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Review article

Prevalence of dentin hypersensitivity: Systematic review and meta-analysis

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ABSTRACT

Objectives: The purpose of this study was to estimate the prevalence of dentin hypersensitivity in various populations. Sources: Four electronic databases (Medline via PubMed, Cochrane Library, Wiley Online Library and Web of Science) were searched until June 2018.
Study selection: Cross-sectional studies on the prevalence of dentin hypersensitivity were included. Meta-analysis were conducted and meta-regression models were used to explain the variation of the prevalence measures. Data were extracted, and the studies were assessed for quality. Data: A total of 65 papers (reporting on 77 studies) met the inclusion criteria and were included in the meta-analysis. The prevalence range was observed to be as low as 1.3% and as high as 92.1%. Effect modifiers for dentin hypersensitivity prevalences were the type of participants included in the study, age range, recruitment strategy and number of study sites. Higher prevalences were observed in studies involving specialty practice patients, younger adults, convenience sample and those characterized as single-site. Conclusion: The best estimate of dentin hypersensitivity was 11.5% (95%CI:11.3%–11.7%) and the average from all studies was 33.5% (95%CI: 30.2%–36.7%). The extremely high degree of heterogeneity among studies can only be partially explained by characteristics of the studies.
Clinical significance: Dentin hypersensitivity is a persistent clinical problem that poses significant challenge for clinicians and affects patients' quality of life. Better understanding of the dentin hypersensitivity burden and its associated factors can assist on resource planning for reducing/preventing any discomfort arising from this condition and will aid in the decision-making process.

1. Introduction

Dentin hypersensitivity (DH) is a frequently chronic finding and a challenging condition to treat in dental clinical practice [1]. Dentin hypersensitivity can be defined as a short sharp pain that arises from the exposed dentin in response to thermal, tactile, osmotic, chemical, or evaporative stimuli that cannot be attributed to any other form of dental defect or pathology [2]. This condition impacts oral health-related quality of life [3,4], producing significant impairment on patients' daily life such as speaking, eating, drinking and toothbrushing [5,6].

Prevalence studies reported in literature have resulted in unpredictable data, ranging from 1.3% [7] to 92.1% [8]. This heterogeneity has been associated to the population screened, recruitment process, study setting, and the different diagnostic criteria used to collect data [9,10]. Dentin hypersensitivity is measured by clinical exam and self-reported questionnaire, evaluation of a person's response to stimulus, and by excluding other dental and periodontal conditions [11]. However, the wide diversity of current diagnostic criteria suggests considerable uncertainty and lack of confidence among dental practitioners about how to diagnose and manage this condition [2,12].

Knowledge of the prevalence of a condition is used to guide diagnosis under the maxim "common things commonly occur." Therefore, uncertainty about the prevalence of dentin hypersensitivity has significant consequences for patients and dental practitioners. Epidemiology, etiology and clinical features have been described in a number of papers but to our knowledge none of these have used a detailed systematic methodology to estimate the prevalence of dentin hypersensitivity worldwide. Therefore, the aim of this study was to systematically review cross-sectional studies to estimate the prevalence of dentin hypersensitivity in various populations and to investigate factors that might influence variation in the prevalence.

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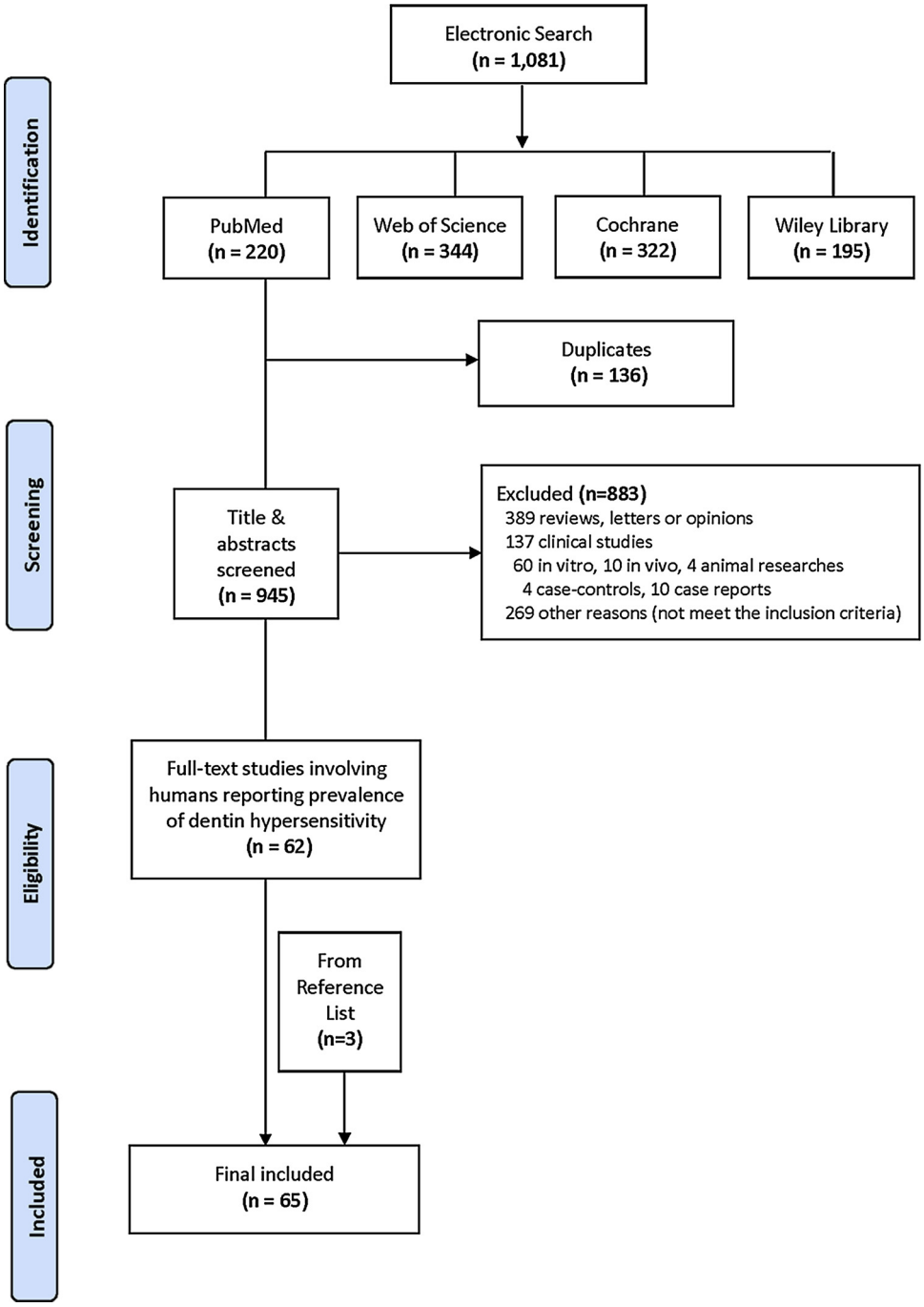

Fig. 1. Flow diagram of the selection of studies.

2. Materials and methods

Methods of this systematic review followed recommendations from the Cochrane Collaboration [13] and its reporting followed the guidelines for Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [14].

2.1. Search strategy to identify studies

An electronic search of the literature was performed on the following databases: Medline via PubMed, Cochrane Library, Wiley Online Library and Web of Science until June 2018 to identify the studies. MeSH terms, keywords and other free terms related to "dentin hypersensitivity", and "prevalence" were used with Boolean operators (OR, AND) to combine searches (see Appendix A). No limitations to the publication time, language or quality were imposed. In addition, hand-searching to check reference lists of included articles was performed.

2.2. Eligibility criteria and study selection

Only studies conducted in humans, and that had specifically reported the prevalence of dentin hypersensitivity were included. Those studies which included very specific populations such as patients with periodontal problems with a small convenience sample and patients with fluorosis or those involving only children were excluded.

Titles and abstracts of the identified articles were independently screened by two reviewers to determine whether they met the inclusion criteria. Whenever discrepancies occurred between the evaluators, they

were solved by discussion and mutual agreement.

2.3. Data extraction and methodological quality assessment

The selected studies were evaluated by using full text copies, after de-duplication. Both reviewers independently performed data extraction and quality assessment using standardized extraction spreadsheets. Any discrepancies were solved by discussion and agreement between the reviewers. The information extracted included the study characteristics (e.g. year, study design, country, number of participants, age, number of sites, recruitment process), dentin hypersensitivity measurement methods, non-response rate and prevalence based on clinical exam and/or questionnaire. In addition, the reviewers screened the quality of the selected studies. The quality assessment of the cross-sectional studies was conducted by using modified Newcastle-Ottawa Quality Assessment Scale which includes the eight items mentioned below:

- Selection (composed of three items) - representativeness of the sample, sample size and non-response rate
- Comparability (one item) between respondents and non-respondents
- Outcome and Analysis (four items) - assessment of outcome of hypersensitivity, reporting of point estimate (prevalence), reporting of the measure of variability for the point estimate and accounting for correlation between multilevel units.

2.4. Data synthesis

Fixed-effects and random-effects meta-analysis were performed by combining the results of all studies. The degree of heterogeneity between studies was calculated (I^2-statistic) [15]. When studies reported the prevalence of DH by using different methods, just one prevalence estimate from each study was selected, giving preference to those based on clinical examinations rather than questionnaires and, among the former, those based on thermo-evaporative stimulus. Because there was a high degree of heterogeneity, random-effects meta-regression models with study characteristics as covariates were fitted to understand the impact of such characteristics as modifiers of the study effect size.

In addition, the predictive interval for a future study was calculated to present the expected range of true effect in a new study, given the data [16]. Statistical analyses were conducted using STATA (Stata Statistical Software, Version 15.1, Stata Corp, College Station, TX, USA).

3. Results

3.1. Search results

The preliminary search of electronic databases yielded 1081 potentially relevant articles (Fig. 1). After the review of study title, keywords and abstracts, 62 papers were retrieved for full-text evaluation. Four studies that met our inclusion criteria were published as full text articles in Chinese [17–20] and 1 in Russian [21]. In addition to the 62 studies, 3 studies [22–24] were included after searching the references lists of included studies and related reviews. Thus, 65 published studies met the selection criteria reporting on 77 cross-sectional studies (see Appendix B for reference list of included studies).

3.2. Characteristics of included studies

Most of the studies were conducted in Europe (40%) and Asia (38%), on or after the year 2010 (51%), in a university clinic or campus (40%) or community setting (39%) and not reported the type of funding received (65%) (Table 1). A total of 97,845 participants were evaluated in the 77 studies. The median number of participants was 700 (range: 40 – 12,692). The participants were mostly adults (65%), from general dental practices (either at University clinics or private practices) (43%), sampled in one site (52%) by convenience of investigators in 40% studies and randomly in 39%. Investigators in the majority of the studies reported only the sample actually enrolled, without mentioning the number of people in the eligible population (intended sample) or the target (external) population (to which results may be generalized). Of the 20 (26%) studies that reported some type of non-response rate, 9 exceeded the widely accepted rate of less than 20% of non-respondents.

The methods for the measurement and diagnosis involved response to stimulation during clinical exam (48%), and the remaining relied on questionnaire only (30%) or questionnaire and clinical exam only upon

Table 1
Description of the studies included in the systematic review of prevalence of dentin hypersensitivity.

	N	%
Total of studies	77	100%
Decade of publication		
1960	1	1%
1980	3	4%
1990	16	21%
2000	18	23%
2010	39	51%
Continent		
Africa	5	6%
Americas	10	13%
Asia	29	38%
Europe	31	40%
Oceania	2	3%
Multiple study sites		
No	40	52%
Yes	37	48%
Funding source		
Not reported	50	65%
Industry	20	25%
Non-profit	7	10%
Type of participants included in the study		
General population	29	38%
Specific groups of general population (e.g. university students)	9	12%
General practice patients	33	43%
Specialty practice patients (e.g. periodontal practice)	6	8%
Age groups		
Adults	50	65%
Young adults	18	23%
Adults and adolescents with or without children	9	12%
Recruitment		
Convenience sample	31	40%
Random sample	30	39%
Consecutive sample	16	21%
Non-response rate		
< 20%	11	14%
20% or greater	9	12%
Not reported	57	74%
Measurement method of dentin hypersensitivity		
Clinical exam	37	48%
Questionnaire only	23	30%
Questionnaire and clinical exam for those positive to self-report questionnaire	17	22%
Stimuli during clinical exam		
Thermo-evaporative only	35	45%
Thermo-evaporative and Tactile	13	17%
Thermo-evaporative and Thermal	3	4%
Tactile only	1	1%
Thermal only	1	1%
Tactile and Thermal	1	1%
None (self-reported questionnaire only)	23	30%
Clinical exam to exclude other causes of dentin hypersensitivity		
No	28	36%
Yes	49	64%
Assessment of the risk of bias		
High	52	68%
Moderate	17	22%
Low	8	10%

a positive response to the questionnaire (22%). Whereas most of the studies relying on self-reports did not mention the questions used, they ranged from non-specific questions such as presence of pain or discomfort to more specific questions mentioning the presence of sensitive teeth.

The majority of studies used only a thermo-evaporative stimulus (air blast) to assess DH (45%) and to measure the intensity, duration and tolerability of the pain. Several scales have been utilized. Verbal rating scale (VRS) scored from 0 to 3, 1 to 3 and 1 to 5 were reported. In addition, visual analog scale (VAS) along with a labeled magnitude scale (Seattle scale), VAS (0–100 mm line) and segmented numeric version of the VAS (numeric rating scales from 0 to 10) were used. Severity of the sensitivity has also been recorded using the semi-subjective scales like ordinal scale and Schiff pain scale. The table with detailed characteristics of each included study is available upon request.

3.3. Risk of bias assessment

The quality assessment of the selected papers indicated that 52 studies (68%) presented a high risk of bias (Appendix C). Common limitations were found in recruitment processes (the majority of studies did not mention the eligible and target population and nonresponse rate), description of sample size calculation (not reported property), measurement processes (clinical exams without independent validation) and analyses (not reported the measure of variability for prevalence).

3.4. Synthesis of the results

The wide range of prevalences reported in the included studies varied from 1.3% to 92.1%. Fixed-effect meta-analysis resulted in a summary estimate of the prevalence of dentin hypersensitivity of 11.5% (95% Confidence Interval: 11.3%–11.7%). The random-effects meta-analysis resulted in a summary estimate of 33.5% (95%CI: 30.2–36.7) (Fig. 2). The predictive interval (applicable for a future study based on past experience) was wide ranging from 4.8% to 62.3%.

3.4.1. Effect modifiers

The results obtained from meta-regressions showed that no statistically significant differences in prevalence among studies were observed by study decades, continents, funding sources or non-response rates. Surprisingly, characteristics of the diagnostic methods used also did not explain the variability in prevalence estimates. Additionally, there were no differences in prevalence among studies when compared by the method of diagnosis (self-reports vs. clinical exam), the method of stimulation during clinical exam (none vs. thermo-evaporative vs. other) or performing a clinical exam to exclude other causes of sensitivity.

On the other hand, effect modifiers that were significant included the type of participants included in the study, age range, recruitment strategy and number of study sites. Studies among specialty practice patients [mean prevalence: 61.2% (95%CI: 37.0–85.4)] and specific subgroups of the general population [mean: 43.3% (95%CI: 22.9–63.6)] had higher prevalence than general population [mean: 30.3% (95%CI: 27.0–33.7)] and general practice [mean: 28.1% (95%CI: 25.0–31.1)] studies. Studies including only young adult patients [mean: 43.9% (95%CI: 32.9–54.9)] reported higher prevalence of DH than those including other age groups, such as older adults [mean: 32.1% (95%CI: 28.1–36.1)] or adults and adolescents with or without children [mean: 20.4% (95%CI: 15.5–25.3)]. In situations in which participants were recruited using a consecutive sample [15.2% (95%CI: 12.4–17.9)] prevalences were lower, when compared with those using random [30.0% (95%CI: 26.6–33.4)] or convenience [46.3% (95%CI: 38.5–54.2)] sampling methods. Finally, studies that involved multiple sites [27.6% (95%CI: 23.6–31.5)] had lower prevalence than single-site studies [39.2% (95%CI: 32.8–45.7)].

4. Discussion

The purpose of this systematic review was to synthesize and integrate the existing information related to prevalence of dentin hypersensitivity. Even though some studies have been done reporting prevalence, we are not aware of reviews that have compiled data from studies conducted in different countries and different populations. The results of this study indicated an estimate of the dentin hypersensitivity of 11.5% (95%CI: 11.3%–11.7%) and 33.5% (95%CI: 30.2–36.7) for the fixed and random-effects meta-analysis models, respectively. The lower summary prevalence from the fixed-effect model can be interpreted as the “best estimate” or the “best guess” for the prevalence in the absence of heterogeneity, whereas the higher summary prevalence from the random-effects model can be interpreted as the average prevalence from all studies [13].

A predictive interval was calculated to quantify the extent of existing heterogeneity and in contrast to a confidence interval, which quantifies the precision of an estimated effect, a prediction interval covers the true effect of a single (new) study with probability $1 - \alpha$ [25]. In this study the predictive interval ranged from 4.8% to 62.3% and includes the possibility that a new study would observe a prevalence of DH as low as 5%, but also the possibility of observing prevalence much greater than the expected average of 33.5%.

To explore these findings further, the effects of different variables on the prevalence of DH were analyzed. The literature [26–28] frequently suggested that self-reported dentin hypersensitivity is likely to overestimate the prevalence in comparison with clinical exams. However, in this study, the meta-regression did not identify the method of diagnosis as an influential factor in the variation of prevalence estimates among studies. A possible explanation for this result is the wide variability in both methods of measurement. The methods for querying participants varied from specific questions on “sensitive teeth” to general questions on “pain or discomfort in teeth”, and the methods for clinical exam varied from eliciting pain to all teeth present to eliciting pain only after a positive self-report. For these reasons, the reporting of these methods of data collection can be improved in future studies by stating the question used for the self-reports and describing in detail the clinical exam (e.g. number of teeth and surfaces tested, amount of time, distance and force used for the stimulus, characteristics of the probe used, protection of adjacent teeth, room temperature during the evaluation, assessment of the participant’s response to the stimulus and clinical experience of assessors).

On the other hand, some significant effect modifiers on the dentin hypersensitivity prevalence were found. The higher prevalence found among specialty practice patients when compared with the other groups could suggest that some specific clinical conditions (e.g. gingival recession, noncarious cervical lesions and tooth wear) [8,29,30] may play a role in the occurrence of dentin hypersensitivity. Studies including only young adults reported higher prevalence. The reduction of dentin hypersensitivity with aging [30,31] has been explained by the obliteration of dentinal tubules and deposition of secondary and tertiary dentin over lifetime, resulting in a thick and protective layer of dentin between the pulp and the external environment [32]. In addition, the habits and lifestyle of young adults increase the vulnerability to an acidic diet and parafunctional habits, favoring the development of dentin hypersensitivity [33]. The number of study sites was another effect modifier found; studies that included multiple sites had lower prevalence than single-site studies. This variation probably happens due to different socio-cultural, lifestyles and dietary habits between the population in studies involving more than one site [10].

High risk of bias of the studies included in this systematic review may in part explain the wide range of prevalences found. Better reporting is needed to allow more accurate evaluation. When describing the recruitment strategy, reference to the target population to which

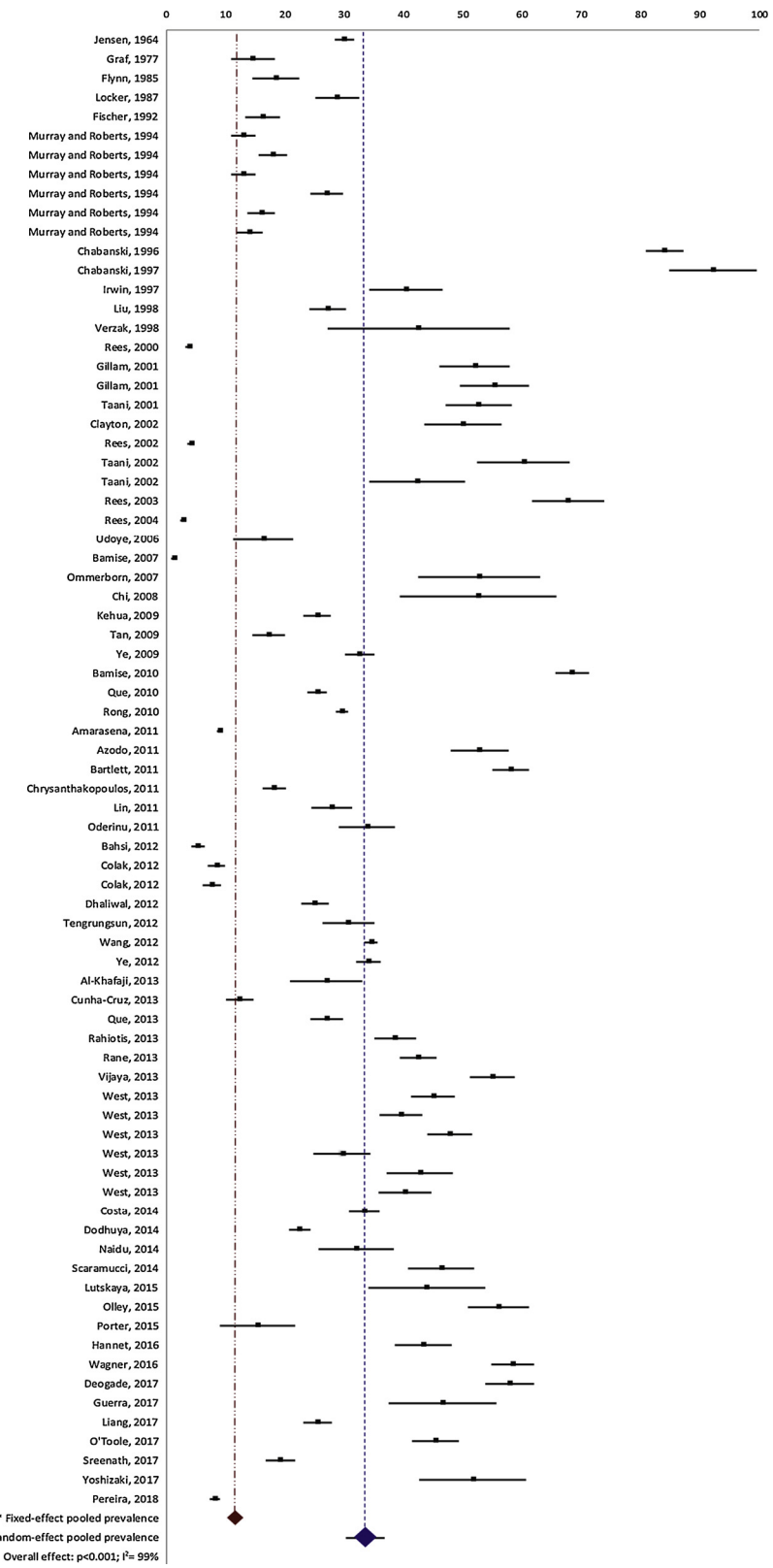

Fig. 2. Forest plot of studies on prevalence of dentin hypersensitivity. Prevalence (95%CI) for individual studies and fixed- (red, narrow dash) and random-effects (blue, wide dash) summary prevalences. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article).

the investigators intend to generalize the results should be provided as well as the number of potential participants who were approached to participate but declined. For the sample size calculation and analyzes of results, the clustering of participants within communities or practices and of teeth within participants should be considered through the use of appropriate statistical methods. Associated to this, new studies should employ systematic (e.g. consecutive) or random sampling schema and consider reporting the comparability between the respondents and non-

respondents, which will yield a better knowledge of how representative is the sample and to ensure more accurate results.

Overall, research in this area would benefit from adherence to the STROBE statement on strengthening the reporting of observational studies in epidemiology [34]. For the future, rather than reporting only the exact prevalence, studies considering the development and severity of hypersensitivity over time are needed.

The information collected in this review are an alert for future generations of professionals about a clinical manifestation increasingly prevalent in the dental practice. Dentin hypersensitivity is a persistent problem that affects quality of life and understanding the burden of dentin hypersensitivity can assist on resource planning for reducing or preventing any discomfort arising from the condition. In addition, this study can serve to improve the quality and reporting of research studies on prevalence of oral diseases.

5. Conclusion

Within the limitations of this study, we can conclude that the best estimate of dentin hypersensitivity is about 11.5%, and the average from all studies is 33.5%. The extremely high degree of heterogeneity among studies can only be partially explained by characteristics of the studies; a new prevalence study could expect to find a prevalence of dentin hypersensitivity anywhere from 4.8% to 62.3%.

Conflict of interest

The authors declare no conflict of interest.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.jdent.2018.12.015.

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