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Prevalence of Apical Periodontitis in Different Communities: A Meta-Analysis

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ABSTRACT

Introduction: The aim of this study was to perform a meta-analysis on the prevalence of apical periodontitis (AP) in different communities to obtain accurate data on its prevalence. **Methods and Materials:** The prevalence of AP in different communities based on the number of individuals, teeth and root-filled teeth was searched using electronic databases of ISI Web of Knowledge, PubMed, Scopus and also ProQuest and Springer. The Metaprop meta-analysis was done using the software R version 3.3.0 with Meta package. The Logit transformation method and random-effects model were used to calculate the pooled prevalence. Heterogeneity was tested by the *Q*-test ($P<0.1$ represented statistical significance), I^2 statistics (25%, 50% and 75% represented low, medium and high heterogeneity, respectively) and 2τ (2τ was calculated by DerSimonian-Laird estimator method). **Results:** A total of 77 studies were identified to qualify for inclusion into this meta-analysis. The prevalence of AP based on the number of individuals, teeth and root-filled teeth with the pooled prevalence was 0.519, 0.0498 and 0.3828, respectively. **Conclusions:** The results of the present study can be helpful for policy makers to monitor the dental public health demographically and compare it to other communities; they may be able find the strengths and drawbacks of their oral and dental health program.

Keywords: Meta-Analysis; Periapical Periodontitis; Root Canal Therapy

Introduction

Apical periodontitis (AP) is the inflammatory involvement of periradicular tissues that occurs predominantly due to persistent microbial infection [1, 2]. Bacteria and their toxins involve the pulp by dental caries, trauma, or dental procedures [3, 4] and then extend to the periapical region [5]. AP is usually a chronic process and thus demonstrates minimal or no clinical signs and symptoms and is primarily found in routine radiographic examinations [6-8]. If left untreated, this condition becomes irreversible and therefore determining its prevalence is highly important [6].

Diagnosis and treatment of AP have a considerable importance. The biologic aim of root canal treatment, which is a complicated clinical procedure, is prevention of AP or providing appropriate conditions for healing the periapical tissues. This can be achieved by eliminating infection and preventing further recontamination of the root canal system [4, 5, 9].

High prevalence of chronic AP is considered an important public health problem in many countries. As a result, several epidemiologic studies have been conducted to determine the prevalence of AP and its associated factors [10-13]. The existing data on the prevalence of AP in different countries indicate differing figures. Although the success rate of root canal treatment in AP is relatively high, the importance of the subject becomes obvious when failure rate is considered. For instance, if every individual has 2 treated root canals, there will be 25 million and 420 million root canals treated in Australia and the United States, respectively. If we assume that 13% of these treatments fail, there will be 3.3 million and 54 million failed root canal

treatments in Australia and the United States, respectively. When the cost of retreatment, placement of crown, and replacement of the restoration is considered, the economic burden of the associated problems will increase [14].

To the best of our knowledge in the present literature, there is no systematic review and meta-analysis to evaluate the prevalence of AP in different communities. Therefore, the aim of the present study was to perform a meta-analysis on the prevalence of AP in different communities to obtain an accurate data on its prevalence in the world. This can be a baseline for future healthcare policies regarding successful endodontic treatments.

Materials and Methods

Protocol and registration

This systematic review was registered (#94529) in the Vice Chancellery for Research and Technology, Kermanshah University of Medical Sciences, Kermanshah, Iran.

Study design

A meta-analysis of human studies was carried out to assess the prevalence of AP in different communities based on the number of individuals, teeth and root-filled teeth.

Eligibility criteria

Inclusion criteria: We included all cross-sectional research articles in English on the prevalence of AP in adult subjects.

Exclusion criteria: Studies without radiographic evaluation of periapical radiolucency or no noting the prevalence of root canal treatment, insufficient statistical data for inclusion in a meta-analysis and studies which measured the prevalence of AP in patients with systemic diseases were excluded. When there were multiple publications from the same population, only data from the most recent reports were included.

Information sources

Electronic databases of ISI Web of Knowledge, PubMed, Scopus and also ProQuest and Springer were searched for the papers published until 6th October, 2016. The reference lists of the published papers were also searched for the relevant publications.

Search strategy

Appropriate keywords and Medical Subject Heading (MeSH) terms were selected and combined with the use of Boolean operators. EndNote basic software X7 (Thompson Reuters, New York, NY, USA) was used to remove any duplicate articles. The search strategy was adapted for each database with the support of a health sciences librarian. The MeSH terms are as follows:

Periapical: [MeSH Terms]"Periapical Diseases "OR" Periapical Periodontitis "OR [Text Word]" Periapical Diseases" OR Periapical OR "apical periodontitis "OR" periapical periodontitis "OR" apical status" OR "periapical status" OR "Periapical index" OR "apical index" OR "periapical lesions "OR" apical lesions" AND prevalence: [MeSH Terms] prevalence OR epidemiology OR [Text Word]prevalence OR epidemiology ("Periapical Diseases" [MeSH Terms]) OR "Periapical Periodontitis" [MeSH Terms]) OR "Periapical Diseases" [Title/Abstract]) OR Periapical [Title/Abstract]) OR "apical periodontitis" [Title/Abstract]) OR "periapical periodontitis" [Title/Abstract]) OR "apical status" [Title/Abstract]) OR "periapical status" [Title/Abstract]) OR "Periapical index" [Title/Abstract]) OR "apical index" [Title/Abstract]) OR "periapical lesions" [Title/Abstract]) OR "apical lesions"[Title/Abstract])) AND (prevalence [MeSH Terms]) OR epidemiology [MeSH Terms]) OR prevalence [Title/Abstract]) OR epidemiology [Title/Abstract]).

All Searches were performed by two independent teams (A: ZA and SSM; B: SMA and MG) and were merged by a senior team (SKH and AKH).

Study selection

All titles and abstracts of eligible papers were screened. If all the required criteria were met, the articles were selected for data extraction at full-text level. The reference list of the selected articles were also reviewed to find possible eligible articles.

Data items and collection process

The included articles were reviewed and the findings were extracted. The extracted data consisted of the author's first and last name, year of publication, country of studied population, study design, sample size and demographic characteristics of the study population.

Data analysis

The Metaprop meta-analysis was done using the software R version 3.3.0 with Meta package. The Logit transformation method and random-effects model were used to calculate the pooled prevalence. The weight of each study was calculated using Inverse variance. The Clopper-Pearson method was used to calculate 95% confidence intervals. Homogeneity was tested by the Q-test (P<0.1 represented statistical significance), I^2 statistics (25%, 50% and 75% represented low, medium and high heterogeneity, respectively) and 2τ (2τ was calculated by DerSimonian-Laird estimator method). The pooled prevalence of AP in the individuals and in the teeth as well as the prevalence of the root-filled teeth was calculated in the individuals according to the countries.

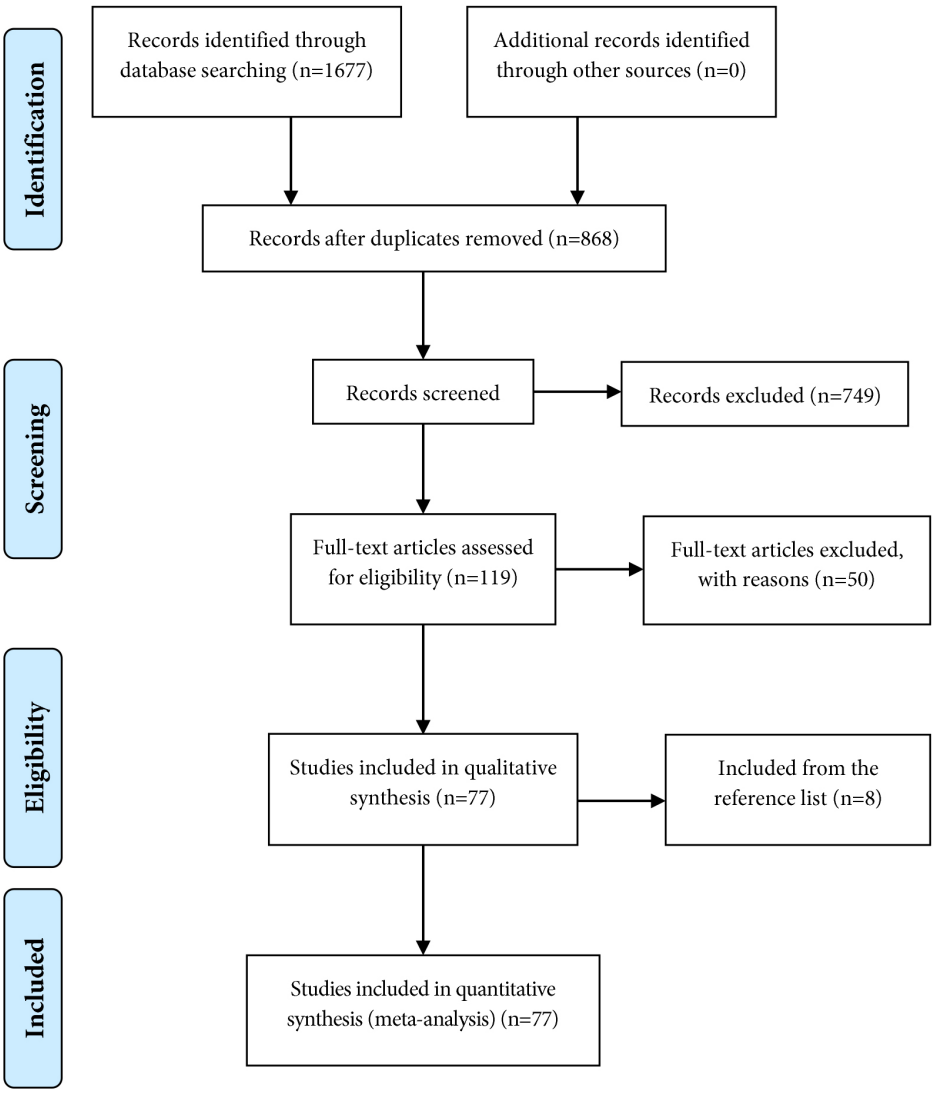

Figure 1. Study flow chart

Results

Study selection

The results of searches yielded 1677 studies. By screening the titles and abstracts, 119 studies were selected. After reading the full text, 50 studies were excluded (Figure 1 and Table 1). Referring to the reference list of articles, 8 other studies were added to the present study. Eventually, 77 studies were identified to qualify for inclusion into this meta-analysis.

AP prevalence based on the number of individuals

The prevalence of AP in individuals varied widely, from 1% in the study by Weiger *et al.* [15] to 86% in the study by Georgopoulou *et al.* [16]. The pooled prevalence of AP was 0.519 (38 studies with 16,404 participants; 95% CI (0.4531, 0.5842); I^2:98.3%; *Q*-test *P*<0.001). The pooled estimate for Belgium was 0.6007 (2 studies with 837 participants; 95% CI (0.5640, 0.6364); I^2:10.3%). The pooled estimate for Brazil was 0.5441 (3 studies with 512 participants; 95% CI (0.4044, 0.6772); I^2:89.5%). The pooled estimate for Nigeria was 0.7055 (2 studies with 1,041 participants; 95% CI (0.6303, 0.7710); I^2:80%). The pooled estimate for Norway was 0.2976 (2 studies with 252 participants; 95% CI (0.2444, 0.3570); I^2:0%). The pooled estimate for Scotland was 0.4017 (2 studies with 585 participants; 95% CI (0.3627, 0.4420); I^2:0%). The pooled estimate for Spain was 0.4723 (2 studies with 577 participants; 95% CI (0.2308, 0.7274); I^2:97.2%). The pooled estimate for Sweden was 0.5960 (6 studies with 2,190 participants; 95% CI (0.4628, 0.7165); I^2:97.1%). The pooled estimate for Turkey was 0.4365 (4 studies with 3,325 participants; 95% CI (0.2271, 0.6713); I^2:99.4%).

AP prevalence based on the number of teeth

The prevalence of AP in the teeth varied, from 1.2% in the study by Ureyen Kaya *et al.* [17] to 21% in the study by Soikkonen [18]. The pooled prevalence of AP was 0.0498 (56 studies with 566,602 teeth; 95% CI (0.0423, 0.0586); I^2: 99.6%; Q-test $P<0.001$). The pooled estimate for Belgium was 0.0617 (2 studies with 15,734 teeth; 95% CI (0.0557, 0.0684); I^2:59.9%). The pooled estimate for Brazil was 0.0667 (4 studies with 36,827 teeth; 95% CI (0.0447, 0.0984); I^2:98.3%). The pooled estimate for Netherlands was 0.0342 (2 studies with 8,790 teeth; 95% CI (0.0196, 0.0588); I^2:95.8%). The pooled estimate for Nigeria was 0.1027 (2 studies with 29,562 teeth; 95% CI (0.0513, 0.1950); I^2:99.6%). The pooled estimate for Norway was 0.0196 (3 studies with 9,838 teeth; 95% CI (0.0102, 0.0374); I^2:95.3%). The pooled estimate for Portugal was 0.0295 (2 studies with 8,650 teeth; 95% CI (0.0132, 0.0645); I^2:97.5%). The pooled estimate for Spain was 0.0339 (2 studies with 13,843 teeth; 95% CI (0.0225, 0.0508); I^2:94.8%). The pooled estimate for Sweden was 0.0559 (6 studies with 47,961 teeth; 95% CI (0.0365, 0.0848); I^2:99.1%). The pooled estimate for Turkey was 0.0219 (6 studies with 121,678 teeth; 95% CI (0.0119, 0.0398); I^2:99.6%). The pooled estimate for the USA was 0.0455 (2 studies with 8,805 teeth; 95% CI (0.0362, 0.0571); I^2:82%).

AP prevalence based on the number of root-filled teeth

The AP prevalence in the root-filled teeth varied from 5% in the study by Boltacz-Rzepkowska *et al.* [19] to 74% in the study by Gencoglu *et al.* [20]. The pooled prevalence of AP was 0.3828 (73 studies with 59,051 root filled teeth; 95% CI (0.3502, 0.4164); I^2: 98.4%; Q-test $P<0.001$). The pooled estimate for Belgium was 0.3816 (4 studies with 2,686 root filled teeth; 95% CI (0.3172, 0.4504); I^2:90.8%). The pooled estimate for Brazil was 0.3816 (4 studies with 2,848 root filled teeth; 95% CI (0.2090, 0.5903); I^2:98.8%). The pooled estimate for France was 0.3150 (3 studies with 3,490 root filled teeth; 95% CI (0.2965, 0.3340); I^2:32%). The pooled estimate for Italy was 0.2776 (2 studies with 1,610 root filled teeth; 95% CI (0.1019, 0.5655); I^2:98.9%). The pooled estimate for Lithuania was 0.3927 (2 studies with 603 root filled teeth; 95% CI (0.3222, 0.4681); I^2:71.6%). The pooled estimate for Netherlands was 0.3086 (2 studies with 321 root filled teeth; 95% CI (0.1826, 0.4714); I^2:96.5%). The pooled estimate for Nigeria was 0.4049 (2 studies with 2,912 root filled teeth; 95% CI (0.3872, 0.4228); I^2:0%). The pooled estimate for Norway was 0.2731 (3 studies with 409 root filled teeth; 95% CI (0.1865, 0.3812); I^2:79.2%). The pooled estimate for Saudi Arabia was 0.4636 (2 studies with 1,321 root filled teeth; 95% CI (0.2484, 0.6934); I^2:98.2%). The pooled estimate for Scotland was 0.5317 (2 studies with 643 root filled teeth; 95% CI (0.4272, 0.6335); I^2:82.6%). The pooled estimate for Spain was 0.5002 (3 studies with 790 root filled teeth; 95% CI (0.2067, 0.7936); I^2:97.9%). The pooled estimate for Sweden was 0.3032 (6 studies with 5,903 root filled teeth; 95% CI (0.2599, 0.3503); I^2:91.3%). The pooled estimate for Turkey was 0.4015 (12 studies with 10,995 root filled teeth; 95% CI (0.2898, 0.5245); I^2:99.3%). The pooled estimate for the USA was 0.3286 (2 studies with 460 root filled teeth; 95% CI (0.2871, 0.3729); I^2:0%).

Table 1. Overview of the studies and reason for rejection that after full-text reading

Author(s)	Reason for rejection
Aleksejuniene *et al.*, Kirkevang and Wenzel, Kirkevang *et al.*, Segura-Egea *et al.* [11, 21-23]	Duplicate
Craveiro *et al.*, Eckerbom *et al.*, Eckerbom *et al.*, Frisk and Hakeberg, Kirkevang *et al.*, Kirkevang *et al.*, Petersson *et al.*, Sánchez-Domínguez *et al.*, Tolias *et al.* [24-32]	Cohort studies
Segura-Egea *et al.*, Sopiñska and Boltacz-Rzepkowska [33, 34]	Literature reviews
da Silva *et al.*, Hamedy *et al.*, Pak *et al.*, Rutz da Silva *et al.*, Rutz da Silva *et al.* [35-39]	Systematic reviews
Cakici *et al.*, Covello *et al.*, Ertas *et al.*, Estrela *et al.*, Frisk *et al.*, Georgopoulou *et al.*, Goldstein *et al.*, Huumonen *et al.*, Jansson, Kirkevang *et al.*, López-López *et al.*, Patel *et al.*, Peršić Bukmir *et al.*, Persic *et al.*, Siqueira Jr *et al.* [40-54]	No outcome measurements of interest
Britto *et al.*, Castellanos-Cosano *et al.*, Castellanos-Cosano *et al.*, Correia-Sousa *et al.*, Costa *et al.*, Falk *et al.*, Gronkjaer *et al.*, Hommez *et al.*, López-López *et al.*, Marotta *et al.*, Mendiburu Zavala *et al.*, Sánchez-Domínguez *et al.*, Segura-Egea *et al.*, Segura-Egea *et al.*, Segura-Egea *et al.* [31, 55-68]	Have been done on patients with systemic diseases

Discussion

This meta-analysis was performed on 77 articles regarding the prevalence of AP based on the number of individuals, teeth and root-filled teeth with the pooled prevalence of 0.519, 0.0498 and 0.3828, respectively.

It should be noted that the year of publication of the article and the method used for detection of AP are some factors affecting the prevalence of AP. With the passage of time from 1990 to 2014, the educational index, health index, human development index, and gross national income index have improved in different regions of the world. These factors influence the prevalence of dental caries and associated conditions [69]. In the present study, the lowest and highest prevalence of AP post-treatment were in Poland and Germany, respectively. Also, the pooled prevalence of AP in endodontically treated teeth was 0.3828. It should be noted that besides the human development factors such as health outcomes, education achievements, national income, composition of resources, and environmental sustainability, which vary in different geographic regions, the sample size, year of publication and AP detection method in the studies may alter, which can influence the prevalence of AP [69].

In populations in which an efficient referral system exists (both in healthcare system and community culture), diagnosis of AP is improved. This may also attribute to higher prevalence of AP in the developed countries. However, many cases of AP may remain undiagnosed in underdeveloped or developing countries. Probably, the success rate of endodontic treatments will improve as the therapeutic procedures are developed over time. Therefore, the approach the clinicians adopt towards novel treatment techniques can be an influential factor in the prevalence of AP. In summary, improvement of diagnostic methods leads to higher prevalence of AP, while improvement of therapeutic techniques results in lower prevalence of AP.

Untreated caries is an important public health issue in most countries around the world. In 2010, nearly 2.4 billion people had untreated caries in permanent teeth, making it the most prevalent condition. Also reports show that 27 new cases of tooth decay in permanent teeth will arise annually from the follow-up of 100 people. According to the WHO, tooth decay is the fourth-most expensive chronic disease to treat. Furthermore, consequences of untreated caries can be serious. The prevalence and incidence of untreated caries have remained unchanged all over the world from 1990 to 2010. However, the burden of untreated caries is not evenly distributed across the globe as there are notable differences in the prevalence and incidence of caries among different regions and countries. Since the population and life expectancy are increasing and the prevalence of tooth loss has significantly decreased from 1990 to 2010 [70], the policy makers must be aware of the predictable burden of untreated caries. AP is one of the challenging consequences of untreated caries which can be influential in the prognosis of the tooth and any treatment performed on the tooth.

The main etiological factor of AP is exposure of dental pulp to the oral cavity due to caries. Moreover, AP can arise from any other factors that lead to contamination of the dental pulp to bacterial infection. Trauma can cause dental fractures and cracks, which may eventually lead to necrosis of the pulp. AP is the result of dynamic interaction between bacterial factors and host immune system in the periapical region, which forms various histopathological categories of AP, which is named periapical lesions. Treatment of AP consists of elimination or considerable reduction of the bacterial load from the root canal system and prevention of further contamination. Practitioners must have a clear understanding of the etiologic factors involved in pulpal and periapical diseases to enhance the success rate of treatment. The treatment has a notable high success rate. However, several factors may lead to failure of endodontic treatments [71].

Chronic AP is usually found in routine radiographic examinations due to its chronic characteristics and faint clinical signs and symptoms. These examinations include conventional plain film radiography, digital radiography, and cone-beam computed tomography (CBCT) [72]. Studies have proven that CBCT is superior to other radiographic modalities in detection of AP [73]. As a result, the prevalence of AP has been higher in recent studies in the developed countries where CBCT is used as the diagnostic radiographic modality. It has been shown that the prevalence of AP is higher when CBCT is recruited compared to periapical and panoramic radiographs. CBCT provides images without superimposition and allows better detection of lesions. Moreover, compared to computed tomography (CT), CBCT possesses increased accuracy, higher resolution, lower scan time, reduced radiation dose, and lower cost for the patient [74]. Also, periapical radiographs are more accurate for detection of AP than panoramic images, especially in the anterior region of jaws [75].

The major challenge in the present analysis was lack of data in certain areas of the globe and quality of published and unpublished data. They were not fully representative of the national, sub national and international populations, so community populations were included to address this challenge or to improve the modeling of data. The methods recruited for detection of AP were different in the studies in which this would results high level of heterogeneity.

One of the limitations was inability to assess whether post-treatment AP is the result of endodontic failures or poor restoration of the treated teeth.

Conclusion

The findings of this analysis and similar analytical studies on other aspects of dental diseases can be helpful for policy makers to monitor and compare disease and treatment need among other communities and look for the strengths and drawbacks of their oral and dental health program.

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Conflict of Interest: 'None declared'.

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