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# Prevalence of self-reported versus diagnosed dentinal hypersensitivity: a cross-sectional study and ROC curve analysis

Nayara Franciele Figueiredo Barroso, Polyana Matos Alcântara, Adriana Maria Botelho, Dhelfeson Willya Douglas-de-Oliveira, Patrícia Furtado Gonçalves and Olga Dumont Flecha

[a]Department of Dentistry, Federal University of Jequitinhonha and Mucuri Valleys, Diamantina, Brazil

**ABSTRACT**

**Objective:** This study aimed to identify and compare the self-reported and diagnosed prevalence of dentinal hypersensitivity (DH) in an University population; and to verify accuracy, sensitivity and specificity of DH stimuli tests.

**Material and methods:** Three hundred and eighty patients (67.2% women and 32.8% men) were assessed by questionnaire, clinical exam, tactile and cold water tests. The intensity of DH was assessed using a visual analogue scale, and a calibrated examiner measured the scores using a caliper. The ICC for intra-examiner was 0.990. Scores above 5 mm were considered sensitive teeth. The association between variables was assessed by Chi-square test. ROC curve analysis determined accuracy, sensitivity and specificity of the tests ($p < .05$).

**Results:** The mean age of participants was 24.08 years. 158 (41.7%) volunteers self-reported the presence of DH, while, 88.7% of the participants were clinically diagnosed ($p = .023$). In total, 8958 teeth were evaluated, of those 3367 (37.6%) were diagnosed sensitive. The most prevalent teeth with DH were incisors and premolars. The accuracy of the tests with cold water and tactile were 99%. The sensitivity and specificity for cold water and tactile tests were 99.9%, 99.7%, 99.1% and 87.6%, respectively.

**Conclusion:** The self-reported prevalence of DH was significantly lower than that clinically diagnosed. The cold test proved to be a highly accurate stimulus for the diagnosis of DH.

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## Introduction

The dentinal hypersensitivity (DH) is defined as an acute pain of short duration due to the dentine exposure in response to a typical stimulus, thermal evaporative, tactile or osmotic, that can not be associated with any other form of dental defect or disease [1].

Normally, dentinal canaliculi are isolated from the external environment by enamel or cementum [2]. It should be noted that not all exposed dentine is hypersensitive [3]. Hypersensitivity seems to occur when the smear layer is removed, opening and exposing the outer ends of the dentin tubules [3].

Several theories attempt to explain the mechanism of dentin hypersensitivity. The most accepted is the hydrodynamic theory, that postulates that the fluids of exposed tubules are disturbed by temperature, physical or osmotic changes and these changes and movements in dentin fluid flow stimulate baroreceptors present in the pulp and dentin, leading to neural discharge and resulting in pain [4].

An increase in DH prevalence may affect dental plaque control and may therefore compromise oral health. When pain is severe, it may result in emotional changes that alter the lifestyle, also affecting feeding and breathing of affected individuals [5,6].

Several studies around the world reported that, among the toothaches, DH is the most common painful condition in the adult population [6], with prevalence ranging between 3% and 98% [7]. Economic differences, diet patterns, hygiene and attitudes towards oral disease affect these rates, and, likewise, how DH is estimated may also interfere in the wide range of prevalence. Studies that determine DH through self-reported questionnaires tend to show a higher prevalence than diagnosed by specific clinical evaluation [8,9].

Few studies have associated questionnaire and clinical examination for DH detection in the Brazilian population [10–12], resulting in a scarce of data related to the actual prevalence of DH in Brazil. This could result in significant consequences for patients and dentists; taking into account the uncertainty of the diagnosis, the appropriate time to deal with the problem and how invasive treatment should be.

The objective of this study was to identify and compare the self-reported and clinically diagnosed prevalence of DH in a population of patients from a Federal University in Diamantina, Minas Gerais, Brazil. The secondary objective

CONTACT Dhelfeson Willya Douglas-de-Oliveira dhelfeson@hotmail.com Department of Dentistry, Federal University of Jequitinhonha and Mucuri Valleys, Rua da Glória, 187, centro, Diamantina, Minas Gerais, 39100-000, Brazil

Table 1. Characteristics of patients ($n = 380$).

| Variables | Mean | SD |
|---|---|---|
| Age | 24.08 | 7.17 |
| Sex | *n* | % |
| Male | 125 | 32.8 |
| Female | 255 | 67.2 |
| DH self-report ($n = 380$) | *n* | % |
| Yes | 158 | 41.7 |
| No/Do not know | 222 | 58.3 |

was to assess the sensitivity and specificity of the stimuli tests used to assess DH.

## Materials and methods

This cross-sectional clinical study was approved by the Research Ethics Committee of the Federal University of Jequitinhonha and Mucuri Valleys (UFVJM), protocol #092/2012, and was held at the Periodontics and Oral Surgery Clinic of UFVJM, in accordance with all the biosafety standards and conducted according to the Helsinki Declaration of 1975, revised in 2013. All participants were instructed about the study and signed the free and informed consent before the enrollment in the research.

### *Selection of volunteers*

The sample was defined through a proportional stratified sampling process between students, professors and administrative technicians of UFVJM (Diamantina, MG, Brazil). Inclusion criteria were: individuals with minimum age of 18 years; both genders; without distinction of race or socioeconomic status; with good general health condition; and that showed interest in participating in the research, reporting or not discomfort on thermal, evaporative, tactile, osmotic stimuli of daily life. Patients were excluded if they were treated for homemade or professional tooth whitening, to avoid overestimation of the population with DH.

To determine the sample size, it was used the prevalence calculation. The significance level was set at 95% and margin of error set at 5%. It was obtained a prevalence of 33.8% in the literature [13]. Thus, the calculated number of patients was 344. It was added 10% to prevent possible losses. The total number of participants was then set at 378.

### *Hypersensitivity evaluation*

Initially, the participants answered one question about self-report of the presence or absence of hypersensitive teeth. The question was based on the questionnaire used by Oderinu et al. [13].

A clinical evaluation was also performed to rule out any pain related to tooth decay, pulp injuries and other processes that could overestimate the prevalence of DH.

An examiner (PMA) was trained for the execution of clinical exams and calibrated for the use of analog caliper through the test-retest method. The value of intra examiner correlation coefficient was 0.990.

Training for the tactile test was performed by measuring the pressure in utility wax to standardize the force (15 g) [14] applied to the explorer. This pressure was achieved with the examiner (PMA) calibration and training prior to the clinical study, using a precision balance. All tactile tests were performed with instruments of the same trademark (Golgran®, São Paulo, Brazil).

To evaluate the DH, two stimuli were performed on all fully erupted teeth in the oral cavity free of cavities and/or restorations and no abutments of bridges or supporting removable partial dentures. One minute interval between the application of each stimulus was used, sequencing clockwise in quadrants.

The tactile test was first performed using explorer #5 to scrape the cervical buccal surface from mesial to distal of each tooth with moderate and constant pressure. Thereafter, thermal test was performed with cold water: a cotton swab was soaked in cold water, with temperature between 5 °C to 10 °C (controlled with analog thermometer) and placed in contact with the cervical buccal surface of each tooth. The stimulus was maintained until the occurrence of painful voluntary response, with a maximum application time of 5 s.

Immediately after application of each stimulus, participants were instructed to mark the intensity of pain on the visual analogue scale (VAS). This scale comprises a horizontal line of 0–100 mm, where the left end is equivalent to 'no pain' and the right 'unbearable pain'. Scores between 0 and 4 mm were considered as absence of pain; 5–44 mm, mild pain; 45–74 mm moderate pain; and 75–100 mm, severe pain [15]. An analog caliper was used to quantify the pain values. For a tooth to be considered with DH, it should respond positively to both clinical tests, with scores equal to or greater than 5 mm. For a person to be considered to have DH, he/she had to have at least one tooth with DH under any one of the two stimuli.

### *Statistical analysis*

Statistical analysis was performed using SPSS® (Statistical Package for the Social Sciences, version 23.0, IBM Corp., Armonk, NY). Descriptive statistical analyzes were performed to obtain frequency, mean and standard deviation. On individual level, the definition of patient with dentin hypersensitivity was used for prevalence estimates; and, the definition of a hypersensitive tooth was used for test accuracy estimates (tooth level).

The normality of the data was verified by the Kolmogorov–Smirnov test. Associations between categorical variables were estimated using the Chi-square test. Receiver operating characteristic (ROC) curve analysis comparing the two stimuli was performed to evaluate diagnostic accuracy, sensitivity, and specificity in diagnosing dentin hypersensitivity. The significance level of 5% ($p < .05$) was adopted.

## Results

We evaluated 380 participants aged 18–61 years. The average age was 24.08 years, and the majority of participants

**Table 2.** Frequency distribution of teeth under different tests for DH and mean of pain scores.

| Variables | | | Scores of pain, Mean (SD) |
|---|---|---|---|
| Tactile test (*n = 329 teeth, 3.7%*) | | | 41.7 (26.9) |
| Teeth | n | % | |
| Premolars | 164 | 49.8% | |
| Incisives | 84 | 25.5% | |
| Canines | 46 | 14.0% | |
| Molars 35 | | 10.6% | |
| Cold water test (*n = 1168 teeth, 13.1%*) | | | 35.3 (24.2) |
| Teeth | n | % | |
| Incisives | 691 | 59.2% | |
| Premolars 269 | | 23.0% | |
| Canines | 147 | 12.6% | |
| Molars | 61 | 5.2% | |

**Table 3.** Association between self-reported and clinically disgnosed DH (*n* = 380).

| | Self-reported | | |
|---|---|---|---|
| DH | Yes | No | *p* |
| Clinically diagnosed | | | |
| Yes | 147 (93.0) | 189 (85.5) | .023 |
| No | 11 (7.0) | 32 (14.5) | |

were woman (*n* = 255; 67.2%). A total of 158 people (41.7%) self-reported the presence of sensitive teeth and 237 people (62.5%) reported the occurrence of sensitivity during brushing and/or drinking/eating (Table 1).

A total of 8958 teeth were examined in 380 patients. Of these, 5591 (62.4%) did not show any sensitivity during clinical exams and 3367 (37.6%) presented DH. Of those who had hypersensitivity, 329 (3.7%) had pain in response to tactile testing and 1168 (13.1%) to test with cold water. Also, there was painful responses to more than one stimulus. Table 2 shows the prevalence of DH teeth for each type of stimulus, as well as most affected teeth in each test.

One hundred and fifty-eight (41.7%) volunteers self-reported the presence of DH. Clinically, 336 people were diagnosed with DH (88.7%). Among those patients who self-reported the presence of DH, 93% had the diagnosis confirmed by clinical exam; and 85.5% of those who did not report sensitivity were clinically diagnosed with the condition (DH). There was a statistically significant difference between the self-reported and clinically diagnosed prevalence of DH (Table 3).

The accuracy of the test with cold water was 0.991 (95% CI: 0.989 to 0.993); and 0.960 (95% CI: 0.955 to 0.966) for tactile test. The cutoff point for testing with cold water was 5mm with sensitivity equal to 99.9% and specificity of 99.7%. The tactile test had a sensitivity of 99.1% and specificity of 87.6% for 5mm cutoff point (Figure 1).

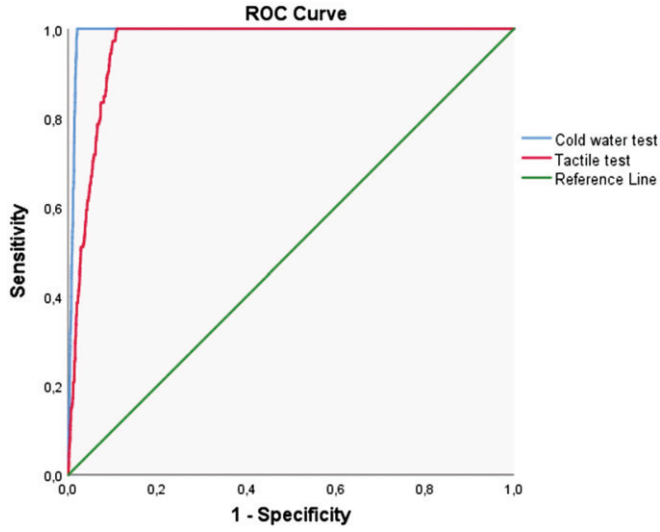


**Figure 1.** ROC curve for the different stimulus.

## Discussion

In this study, self-reported prevalence of DH was 41.7%, while the diagnosed prevalence in clinical examination was 88.7%. Other studies that also used questionnaire and clinical examination for DH diagnostic found a prevalence ranging between 9.1 and 67.7% [16,17]. Although 237 volunteers (62.5%) asserted the occurrence of dental sensitivity during brushing and/or food intake; there was an underestimation in reporting sensitive teeth in the questionnaire, resulting in a lower self-reported prevalence compared to the results of clinical diagnosis. This contrasts with some other clinical studies [6,13,18,19]. This fact can be explained by a variety of factors such as: (1) the overall average score being in slight pain range (5–44 mm), suggesting no interference of pain in the daily lives of patients; (2) two distinct tests for pain were performed, therefore, more comprehensive, causing sensations hitherto unknown for the patients; (3) the direct stimulation of pain sites and the episodic nature of this condition that can evoke or subdue the symptoms of pain, as the dentinal tubules are open or closed [20]. The lower specificity for the tactile stimulus may infer that such stimulus is capable to influence the experimental system by interfering with the smear layer, and thus 'initiate' DH.

The teeth groups most affected by DH were, respectively, the incisors and premolars. Some studies [12,21] indicated that incisors are more affected by DH because they exhibit naturally a smaller enamel thickness when compared to other groups [22]. In addition, many investigators have found that, in general, the teeth most commonly affected by DH in the adult population are premolars [20,23]; due to its placement in the dental arch they may be more likely to be brushed with excessive force and, therefore, more prone to gingival recession, non-carious cervical lesions and loss of cementum [24], factors typically associated with the development of DH.

The correct diagnosis of DH is essential to estimate its real prevalence. According to Gillam and Newman [25] there is no diagnostic method that can be considered ideal for determining hypersensitivity. Some authors [10,26] have suggested that the reliability of results based on intraoral tests can be questioned, since they are not exact representations of stimuli of daily life.

Reinforcing what has been reported in the literature [27], the present results of thermal testing were the most triggering stimulus for hypersensitivity frames; however it is important to consider that the response to tactile test may have been low due to the possibility of the probe does not reach the sensitive locations of some teeth [10]. To diagnose

hypersensitivity and quantify pain responses can be considered difficult to implement since it is a subjective experience, difficult to measure and depends on several factors, such as the psychological profile of the individual, previous experiences, and anxiety levels [10,26].

A study suggests that at least two methods of testing should be used for the diagnosis of DH [28]. In this study, in order to reduce the possibility of bias, providing greater reliability to the results and increasing the internal validity, clinical tests were associated with a clinical survey questionnaire, which made it possible to exclude teeth with prosthetic preparations, cavities, restorations and pulp alterations, which can cause pain and confuse the diagnostic [29]. In addition, calibration of a single examiner provided standardization, minimizing the occurrence of methodological variations in clinical testing and the determination of etiological factors. The use of a probe from a single manufacturer reduced the possibility of variations during the tactile test, as well as the thermometer has kept the water used in the thermal test to the same temperature range throughout the data collection.

It is important to note that DH initiation is caused more over by loss of the smear layer, and consequently, patency of the dentin tubules [30]. The presence of smear layer may be able to prevent DH because this layer debris is forced down into each dentinal tubule, occluding the tubules [31,32]. However, this protective layer is easily removed from tooth surface by erosion and abrasion [33,34]. This fact may explain the episodic phenomenon of this clinical condition [20,30]. The investigated sample herein may have had a transient DH, considering the high DH prevalence (compared to the self-reported), the tactile stimulus performed and the patient coping.

Different methods have been used for stimulation and evaluation of DH, and a gold standard method still cannot be established [35]. This study showed that the cold water as a stimulus for DH had excellent ability to distinguish between hypersensitive and non-hypersensitive teeth, and also presented high sensitivity and specificity. The explanation proposed here is that cold water probably simulate conditions of daily activities in which oral environment is subjected, and its low temperature has faster effect on intrabular fluid movement.

According to Holland et al. [36], the stimuli for assessing DH can be thermal, evaporative or tactile; and the weakest stimulus should be performed first. There is a variety of tests in stimulating DH which are efficient in evaluating DH [37]. It is important to note that the cold water and tactile had high specificity, in other words, this test is highly able to rule out hypersensitivity, leading to a low proportion of false positive results [38].

The ROC curve graphically represents the overlap between the distribution of sensitivity and specificity for each threshold between normal and abnormal. The best point should be one that shows the highest sensitivity and higher specificity, corresponding to the highest and diverted point to the left or the curve closest to the crossing of the two axis [39]. Through ROC curve analysis, the ideal cutoff point for both stimuli was 5 mm in VAS. This result confirms the findings of Jensen et al. [15] which propose that values below 49 mm should not be considered as presence of pain (hypersensitivity). It is suggested that future studies with the use of VAS for evaluation of DH should consider as hypersensitive teeth only those presenting scores equal or greater than 5 mm.

Although well conducted, this study has limitations. For now, the study population may not be representative of the Brazilian population since it was used a population from a Brazilian University.

In the future, with increasing life expectancy and the teeth being preserved and kept for longer periods of time, a growing number of people can be affected by predisposing dental injuries leading to hypersensitivity [40]. This confers clinical importance to research seeking new ways to treat DH, easy access and effective products such as the cyanoacrylate recently found as a viable alternative for the treatment of DH, since it shows similar effectiveness when compared to laser [41]. Finally, it is essential to perform studies to investigate the prevalence and factors associated with the condition; since the development and evaluation of new products and the choice of appropriate treatment depends on a clear conception of this condition by clinicians [42].

It was concluded that self-reported prevalence (41.7%) was significantly lower than the clinically diagnosed prevalence (88.7%). The cold water proved to be a highly accurate stimulus for the diagnosis of DH. The cutoff point to consider a tooth as hypersensitive should be 5mm in the VAS.

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## Disclosure of interest

The authors declare that they have no conflict of interests.

## ORCID

Dhelfeson Willya Douglas-de-Oliveira http://orcid.org/0000-0002-8628-3122
Olga Dumont Flecha http://orcid.org/0000-0002-6999-5398

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