (52.3%) and/or hygiene (58.3%) instructions, followed or not by the application of a desensitizing product (63.4%). On the other hand, despite 72.5% of dentists conducting dietary and hygiene orientations associated with the application of a desensitizing agent, occlusal adjustments alone were the method most dentists used to manage DH (78.7%). This topic is important because occlusal adjustments require wearing the teeth, which could expose dentin and cause DH.[33] For this reason, the Canadian Advisory Board on Dentin Hypersensitivity recommends reversible procedures to be employed before nonreversible ones depending on the condition's severity and extent.[1]

Among the reversible procedures are the application of desensitizing products. Several studies have addressed their mechanism, effectiveness and durability.[34-41] In the study of Zeola et al.,[14] 29% of dentists could not distinguish the different classifications of desensitizers (i.e. their mechanism of action). Similarly, in this present study, almost half the students did not know the mechanism of fluoride on DH, and more than half of both dentists and undergraduates did not know the mechanisms of glutaraldehyde/HEMA, potassium nitrate and potassium oxalate for DH, despite reporting scientific papers as the main source of information. This is particularly concerning because knowing the mechanism of action of desensitizing products may aid in the decision-making process, considering that different products behave differently under dissimilar circumstances.[38]

The hypothesis to justify this lack of knowledge is that some Brazilian dentists and students might either have limited access to good scientific papers (unaffordable in most cases) or cannot fully understand what is reported in those papers.[42] This data is particularly important because a report from the British Council evidenced that only 5.1% of the Brazilian population have some knowledge of the English language.[43] Moreover, students and dentists reporting scientific papers to be their main source of information could be biased due to the Hawthorne effect.[44] This effect consists on people behaving differently when they are aware they are being analyzed, therefore the participants could have reported using scientific papers as their main source of information because they assumed this would fill the researchers expectations, but in reality the participants could use other sources as their main source of information on DH, such as advertisements or recommendations from other professionals.

In respect of the results from multiple linear regression for students, the final model contained only the % of completed course as the predicting variable. The effect of this independent variable is logical because students who have completed less than 25% of the course (i.e. likely first-year students) have not yet been taught this subject. Therefore, they were not included in the study because their responses would be based on guessing, which could have biased the results. The knowledge of student who completed between 50%-75% of the course was slightly higher than of those who completed 25%-50% and >75%. This probably occurred because the subject is taught during that time, so the students are more familiarized and updated with the topic.

For dentists, the final regression model contained gender, age, post-graduation degree and years since graduation as the predicting variables. A higher score was detected for males, and we hypothesize that this occurred because, in this sample, more males (82.4%) attended meetings/congress within the last years compared to females (72.2%), so this could mean the former were more updated than the later, but this could also be a result of women underrepresentation in scientific community. There is evidence of women being underrepresented in science in general, with more males being invited as speakers in conferences,[45,46] more males serving as editors in scientific journals[47] and males presenting a significantly higher publication rate than females.[48] No statistical difference was detected between genders for the conference attendance in this study, although this could have occurred because of the lower number of male participants in this study (n<30%) when compared to the number of females (n>70%), so there could have been no sufficient statistical sample for this analysis. Further research on this topic is necessary to properly identify the reason for males to have a higher real knowledge score on DH than females.

Also, younger dentists (between 18 and 30 years old) had higher scores than older dentists, probably because the former were more updated with the subject than the later. However, the highest scores of the questionnaire were observed for those who held a PhD degree, which means that these participants spent more time studying the subject then those without a PhD degree. This could also be

reason why dentists presented a slightly higher score on the self-reported and real knowledge on DH than undergraduate students.

Based on these results, it is reasonable to assume that more educational strategies should be conducted to solve this knowledge gap in both undergraduate students and dentists, such as the use of leaflets, courses and even online. Also, the attendance of the participants in conferences/meetings was not in the final regression model probably because these conferences could not have included discussions on DH, and could have focused their discussion on other topics. This could also justify the lack of knowledge on the mechanism of different desensitizing agents, which could be addressed even online. A recent study evidenced that reliable and helpful information on DH can be found on YouTube, which could serve as a good and democratic source of information.[49]

This study also has some limitations. Considering that both students and dentists knew that those responsible for the study were from a University, their answers could have been subjected to the Hawthorne effect. Also, considering this was an online survey, the participants needed internet access to the respond to the questions, thus, they could also have used the internet to search for the correct responses for the questions. Additionally, this study was conducted during the COVID-19 pandemic, which also limited the number of meetings/conferences available for students and dentists to attend. The sample size can also be a limitation when comparing to population-based studies, as this could have been the reason for variables such as the region the participants came from to not have remained in the final regression model for both undergraduate students and dentists. Future studies with larger population-based samples should be conducted. Additionally, longitudinal studies with educational practices should also be conducted to investigate their effectiveness on this subject.

CONCLUSIONS

Both students and dentists think they know about DH more than they actually know, as both presented deficiencies in the knowledge on the prevention, diagnosis and management of DH. Yet, the knowledge of students improves as they reach the end of the Dentistry course whilst younger dentists and those who hold a PhD degree seem to be more acquainted with the subject. Higher education institutions should implement targeted educational initiatives aimed at instructing undergraduate students about DH throughout their academic program. Additionally, educational interventions should be conducted for experienced professionals, particularly those in older age groups.

CLINICAL RELEVANCE

Scientific rationale for study

Dentin hypersensitivity can impair patients' quality of life, but studies suggest that dentists and undergraduates present a knowledge gap on preventing, diagnosing and managing it. Therefore, this study analyzed the knowledge of undergraduates and dentists, and investigated what variables could explain the results.

Principal findings

Dentists and undergraduates presented a knowledge gap. For undergraduates, the completion percentage of the Dentistry course could partially explain the results, whilst for dentists, gender, age, post-graduation degree, and years since graduation were the explaining variables.

Practical implications

Dentin hypersensitivity should be better explored in undergraduate courses and educational strategies should be developed for dentists, especially the older ones.

AUTHOR CONTRIBUTIONS

V.M., J.C.J., D.C.S. and L.W. conceived the ideas; V.M. and G.S.Z. collected the data; V.M., H.M.H. and L. W. analyzed the data; and V.M. and L.W. led the writing**.**

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TABLES

Table 1: Demographic characteristics of the undergraduates (left columns) and dentists (right columns).

Undergraduates		Demographic characteristics	Dentists	
%	n		n	%
		Gender		
71.2	94	Females	252	74.6
28.8	38	Males	85	25.1
0	0	Other	1	0.3
		Age (in years)		
95.5	126	Between 18 and 30	153	45.2
3	4	Between 31 and 40	94	27.8
1.5	2	Between 41 and 50	56	16.6
0	0	Between 51 and 60	29	8.6
0	0	Over 60	6	1.8
		Region		
1.5	2	North	9	2.7
21.2	28	Northeast	52	15.4
0.8	1	Central-west	19	5.6
75	99	Southeast	235	69.5
1.5	2	South	23	6.8
100	**132**	**Total**	**338**	**100**

Table 2: Educational characteristics of the undergraduate students' and dentists' samples.

Educational characteristics of undergraduate students	**n**	**%**
Dental School		
Private	50	37.9
Public	82	62.1
Course duration		
4 years	62	47
5 years	70	53
Completed course at the moment of this survey		
25-50%	15	11.3
50-75%	76	57.6
>75%	41	31.1
Extracurricular activity		
Yes	21	15.9
No	111	84.1
Last conference/meeting		
Less than 2 years	118	89.4
Between 2 and 5 years	9	6.8
More than 5 years or does not attend	5	3.8
Was DH taught during the Dentistry course?		
Yes	109	82.6
No	23	17.4
Educational and practice characteristics of dentists	**n**	**%**

Post-graduation degree			
	No	137	40.5
	Masters	86	25.5
	PhD	101	29.9
	Post-Doctoral	14	4.1
Specialist degree			
	Yes	265	78.4
	No	73	21.6
University from which they graduated			
	Public	232	68.6
	Private	106	31.4
Time spent since graduation			
	0 to 5 years	130	38.5
	6 to 10 years	65	19.2
	More than 10 years	143	42.3
Current practice			
	Private clinic	131	38.7
	Public clinic	56	16.6
	Teaching	80	23.7
	Other	71	21
Last conference/meeting			
	Less than 2 years	252	74.5
	Between 2 and 5 years	55	16.3
	More than 5 years or does not attend	31	9.2

Table 3: Undergraduates' (left columns) and dentists' (right columns) knowledge and attitudes towards patients with DH and the mechanism of action of different desensitizing products.

Undergraduates		**Knowledge and attitude**	**Dentists**	
%	**n**		**n**	**%**
		Prevalence of patients with DH they assisted		
27.3	36	1% to 10%	29	8.6
11.4	15	11% to 20%	45	13.3
17.4	23	21% to 30%	72	21.3
16.7	22	31% to 40%	67	19.8
9.8	13	41% to 50%	29	8.6
5.3	7	51% to 60%	43	12.7
4.5	6	61% to 70%	19	5.6
3.8	5	71% to 80%	23	6.8
3.8	5	81% to 90%	10	3
0	0	90% to 100%	1	0.3
		Situations patients reported episodes of DH		
98.5	130	Intaking cold food/beverages	331	97.9
22.7	30	Intaking hot food/beverages	49	14.5
76.5	101	Upon air from compressed air syringe	282	83.4
9.1	12	While talking	40	11.8
22	29	While using exploratory clinical probe	114	33.7
12.1	16	While using periodontal probe	21	6.2
15.2	20	Percussion tests	10	3
		Predisposing factors of DH		

87.1	115	Acidic diet	298	88.2
82.6	109	Parafunctional habits	278	82.2
57.6	76	Occlusal disturbance	233	68.9
41.7	55	Orthodontic treatment	140	41.4
80.3	106	Inappropriate hygiene habits	288	85.2
93.9	124	Gingival recession	327	96.7
66.7	88	Gastric disturbances	223	66
15.2	20	Sports drinks	110	32.5
15.2	20	Illicit drugs consumption	134	39.6
		Most affected age group		
1.5	2	Between 6 and 17 years old	3	0.9
52.3	69	Between 18 and 35 years old	141	41.7
34.8	46	Between 36 and 50 years old	167	49.4
11.4	15	Between 50 and 70 years old	27	8
0	0	Above 70 years old	0	0
		How they diagnose DH		
82.6	109	Air blast	285	84.3
52.3	69	Applying cold stimulation	64	18.9
19.7	26	Applying warm stimulation	8	2.4
17.4	23	Exploratory probe	134	39.6
11.4	15	Does not perform any DH test	62	18.3
		Intervention used for DH management		
10.6	14	Laser	41	12.1
24.2	32	Laser + any desensitizing agent	77	22.8
37.9	50	Fluoride-based desensitizing agent	112	33.1
6.1	8	Glutaraldehyde/HEMA*-based desensitizing agent	26	7.7
6.8	9	Other desensitizing agent	40	11.8
25	33	Occlusal adjustment	266	78.7
52.3	69	Dietary orientation	177	52.4
58.3	77	Hygiene orientation	214	63.3
67.4	89	Dietary/hygiene orientation + desensitizing agent	245	72.5
7.6	10	Endodontic treatment	6	1.8
11.4	15	Do not treat DH	12	3.6
		How they chose what desensitizing agent to have in their office		
32.6	43	Price	127	37.6
43.9	58	Other dentists recommended	136	40.2
31.8	42	Congress/Meetings	104	30.8
63.6	84	Scientific papers	162	47.9
2.3	3	Advertisements	20	5.9
		Mechanism of action of fluoride		
47.7	63	Incorrect	101	29.9
52.3	69	Correct	237	70.1
		Mechanism of action of glutaraldehyde/HEMA*		
75.8	100	Incorrect	216	63.9
24.2	32	Correct	122	36.1
		Mechanism of action of potassium nitrate		
73.5	97	Incorrect	232	68.6
26.5	35	Correct	106	31.4
		Mechanism of action of potassium oxalate		
65.2	86	Incorrect	192	56.8
32.6	43	Partially correct	133	39.3
2.3	3	Correct	13	3.8
		Mechanism of action of S-PRG fillers		
84.1	111	Incorrect	302	89.3

15.9	21		Correct	36	10.7
		Proper DH			
34.8	46		Incorrect	144	42.6
65.2	86		Correct	194	57.4
		Non-carious cervical lesions and DH			
4.5	6		Incorrect	9	2.7
95.5	126		Correct	329	97.3
		Caries			
18.9	25		Incorrect	50	14.8
81.1	107		Correct	288	85.2
		Occlusal wear and DH			
22	29		Incorrect	45	13.3
78	103		Correct	293	86.7
		Molar incisor hypomineralization			
57.6	76		Incorrect	117	34.6
42.4	56		Correct	221	65.4

*HEMA = hydroxyethyl methacrylate

Table 4: Median (first - third quartiles) of the self-reported and real knowledge values from undergraduate students and dentists on DH.

	Self-reported knowledge	Real knowledge
Students	7.0 (5.0 – 7.0) Aa	5.0 (3.5 – 6.0) Ab
Dentists	7.0 (6.0 – 8.0) Ba	5.5 (4.5 – 6.5) Bb

*Different uppercase letters represent statistical differences between students and dentists (within the same column) (Mann-Whitney test, $p=0.002$ for self-reported knowledge; $p<0.001$ for real knowledge values).

*Different lowercase letters represent statistical difference between self-reported and real knowledge (within the same line) (Wilcoxon test, $p<0.001$ for both).

Table 5: Final regression model for undergraduate students and dentists indicating the predictive variable related to the dependent variable (real knowledge score).

Undergraduate students				
Predictor	**Estimate**	**SE**	**t**	**p**
Intercept	3.929	0.482	8.15	< 0.001
% of completed course:				
50-75% – 25-50%	1.374	0.525	2.62	0.010
>75% – 25-50%	0.889	0.558	1.59	0.114
Dentists				
Predictor	**Estimate**	**SE**	**t**	**p**
Intercept	5.020	0.174	28.90	< 0.001
Gender:				
Male – Female	0.626	0.198	3.16	0.002

Other – Female	-2.396	1.557	-1.54	0.125
Age:				
Between 31 and 40 – Between 18 and 30	-0.745	0.277	-2.69	0.008
Between 41 and 50 – Between 18 and 30	-0.906	0.359	-2.52	0.012
Between 51 and 60 – Between 18 and 30	-0.974	0.420	-2.32	0.021
Over 60 – Between 18 and 30	-1.808	0.709	-2.55	0.011
Post-graduation degree:				
Masters – None	0.376	0.217	1.73	0.084
PhD – None	1.245	0.211	5.89	< 0.001

PAGE 1/4

Are you an undergraduate student or a dentist (already graduated)?

( ) Undergraduate student ( ) Dentist

PAGE 2/4: QUESTIONS SOLELY FOR UNDERGRADUATE STUDENTS

Demographic and education data

E-mail address: _____

1. Gender you identify with:

( ) Female ( ) Male ( ) Other

2. Your age:

( ) Between 18 and 30 years old

( ) Between 31 and 40 years old

( ) Between 41 and 50 years old

( ) Between 51 and 60 years old

( ) More than 60 years old

3. Region in which your University is located:

( ) North ( ) Northeast

( ) Central-west ( ) Southeast

( ) South

4. What stage of undergraduation course are you studying?

( ) First year (1^{st} or 2^{nd} semester)

( ) Second year (3^{rd} or 4^{th} semester)

( ) Third year (5^{th} or 6^{th} semester)

( ) Forth year (7^{th} or 8^{th} semester)

( ) Firth year (9^{th} or 10^{th} semester)

( ) Sixth year (11^{th} or 12^{th} semester)

5. The University where you study is:

( ) Public ( ) Private

6. What is the regular duration of your course?

( ) 4 years ( ) 5 years ( ) 6 years

7. Have you done or are you doing any extra-curricular activities (such as undergraduate research projects and internships) ?

( ) Yes ( ) No

8. When was the last conference/meeting you attended?

( ) Less than 2 years ago

( ) Between the last 2 and 5 years

( ) More than 5 years ago / I do not attend conferences

9. In your course curriculum, specific content is taught on the etiology, diagnosis and treatment of dentin hypersensitivity?

( ) Yes ( ) No

10. On a scale of 0 to 10, how much do you think your knowledge about dentin hypersensitivity is? (where 0 = I don't know anything about the topic and 10 = any additional information beyond what I already have is unnecessary):

( ) 0
( ) 1
( ) 2
( ) 3
( ) 4
( ) 5
( ) 6
( ) 7
( ) 8
( ) 9
( ) 10

PAGE 2/4: QUESTIONS SOLELY FOR DENTISTS (ALREADY GRADUATED)

Demographic and education data

E-mail address: _____

1. Gender you identify with:

( ) Female ( ) Male ( ) Other

2. Your age:

( ) Between 18 and 30 years old

( ) Between 31 and 40 years old

( ) Between 41 and 50 years old

( ) Between 51 and 60 years old

( ) More than 60 years old

3. Region in which the University you graduated from was located:

( ) North ( ) Northeast

( ) Central-west ( ) Southeast

( ) South

4. The University where you graduated from as a dentist was:

( ) Public

( ) Private

5. Do you have a post-graduation degree? If yes, please select the highest:

( ) Master's degree

( ) PhD

( ) Post-doctoral

( ) I do not have a post-graduation degree

6. Do you have a specialist degree?

( ) Yes ( ) No

7. How many years ago did you graduate?

( ) 0 to 5 years
( ) 6 to 10 years
( ) 11 to 15 years
( ) 16 to 20 years
( ) 21 to 30 years
( ) More than 30 years

8. When was the last conference/meeting you attended?
( ) Less than 2 years ago
( ) Between the last 2 and 5 years
( ) More than 5 years ago / I do not attend conferences

9. What is your current practice (more than one option can be selected:
( ) Private clinic
( ) Public clinic
( ) Teaching
( ) Other

10. On a scale of 0 to 10, how much do you think your knowledge about dentin hypersensitivity is? (where 0 = I don't know anything about the topic and 10 = any additional information beyond what I already have is unnecessary):
( ) 0
( ) 1
( ) 2
( ) 3
( ) 4
( ) 5
( ) 6
( ) 7
( ) 8
( ) 9
( ) 10

PAGE 3/4: FOR BOTH UNDERGRADUATES AND DENTISTS

Specific questions about dentin hypersensitivity (DH)

1) What is the prevalence of patients with dentin hypersensitivity (DH) you assist during your undergraduation or in the office you work?

( ) 1% to 10%
( ) 11% to 20%
( ) 21% to 30%
( ) 31% to 40%
( ) 41% to 50%
( ) 51% to 60%
( ) 61% to 70%
( ) 71% to 80%
( ) 81% to 90%
( ) 91% to 100%

2) In which situation(s) do your patients report episodes of DH more frequently? (It is possible to select more than one alternative)

( ) Intaking cold food/beverages
( ) Intaking hot food/beverages
( ) Upon air from compressed air syringe
( ) While talking
( ) While using exploratory clinical probe
( ) While using periodontal probe
( ) In percussion tests

3) Among your patients, what factors do you believe are predisposing to the development of DH? (It is possible to select more than one alternative)

( ) Acidic diet
( ) Parafunctional habits
( ) Occlusal disturbance
( ) Orthodontic treatment
( ) Inappropriate hygiene habits
( ) Gingival recession
( ) Gastric disturbances
( ) Sports drinks
( ) Illicit drugs consumption

4) Among your patients, what age group is most affected by DH?

( ) Between 6 and 17 years old
( ) Between 18 and 35 years old
( ) Between 36 and 50 years old

( ) Between 50 and 70 years old

( ) Above 70 years old

5) How do you diagnose DH in your patients? (It is possible to select more than one alternative)

( ) With air blast from the syringe

( ) By applying cold stimuli (as in pulpal tests, for example)

( ) By applying warm stimuli (as in pulpal tests, for example)

( ) With the exploratory probe

( ) I do not perform any test to diagnose DH

6) When a patient presents with DH, which interventional do you use to manage this condition? (It is possible to select more than one alternative)

( ) Laser application

( ) Laser application associated with a desensitizing agent

( ) Use of fluoride-based desensitizing agent

( ) Use of glutaraldehyde/HEMA-based desensitizing agent

( ) Use of other desensitizing agent

( ) Occlusal adjustment

( ) Dietary orientation

( ) Hygiene orientation

( ) Dietary/hygiene orientation associated with use of a desensitizing agent

( ) Endodontic treatment

( ) I do not treat DH

7) How do you choose what desensitizing agent to have in your office or to use in your University? (It is possible to select more than one alternative)

( ) For the price (value for money)

( ) Through recommendations from other dentists

( ) Through courses at conferences

( ) Through scientific papers

( ) Through brand advertisements

PAGE 4/4: FOR BOTH UNDERGRADUATES AND DENTISTS

Mechanism of action of different desensitizing agents and diagnosis of DH

****Correct answers (in bold) were not available for the participants**

1) Regarding the use of fluoride varnish (example: Duraphat, Colgate), what is the mechanism of action of this product for managing DH?

( ) Formation of mineral deposits that help to occlude the patent dentinal tubules and reduce sensitivity

( ) It has neural action, where it is capable of desensitizing the nerve cells and reducing the sensation of pain

( ) It presents obliterating action through the reaction with proteins, in addition to promoting collagen fixation

( ) I do not know

2) Regarding the use of glutaraldehyde-based products (example: Gluma, Kulzer), what is the mechanism of action of this product for managing DH?

( ) Formation of mineral deposits that help to occlude the patent dentinal tubules and reduce sensitivity

( ) It has neural action, where it is capable of desensitizing the nerve cells and reducing the sensation of pain

( ) It presents obliterating action through the reaction with proteins, in addition to promoting collagen fixation

( ) I do not know

3) Regarding the use of potassium nitrate-based products (example: Desensibilize, FGM), what is the mechanism of action of this product for managing DH?

( ) Formation of mineral deposits that help to occlude the patent dentinal tubules and reduce sensitivity

( ) It has neural action, where it is capable of desensitizing the nerve cells and reducing the sensation of pain

( ) It presents obliterating action through the reaction with proteins, in addition to promoting collagen fixation

( ) I do not know

4) Regarding the use of potassium oxalate-based products (example: Oxa-Gel), what is the mechanism of action of this product for managing DH?

( ) Formation of mineral deposits that help to occlude the patent dentinal tubules and reduce sensitivity

( ) It has neural action, where it is capable of desensitizing the nerve cells and reducing the sensation of pain

( ) It presents obliterating action through the reaction with proteins, in addition to promoting collagen fixation

( ) I do not know

5) Regarding the use of S-PRG filler-based products (example: PRG Barrier Coat, Shofu, containing ions Na^{+}, BO_3^{3-}, SiO_3^{2-}, F^{-}, Sr^{2+} e Al^{3+}), what is the mechanism of action of this product for managing DH?

( ) Formation of mineral deposits that help to occlude the patent dentinal tubules and reduce sensitivity

( ) It has neural action, where it is capable of desensitizing the nerve cells and reducing the sensation of pain

( ) It presents obliterating action through the reaction with proteins, in addition to promoting collagen fixation

( ) I do not know

6) This patient (24 years old) sought care complaining of pain in the upper and lower incisors when drinking a cold drink and upon the air blast from the syringe. No carious lesions nor wear was detected. Do you believe that this patient has dentin hypersensitivity?

( ) No, because this patient has dental caries

( ) Yes, because this patient has dental caries

( ) No, because this patient has molar-incisor hypomineralization

( ) Yes, because this patient has molar-incisor hypomineralization

( ) No, because the patient presents exacerbated pain

( ) Yes, because the patient presents exacerbated pain

7) This patient (35 years old) sought care complaining of pain in the premolars and upper and lower canines when drinking a cold drink and upon the air blast from the syringe. Erosive and abrasive wear was detected in the cervical area of teeth 33 and 34. Do you believe this patient has dentin hypersensitivity?

( ) No, because this patient has dental caries
( ) Yes, because this patient has dental caries
( ) No, because this patient has molar-incisor hypomineralization
( ) Yes, because this patient has molar-incisor hypomineralization
( ) No, because the patient presents exacerbated pain due to exposure of dentin
( ) Yes, because the patient presents exacerbated pain due to exposure of dentin

8) This patient (27 years old) sought care complaining of pain in tooth 37 when drinking a cold drink. A ICDAS 4 carious lesion was detected clinically and on the bitewing radiograph. Do you believe that this tooth has dentin hypersensitivity?

( ) No, because this patient has dental caries
( ) Yes, because this patient has dental caries
( ) No, because this patient has molar-incisor hypomineralization
( ) Yes, because this patient has molar-incisor hypomineralization
( ) No, because the patient presents exacerbated pain due to exposure of dentin
( ) Yes, because the patient presents exacerbated pain due to exposure of dentin

9) This patient (22 years old) sought care complaining of pain in tooth 47 only when drinking a cold drink and upon the air blast from the syringe. When removing the stimulus, sensitivity ceased. Erosive wear was detected in the occlusal surface of tooth 47 with evident exposure of dentin. Do you believe that this tooth has dentin hypersensitivity?

( ) No, because this patient has dental caries
( ) Yes, because this patient has dental caries
( ) No, because this patient has molar-incisor hypomineralization
( ) Yes, because this patient has molar-incisor hypomineralization
( ) No, because the patient presents exacerbated pain due to exposure of dentin
( ) Yes, because the patient presents exacerbated pain due to exposure of dentin

10) This patient (23 years old) sought care complaining of pain in tooth 36 when drinking a cold drink and upon the air blast from the syringe. A brownish lesion was detected on the first molar covering the mesiobuccal cusp. Also, a white creamy opacity was observed in the incisors. Do you believe that this tooth has dentin hypersensitivity?

( ) No, because this patient has dental caries
( ) Yes, because this patient has dental caries
( ) No, because this patient has molar-incisor hypomineralization
( ) Yes, because this patient has molar-incisor hypomineralization
( ) No, because the patient presents exacerbated pain due to exposure of dentin
( ) Yes, because the patient presents exacerbated pain due to exposure of dentin

Thank you for your participation!