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Impact of waterpipe smoking on oral health of users: a systematic review and meta-analysis

Wpływ palenia fajki wodnej na zdrowie jamy ustnej: przegląd systematyczny i meta-analiza

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smoking water pipes, periodontitis, dental plaque, oral health, tobacco use, systematic review, meta-analysis

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Streszczenie

Aim of the study. *The world sees a rising consumption of waterpipe. The present systematic review aims to assess clinical and radiographic manifestations of oral illnesses, dental, periodontal, or soft tissue disorders related to waterpipe use.*

Methods. *The authors searched MEDLINE, Cochrane Library, and LILACS for oral health manifestations due to waterpipe consumption. PRISMA guidelines were adopted for the current systematic review. Meta-analysis performed with Review Manager 5.4 assessing risk of bias across included studies.*

Results. *Nine studies assessing oral impact of waterpipe were included. Majority of articles are from a Middle Eastern population where the waterpipe use is more common than other parts of the world. Studies have assessed some oral health issues such as gingival inflammation, bleeding on probing, clinical attachment, probing pocket depth, bone height and tooth mobility.*

Summary

Cel pracy. *Obserwuje się ogólnoświatowy wzrost stosowania fajek wodnych. Prezentowany przegląd ma na celu ocenę klinicznych i radiologicznych objawów chorób jamy ustnej: zębów, przyzębia i tkanek miękkich, będących konsekwencją użytkowania wspomnianych fajek.*

Metody. *Autorzy przeszukali następujące bazy: MEDLINE, Cochrane Library i LILACS pod kątem informacji na temat objawów w jamie ustnej, pojawiających się wskutek stosowania fajek wodnych. Zastosowano wytyczne PRISMA do przeprowadzenia systematycznego przeglądu. Meta-analizę przeprowadzono przy pomocy Review Manager 5.4, oceniając ryzyko stronniczości w wybranych pracach.*

Wyniki. *Uwzględniono dziewięć prac oceniających wpływ fajek wodnych na zdrowie jamy ustnej. Większość prac dotyczy społeczności z Bliskiego Wschodu, gdzie popularność fajek wodnych jest najwyższa. Badania skupiały się*

Conclusion. *Contrary to popular belief, waterpipe use is not safer than cigarette smoking. Both are detrimental to dental and periodontal health.*

Wniosek. *Wbrew powszechnym opiniom, palenie fajki wodnej nie jest bezpieczniejsze od palenia papierosów. Obydwie czynności niosą ryzyko dla zdrowia zębów i przyzębia.*

Introduction

"Waterpipe tobacco smoking involves the use of a multi-stemmed instrument containing water at its base through which tobacco smoke, often fruit-flavoured, passes before inhalation".[1] A modern waterpipe comprises six parts: the head, the body, the bowl, the hose, the vase, and the mouthpiece.[2] The smoking mixture is placed in the head.[2]

People started using this form of tobacco around seven centuries ago. The most ancient traces were found in the Lalibela cave in Ethiopia. Radiocarbon dating situated their use around years 1320±80.[3] Despite this long history of waterpipe, cigarettes remain the most consumed form of tobacco. However, in recent years, there has been an increasing trend in waterpipe use in several regions such as Latin America.[4] A study conducted in Brazil involving 16273 participants aged 12 to 16 years showed that the overall proportion of waterpipe use in the past 12 months was 1.65%.[5] This rate is increasing specifically among young people.[5]

Different synonyms are used to refer to waterpipe such as "Arghile", "Chicha", "Hookah", "Hubble-bubble", "Narghile".[2] The preference of one term or the other depends on the region and the country.[2] A Pubmed search assigned at least 32 names of waterpipe in the English literature.[6] "Waterpipe" is the word most commonly used in scientific publications.[7]

For decades, public opinion has underestimated the damaging effects of this form of tobacco use.[4] Waterpipe is implicated in many pathologies, including respiratory diseases (COPD, bronchitis, and wheezes due to exposure to passive waterpipe smoking), low birth weight, metabolic syndrome, cardiovascular disease, and mental health.[8] An association between waterpipe use and malignancies (oral and lung cancers) has also been suggested.[8] It has been proven that waterpipe smoke is rich in hundreds of substances potentially hazardous to health, including nicotine, carbon monoxide, carcinogenic polycyclic aromatic hydrocarbons, aromatic amines, aldehydes, furanic and phenolic compounds, tar, particulate matter, heavy metals, and ammonia.[2]

Several articles were published concerning the oral health effects of waterpipe.[9] They showed that this form of tobacco smoking is burdened with a high risk of harmful effects impacting both the periodontium and the oral mucosa, and even peri-implant health.[10] However, these studies present conflicting results.[9] Therefore, the aim of this paper is to systematically analyse the scientific literature regarding the effects of waterpipe tobacco smoking on oral health. This systematic review is referenced to PICOS guide: waterpipe users (P); oral health (I); cigarette smokers and non-smokers (C); bone loss, pocket depth, plaque index, MLFT index (O); qualitative and quantitative method (S).

Materials and methods

Study design

This is a Systematic Review and Meta-Analysis lead according to the recommendations from the Cochrane Group[11] and the book "Systematic reviews in health care: meta-analysis in context".[12] A search protocol was specified in advance and registered at PROSPERO (International Prospective Register of Systematic Reviews) CRD42021239383. This review was conducted according to PRISMA guidelines.[13]

Focused question

We intended to answer the following focused question: is waterpipe a safe addiction that would not have any damaging effects on oral health due to tobacco filtering through water?

Eligibility criteria

Clinical and radiographic original studies were considered in this systematic review. No language or year of publication restriction was applied. Records that fulfilled the following items were considered: a) inclusion of waterpipe habitual smokers; b) any alteration in oral, soft tissues, periodontal and dental health. Records including results about cytotoxicity, histopathological outcomes, and genetic modifications only were not considered. Patients' gender and age range were not exclusion criteria.

Studies that met the inclusion criteria or those with doubtful information either in the title or the abstract were selected for full-text assessment in this review's second round. Reasons for rejection of studies were recorded for each report. According to our protocol, studies related to other anatomic sites excluding oral cavity, implant, and peri-implant health were excluded.

Animal studies and comparative studies but with no conclusion specific to waterpipe were excluded, and so were the comments, letters, expert opinions, and reviews. Comparative studies were included when comparing a control group (non-smokers) or cigarette smokers with waterpipe users.

Search strategy

The first hit was conducted online by two independent reviewers (RG and YSS) in MEDLINE (via PubMed), Cochrane Library, and LILACS from inception until November 30th of 2021. A gray literature search was not performed. The following strategy was used: ((((hookah) OR (shisha) OR (waterpipe) OR (water pipe) OR (narghile)))) AND (((oral) OR (oral health) OR (dental) OR (buccal))) NOT ((((systematic review) OR (literature review)) OR (case report))).

Risk of bias across studies

To assess the studies' quality, the risk of bias was assessed according to the Cochrane handbook of systematic reviews of interventions. The results were used in Review Manager Software 5.4 (Review Manager (RevMan) [Computer program]. Version 5.4. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014). The queries of the included studies are briefly explained as follows:

a. Random sequence generation (selection bias);

b. Allocation concealment (selection bias);

c. Blinding of participants and researchers (performance bias);

d. Blinding of outcome assessment (detection bias);

e. Incomplete outcome data (attrition bias);

f. Selective reporting (reporting bias);

g. Other bias.

Data collection process

The reviewers RG and YSS separately submitted all eligible studies to a qualitative

synthesis using an extraction data form, including: PERIODONTAL health; a) gingival inflammation, b) bleeding on probing, c) probing pocket depth, radiographic (marginal bone loss), d) clinical attachment loss; DENTAL and ORAL health: a) missing teeth, b) plaque index, c) teeth mobility, d) decayed, missing or filled teeth (DMFT index), e) soft-tissue appearance. No restriction was applied concerning method of periodontal, dental or oral analysis.

Subsequently, all extraction data forms with each included study's results were verified together to calibrate this process's validity and reliability. The data were analyzed with Microsoft Excel and Review Manager 5.4. Statistical tests were performed and a 95% confidence interval was considered significant.

Results

The first hit retrieved 210 records from databases. The searched records distribution and the number of studies finally selected are shown in the flow diagram (Figure 1). Excluded studies and reasons for refusal are shown in Table 1. Records that remained from the first hit were independently selected by reading their titles and abstracts (first round). Disagreements in this selection were resolved by mutual discussion. Afterwards, all records screened from the first round had their full-text independently assessed for the same reviewers' eligibility.

All included articles were prospective comparative studies, between waterpipe smokers (WS) and cigarette smokers (CS). Seven studies also compared WS and non-smokers.[14-20] Three studies evaluated adult patients from 17- [14] or 18-[15,19] to 60-years-old, while six studies restricted the age range to reduce the risk of age interference on results.[16-18,20-22] Seven articles rated the Middle Eastern population[14-20] and two articles North African participants.[21,22]

The oldest study included in this systematic review[14] is from Sweden. It was based on a sample of 355 individuals from Jeddah, Saudi Arabia, aged from 17 to 60 years. The study

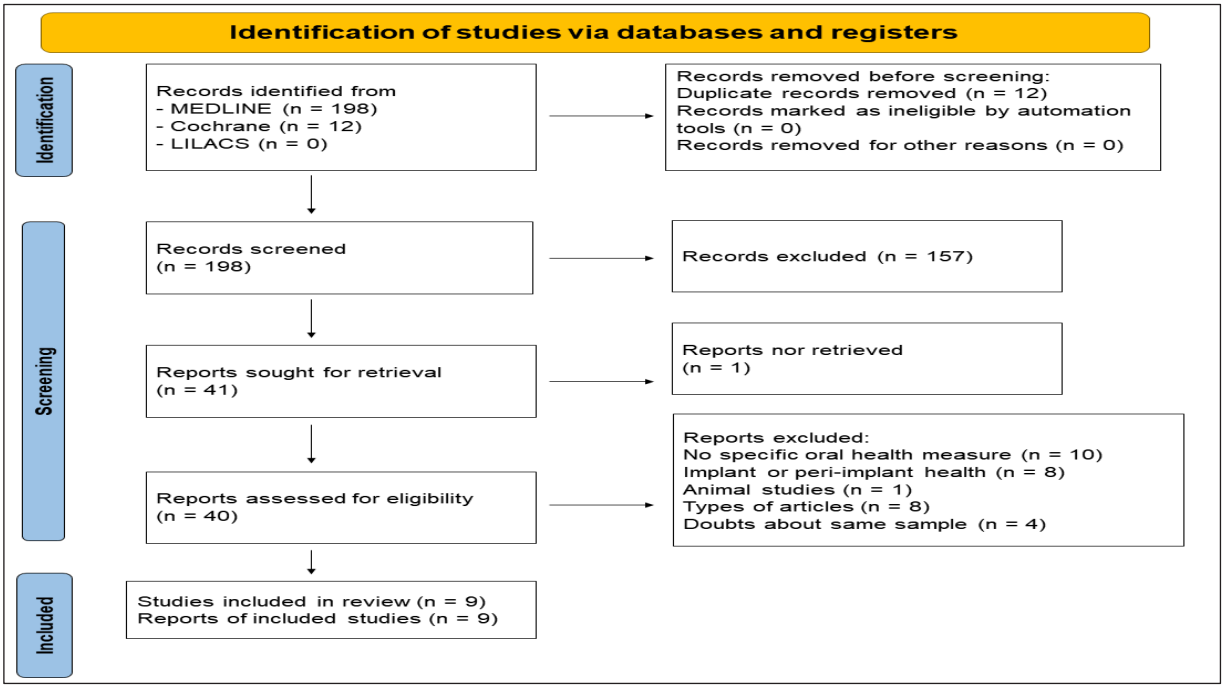

Fig. 1. Flowchart of included articles.

Table 1. Articles excluded and reasons for their exclusion

Reason	Authors (in alphabetic order)
No specification of oral health measurement	Al-Amad et al., 2014[24]; Alharbi, Quadri, 2018[25]; Ali, 2006[26]; Amer et al., 2019[27]; Al-Naggar, Bobryshev, 2012[28]; Dangi et al., 2012[29]; Jawad et al., 2016[30]; Kakodkar et al., 2013[31]; Miri-Moghaddam et al., 2019[32]; Taghibakhsh et al., 2019[33]
Related to implant survival or peri-implant health	Abduljabbar et al., 2017[34]; Alahmari et al., 2019[35]; Al-Hamoudi et al., 2021[36]; AlHarthi et al., 2018[37]; AlQahtani et al., 2018[38]; Alqahtani et al., 2019[39]; Al-Sowygh et al., 2018[40]; BinShabaib et al., 2018[41]
Study with no human participation	Saito et al., 2012[42]
Comments, letter to editor, expert opinions and reviews	Alves et al., 2021 [43]; Chaouachi, 2007[44]; Dar, 2015[45]; Khemiss, Saad, 2016[46]; Patil et al., 2019[47]; Rastam et al, 2010[48]; Warnakulasuriya, 2011[49]; Yakin et al., 2017[50]
The same authors, setting and period of the study has been published in another paper	Natto et al., 2004[51]; Natto et al., 2005b[52]; Natto, 2005[53]; Natto et al., 2005c[54]
Article not found	Al-Attas et al., 2014[55]

suggested that vertical periodontal bone loss is higher in tobacco smokers. The authors concluded that waterpipe use is as prejudicial as cigarette smoking.

Another multicenter study from the United States and Saudi Arabia[16] compared periodontal status (clinically and radiologically) of waterpipe and cigarette smokers. It was concluded that both the periodontal and dental status of the two groups was altered. The authors compared plaque index, bleeding on probing, probing depth, clinical attachment loss, marginal bone, and missing teeth factors. All of these conditions were similar in waterpipe and cigarette smokers.

In 2015, a study from Jordan[15] evaluated periodontal health in 190 individuals, comparing non-smokers with waterpipe, cigarette, and dual smokers (both waterpipe and cigarette). Plaque index, gingival index, calculus index, probing pocket depth, clinical attachment loss, and bleeding on probing factors were evaluated. Contrary to what most people believe, waterpipe use is not safer than cigarettes when periodontal health is considered. A Yemeni study[20] assessed periodontal health of 150 patients and implicated cigarette and waterpipe use as harmful to periodontal tissues.

One study from Tunisia conducted in 2016[21] compared periodontal bone height of exclusive waterpipe and cigarette smokers with regard to the number of retained teeth, plaque index, and periodontal bone height. It was concluded that both groups had the same periodontal bone loss. From the same study center,[22] in 2019 another study compared the periodontal status only of exclusive waterpipe male users with exclusive cigarette smokers. The authors compared probing pocket depth, plaque index, the number of retained teeth, gingival index, and periodontal disease factors in males aged 20-40 years. Chronic exclusive waterpipe smokers had fewer periodontal health adverse effects than exclusive cigarette smokers.

In 2018, another multicenter study (Saudi Arabia, USA, Germany)[17] compared plaque

index, bleeding on probing, probing pocket depth, and clinical attachment loss, besides radiographic marginal bone loss as related to the subject matter. The authors also compared salivary cotinine and interleukin levels in waterpipe, cigarette, and E-cig users. Oral and periodontal health was similar between E-cig smokers and non-smokers. Waterpipe and cigarette smokers' clinical and radiographic conditions were similar, and worse than E-cig and non-smoker groups.

One Iranian study from 2021[18] evaluated 10,000 participants in a cohort study, assessing the prevalence of denture stomatitis related to cigarette, waterpipe and opium consumptions. This is the only article included that compared waterpipe users with opium users. Waterpipe was related to an increase of denture stomatitis with a dose-response relation. The same relation was not found on opium consumption. Another recent study from 2021[19] assessed oral microbiome of different types of tobacco consumption, including cigarette and waterpipe in different forms. No specific microbiota was related to one or other kind of tobacco consumption. The authors concluded that both cigarettes and waterpipes are harmful to periodontal health.

A meta-analysis was performed and the risk of bias across studies performed through RevMan 5.4 is expressed in Figures 2 and 3. No additional analyses were pre-specified and made.

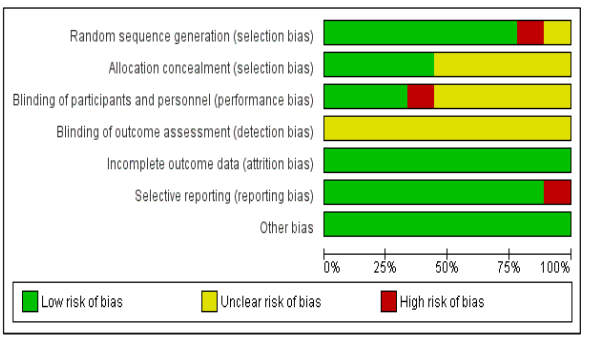

Fig. 2. Risk of bias graphic.

Discussion

The majority of included studies only evaluated male waterpipe users mainly due to a very high prevalence of men in this addiction; about 70% to 80% of waterpipe users are male.[14,15,19,20,22] Some studies have not used gender information as an exclusion criteria, but regardless, there were no female waterpipe users.[16,17] Because of this discrepancy, female inclusion in this kind of study could influence the interpretation of results.[21] The majority of studies have used a broad age range. This parameter is essential due to the higher incidence of periodontitis in older individuals and limiting this age range could lead to a scientific error. The study assessing denture prosthesis in its participants[18] reported a mild prevalence of men who were older than participants in other studies.

All the included studies have randomized samples (convenience sampling), collected

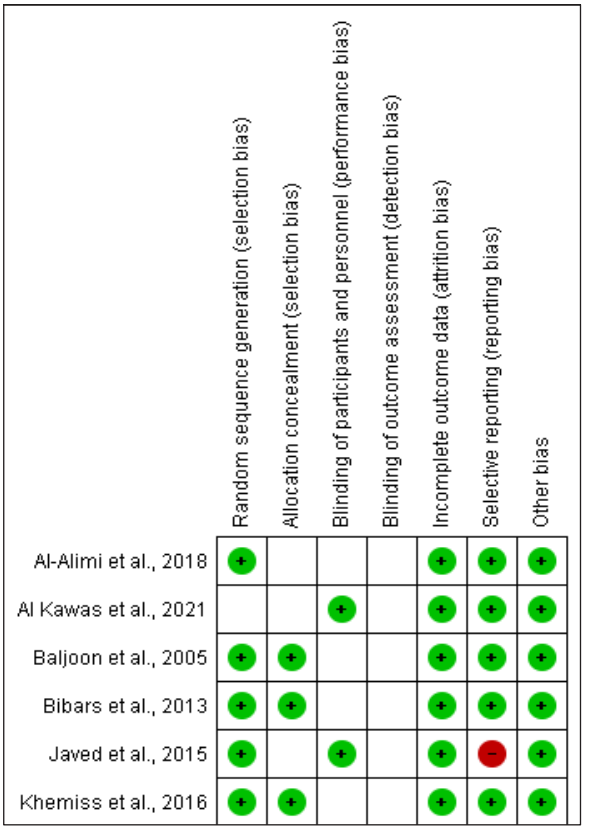

Fig. 3. Risk of bias summary.

through flyers distributed in city cafés, which waterpipe users usually attend,[15,21,22]; they were randomly approached and invited to participate[16-20], or invited through journals.[14] This kind of sample recruiting generates a low risk of selection bias.

Studies have evaluated the effect of waterpipe addiction comparing cigarette smokers,[14-22] non-smokers,[14-17,19] E-cig smokers,[17] and opium smokers.[18]

Clinical evaluation

Although the same clinical tests were applied, there is no standardization in how to present the results. This makes it impossible to create a table elucidating all data. Plaque indices were higher in waterpipe users than in cigarette smokers and significantly higher among non-smokers.[15–17,20–22] Plaque index in waterpipe users can achieve a ratio twice as high as in non-smokers[15-17,20] since the researchers use different counting methods and present available data about plaque index by creating any table or graphic form to adequately visualize information.

The rate of missing teeth is higher in waterpipe users and cigarette smokers than in a non-smoker group.[16] It is equivalent in waterpipe and cigarette smokers.[16,20,22] Only one study[21] found equivalent values for all the groups, but this can be explained by the limitation of mean age, excluding older individuals from the evaluation. Also, just one single study[15] used missing teeth as an adjustment measure to periodontal health, but no information about quantity was available. One study has implicated soft tissue damage, including only full prosthesis users and waterpipe consumers.[18]

Pockets on probing were deeper in cigarette smokers than in waterpipe users,[15,17,21] and significantly more profound than in non-smokers[15-17,20] and even in E-cig smokers.[17] According to one paper,[16] pocket depth was slightly higher in cigarette smokers than in waterpipe users. Bleeding on probing was similar to both groups,[16,21] even more prominent in non-smokers.[16,17] One study[15] found higher levels of bleeding on probing in waterpipe users. Probing pocket depth is one of the most evident oral issues among waterpipe users and non-smokers, with a pocket depth being about three[17] to about six[16] times more profound. A slight difference on oral microbiota was found but no specific damage to periodontal tissues was reported.[19] In this article, the authors concluded that cigarettes as well as waterpipes have detrimental effects on periodontal tissues. The study showed differences between groups in a graphic form, but this type of information cannot be presented graphically because there is visual information but no data description.[17]

Only one article has evaluated tooth mobility with a similarity between waterpipe and cigarette groups.[21] No tooth mobility evaluation comparing waterpipe users and non-smokers was found.

Radiographic evaluation

One crucial indication of periodontitis is the width of crestal bone, and this can be measured through intra-oral radiographs. Bone loss in smokers is more than two times more profound than in non-smokers[14,16,17] and similar between waterpipe and cigarette groups.[14,16,17,21]

Periodontal health can be evaluated by checking on gingival inflammation, bleeding on probing, clinical attachment, probing pocket depth, bone height and tooth mobility. Articles that concern periodontal health in waterpipe users are scarce, and no article based its evaluation on all of these periodontal factors. There was no evidence showing which group is more affected by periodontal disease: waterpipe or cigarette users. However, all of the studies are clear in affirming that both groups are more prone to detrimental influences than non-smokers.[14-20]

Quantitative synthesis

In studies that compared waterpipe users with non-smokers, Odds Ratio calculation (OR) returned a value of 4.81. The 95% confidence interval ($p<0.05$) used to estimate the precision of OR returned a value of 0.27, indicating a high accuracy of Odds Ratio.[23] It is possible to conclude that waterpipe users have 4.81 higher chance to suffer from periodontal disease than non-smokers.

The same statistic measure was applied to dental health with an Odds Ratio of 3.49 with a confidence interval of 0.019 ($p<0.05$). Waterpipe users have 3.49 higher chance to suffer from dental disease than non-smokers.

One limitation of the present study is the number of articles included. Further studies with higher amount of data are needed to draw stronger conclusions. The authors believe, however, that inclusion of more articles would not change the conclusion.

Conclusion

Waterpipe smoking is at least as harmful as cigarette smoking. Both are detrimental to oral health, not only dental but mainly periodontal health when compared to non-smokers. Despite some methodological limitations of included articles, we can conclude that contrary to popular belief waterpipe is not safer than a cigarette. All included studies in this systematic review are categorical in affirming this.

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