

LETTER TO THE EDITOR

Critical analysis of the published literature about the effects of narghile use on oral health

During the last decades, there has been an increased trend in narghile use globally (1, 2). It has been considered as a global threat and given the status of an epidemic by public health officials (3).

Several reviews were written concerning the health effects of narghile use, especially cardiorespiratory (2–7). As dentists are almost certain to encounter narghile smokers (NS) amongst their patients, it is important to inform the dental team of the significantly detrimental impacts of narghile use on oral health. However, to the best of the authors' knowledge, no review has raised its oral health effects. Nevertheless, data regarding its effects on oral health are few. We searched MEDLINE and SCOPUS on June 30, 2015, using the combination of the following keywords: ('narghile' or its different synonyms) and ('oral lesions' or 'oral cancer' or 'dry socket' or 'periodontium'). Only 16 studies (8–23) were found. The studies of Ashril and Al-Sulamani (22) and Natto (23) were not retained since their full texts were not retrieved. Direct contact with authors (mail or postal addresses) failed to obtain a copy of their manuscripts. When looking into the abstract of Natto study (23), having the same title as a previous one by the same team (18), it seems like a synthesis of their previous studies (17–20). Therefore, only 14 studies were retained (8–21). Tables 1 and 2 display their designs and main results. There is a high risk that narghile use may have harmful effects on oral cavity. However, several methodological limitations were noted in the 14 retained studies.

The first limitation concerns the 'narghile' synonyms. Narghile is the generic name for any method of tobacco use featuring the passage of smoke through water before being inhaled (2, 6). In the literature, the name of this mode of smoking depends on the country of origin and includes several terms: goza, shisha, water pipe, water-pipe, waterpipe, hubble-bubble, mada'a, moassel, narghile, and hookah (Tables 1 and 2). One error, of a methodological nature, is to group under one universal entity ('waterpipe', particularly in one word) different types of pipes which are actually used with different smoking products in different contexts (24). This error is not only a scientific reductionism but also a nominalism that has fuelled world confusion (2, 6). Two examples of such confusion were highlighted by Chaouachi (25, 26).

The second limitation concerns the study sample sizes. The number of NS included in the retained studies varied from 3 (8) to 228 (13) subjects, and only one study (13) has

calculated the required sample size. The calculation of the sample size is a statistically central point since determining its finest size for a study guarantees enough power to distinguish statistical significance and is a serious step in the design of a planned research procedure (27). In the future and accordingly, similar studies should comprise a suitable calculated sample size (27).

The third limitation concerns the applied medical questionnaires. Five studies (16–20) applied standardized questionnaires, however, without citing any reference. Six others (9, 11–14, 21) applied non-standardized questionnaires and three (8, 10, 15) did not mention how patients' information was selected. It is interesting to note that there is a pressing need to standardize items in epidemiological questionnaires used in studies addressing the narghile use (28).

The fourth limitation concerns the applied inclusion and non-inclusion criteria. Four remarks concerning this issue should be raised. 1) Only nine studies (9, 14–21) included exclusive-NS (ENS). In the case-series study (8), there were two ENS and one mixed smoker (MS, cigarette and narghile). Only one study (14) has excluded passive smokers. Ignoring the profile of volunteers participating in the trial (often ex-cigarette smokers [CS] who start narghile use) is a methodological mistake (29). For that reason, only ENS should be evaluated in the NS group (2, 6). 2) The inclusion of elders (16–21) may introduce a bias because the prevalence of periodontal diseases (PD) increases with age (30). 3) One key information that could be addressed as a non-inclusion criterion, particularly in studies performed in Saudi Arabia (16–20), is about chewing stick called 'miswak', which is widely used there (31). It seems that 'miswak use' was at least as successful as tooth brushing in reducing plaque and gingivitis, and that its antimicrobial effect is advantageous for prevention/treatment of PD (32). 4) One major limitation noted in the study of El-Setouhy et al. (11), aiming to investigate the genotoxic effect of narghile smoke on oral mucosa, was the inclusion of a high percentage (53%) of NS reporting exposure to agriculture pesticides, since the last augments the micronuclei frequency in exfoliated oral cells (33).

The fifth limitation concerns the recruitment methods reported only in six studies (16–21). In 12 studies (9, 10, 12–21), subjects were selected by a convenience sample. As in any study using convenience samples for their relative ease of access volunteers, there was a possibility of volunteer bias.

Table 1. Study designs and characteristics of included subjects in published studies aiming to evaluate the effects of narghile use on periodontal health (clinical, radiological, and microbiological studies)

First author	Baljoon (16)	Natto (17)	Natto (18)	Natto (19)	Natto (20)	Bibars (21)
Town (country)	Jeddah (Saudi Arabia)	Jeddah (Saudi Arabia)	Jeddah (Saudi Arabia)	Jeddah (Saudi Arabia)	Jeddah (Saudi Arabia)	Irbid (Jordan)
Study design	Cross-sectional Comparative	Cross-sectional Comparative	Cross-sectional Comparative	Cross-sectional Comparative	Cross-sectional Comparative	Cross-sectional Comparative
Recruitment method	Announcements/ newspaper	Announcements/ newspaper	Announcements/ newspaper	Announcements/ newspaper	Announcements/ newspaper	Flyers (cafés; restaurants and university campus)
Name of the smoking mode	Water-pipe	Water-pipe	Water-pipe	Water-pipe	Water-pipe	Waterpipe
Inclusion criteria	>20 teeth	≥25 Y	>20 teeth	>20 teeth	>20 teeth	NR
Non-inclusion criteria	Pregnancy Unhealthy	NR	Pregnancy Unhealthy	Pregnancy Unhealthy	Pregnancy Unhealthy	Chronic systemic diseases Endocrine or hematological pathologies Pregnancy Dental scaling within the last 6 months Orthodontic appliance
Exclusive-NS	Yes	Yes	Yes	Yes	Yes	Yes
Calculated sample size	No	No	No	No	No	No
Number	117	76	80	117	58	72
Age (Y)	39 (37–41) ^a 17–60 ^b	39.4 ^c 25–70 ^b	17–60 ^b M: 38 (36–41) ^{a‡} F: 39 (34–44) ^{a‡} TS: 38.5 ^c	17–60 ^b M: 39 (37–41) ^a F: 38 (34–43) ^a	39 (36–41) ^a	27 ± 9 ^{d*} 18–60 ^b
Number of years of smoking	NR	NR	NR	NR	NR	NR
Type of tobacco	NR	NR	NR	NR	NR	NR
Method of narghile-use quantification	RY	NR	RY	RY	NR	NW
Quantity of used tobacco	57 (48–66) ^a RY 44%: <40 RY 56%: ≥40 RY	NR	36 (27–44) ^a RY 40%: <27 RY 60%: ≥27 RY	57 (48–66) ^a RY 44%: <40 RY 56%: ≥40 RY	NR	3.4 ^c NW
Last narghile (h)	NR	NR	NR	NR	NR	NR
Explorations	Clinical examination (four sites [buccal, mesial, distal, lingual] for all the teeth) Radiographic examination	Clinical examination Radiographic examination	Clinical examination (four sites [buccal, mesial, distal, lingual] for all the teeth)	Clinical examination (four sites [buccal, mesial, distal, lingual] for all the teeth) Radiographic examination	Clinical examination Bacteriological study	Clinical examination (four sites [buccal, mesial, distal, lingual] for 6 teeth)
Questionnaires	Standardized	Standardized	Standardized	Standardized	Standardized	Non-standardized

Table 1 (Continued)

First author	Baljoon (16)	Natto (17)	Natto (18)	Natto (19)	Natto (20)	Bibars (21)
Comparison with active CS	<i>n</i> = 72 37 (35–39) ^a Y 230 (193–268) ^a CY 37 subjects: < 170 CY 52 subjects: ≥ 170 CY	<i>n</i> = 49 36.7 ^c Y 25–70 ^b	<i>n</i> = 50 36.5 ^c Y 210 (169–251) ^a CY	<i>n</i> = 72 M: 36 (34–38) ^a Y F: 38 (34–43) ^a Y 230 (193–268) ^a CY 37 subjects: < 170 CY 52 subjects: ≥ 170 CY	<i>n</i> = 35 37 (34–40) ^a Y	<i>n</i> = 30 34 ± 10 ^d Y 14.1 ^c CD
Comparison with healthy non-S	<i>n</i> = 99	<i>n</i> = 70 34.4 ^c Y 25–70 ^b	<i>n</i> = 78 33.2 ^c	<i>n</i> = 99 M: 38 (35–41) ^a F: 35 (32–39) ^a	<i>n</i> = 80 40 (35–41) ^a Y	<i>n</i> = 38 32 ± 11 ^d Y
Comparison with MS	<i>n</i> = 67 33 (31–35) ^a Y 174 (141–207) ^a CY 24 (18–30) ^a RY	<i>n</i> = 49 38.1 ^c Y 25–70 ^b Y	<i>n</i> = 54 37.1 ^c Y 1.91 (154–229) ^a CY 17 (10–6) ^a RY	<i>n</i> = 67 M: 33 (31–35) ^a Y F: 32 (28–37) ^a Y 174 (141–207) ^a CY 24 (18–30) ^a RY	<i>n</i> = 25 33 (30–37) ^a Y	<i>n</i> = 50 28 ± 10 ^d Y 1.9 ^c NW 10.6 ^c CD
Main results	VD prevalence and severity are greater in NS and CS than in non-S Similar associations of VD with narghile or cigarette smoking Narghile use exerts a negative impact on the periodontal bone	Gingival health is compromised by narghile use	Association between narghile use and PD manifestations	Narghile use is associated with PBH reduction	No major differences were observed between CS, NS, and non-S regarding the occurrence of PM	NS were significantly more likely to have PD

CD, cigarette/day; CS, cigarette smokers; CY, cigarette-years; F, female; M, male; NS, narghile smokers; non-S, non-smokers; NR, not reported; NW, narghile/week; PBH, periodontal bone height; PD, periodontal disease; PM, periodontal microflora; RY, run-years; VD, vertical defect; Y, years.

^aData are mean (95% confidence interval); ^bdata are range (minimum–maximum); ^cdata are mean; ^ddata are mean ± SD.

Significant differences: *NS vs. CS; †NS vs. MS. No significant difference was found between NS vs. non-S.

Table 2. Study designs and characteristics of included subjects in published studies aiming to evaluate the effects of narghile use on oral mucosa (clinical and histological studies)

First author	El-Hakim (8)	Al-Belasy (9)	Ali (10)	El-Setouhy (11)	Dangi (12)	Al-Attas (13)	Seifi (14)	Al-Amrah (15)
Town (country)	Cairo (Egypt) Al Khobar (Saudi Arabia)	Mansoura (Egypt)	NR (Yemen)	Qalyubia (Egypt)	Haryana (India)	Jeddah (Saudi Arabia)	Babol (Iran)	Jeddah (Saudi Arabia)
Study design	Case-series	Longitudinal Comparative	Cross-sectional Comparative	Cross-sectional	Cross-sectional Descriptive	Cross-sectional Descriptive	Cross-sectional Comparative	Cross-sectional Comparative
Recruitment method	Patient consultants	Patient consultants	Patient consultants	Randomized sample of households	NR	Population clusters	Cafes Entertainment centers Dental students Medical sciences students	Coffee shops Resting areas
Name of the smoking mode	Goza Shisha Hubble-bubble	Shisha Water pipe Hookah	Water-pipe Mada'a	Waterpipe	Hookah	Shisha Moasel	Waterpipe Hookah	Waterpipe Gouza Shisha Hubble-bubble Narghile Hookah
Inclusion criteria	NR	Healthy No drugs Unilateral high mesioangular Impactions + exposed occlusal surfaces	Using qat daily on only one side of the mouth for ≥ 10 Y	> 18 Y Male Current NS (at least once per/week and smoked < 100 cigarettes in their life) Never smokers	NR	> 18 Y	20–40 Y	Healthy Male Adult
Non-inclusion criteria	NR	MS Former smokers Medication use Recent antibiotic use Need for antibiotic prophylaxis	Unhealthy Systemic disease	Female	Pregnancy Child Diagnosis of oral cancer prior to entry the study	Non-S	Systemic disease Alcohol use Fixed or removable partial denture PS Oral mucosa lesion	Alcohol use Medications use
Exclusive-NS	No Case 2 was an occasional CS	Yes	No	No	No	No	Yes	Yes
Calculated sample size	No	No	No	No	No	Yes	No	No
Number	3	100	11	128	163	228	40	20
Age (Y)	61 23 20	29 ^a 22–39 ^b	45 \pm 9 ^c 22–55 ^b	47 \pm 14 ^{c†}	45–95 ^b	34.9 ^a	30.15 \pm 6.02 ^c 20–40 ^b	37.5 ^a 28–65 ^b

Table 2 (Continued)

First author	El-Hakim (8)	Al-Belasy (9)	Ali (10)	El-Setouhy (11)	Dangi (12)	Al-Attas (13)	Seifi (14)	Al-Amrah (15)
Number of years of smoking	Case 1: >20 Y Case 2: 3 Y	NR	NR	70 subjects ≤ 14 Y 58 subjects > 14 Y	NR	NR	NR	NR
Type of tobacco	Moassel Tomback	NR	NR	NR	NR	Moassel	NR	Moassel Jurak
Method of narghile use quantification	NR	ND	NR	HW HD	NR	NR	NW	ND
Quantity of used tobacco	Case 1: twice a day ≥ 20 Y Case 2: twice a day for 3 Y Case 3: regular smoker 4 Y	30%: 1–3 ND 37%: 4–6 ND 17%: 7–9 ND 16%: 10 to12 ND	NR	54%: ≤28 HW 46%: >28 HW 52%: ≤4 HD 48%: >4 HD	NR	NR	1–3 NW 20–80 min 3–5 Y	1–4 ND . > 15 min
Last narghile (h) Explorations	NR Clinical examination Lesion biopsy	NR Clinical examination	NR Clinical examination Histological study: two biopsies (chewing and contralateral sides)	NR Clinical examination Genetic study	NR Visual-tactile-examination	NR Clinical conventional oral examination	NR Clinical oral examination Histological study (cytological smear samples from three different areas)	NR Histological study: collection of buccal cells The comet assay
Questionnaires	NR	Non-standardized	Non-standardized	Non-standardized	NR	Non-standardized	Non-standardized	NR
Comparison with active CS	No	<i>n</i> = 100 27 ^a Y 20–38 ^b Y	<i>n</i> = 11 38 ± 12 ^c Y 24–58 ^b Y Heavy smokers (>20 CD)	No	No	No	<i>n</i> = 40 30.32 ± 5.69 ^c Y 20–40 ^b Y 3–30 ^b CY	No
Comparison with healthy-Non-S	No	<i>n</i> = 100 (100 M/0 F) 28 ^a Y 20–37 ^b Y	<i>n</i> = 11 32 ± 10 ^c Y 22–58 ^b Y	<i>n</i> = 78 53 ± 11 ^c Y	No	No	<i>n</i> = 40 30.30 ± 5.83 ^c Y 20–40 ^b Y	<i>n</i> = 20
Comparison with MS	No	No	No	No	No	No	No	No
Main results	Narghile use may predispose to OC.	NS have three times the risk of non-S for developing DS Increased frequency of smoking either cigarettes or narghile results in increased DS incidence Patients who smoke either cigarettes or narghile the day of surgery are at a significantly greater risk of developing DS	Histopathologic changes in the oral mucosa of both sides: no significant differences between the three groups	TMN and CMN: higher in NS vs. non-S	Narghile use is associated with higher risk of SL	Narghile use is associated with SL while CT was positively associated with these lesions	Narghile use is effective in creating some quantitative cytometric alterations in oral mucosa	Narghile use causes DNA damage in buccal cells

Table 2 (Continued)

First author	El-Hakim (8)	Al-Belasy (9)	Ali (10)	El-Setouhy (11)	Dangi (12)	Al-Atlas (13)	Seifi (14)	Al-Amrah (15)
		than are the patients who do not smoke postoperatively or who smoke the second day after surgery DS in smokers appears to favor a systemic etiology rather than a direct effect of heat/smoke or suction on the extraction socket	Pathologic changes of the oral mucosa were related mainly to takhzeen al-qat					

CD, cigarette/day; CMN, number of cells containing micronuclei; CT, chewing tobacco; CY, cigarette-years; DNA, deoxyribonucleic acid; DS, dry-socket; HD, hagar/day; HW, hagar (narghile tobacco unit)/week; MS, mixed smokers; ND, narghile/day; NS, narghile smokers; non-S, non-smokers; NR, not reported; NW, narghile/week; OC, oral cancer; PS, passive smoker defined as individuals who were exposed to cigarette smoke at home or work; SL, suspicious lesions; TMN, total number of micronuclei; Y, years.

^aData are mean; ^bdata are range (minimum–maximum); ^cdata are mean ± SD.

Significant differences: ¹NS vs. Non-S. No significant difference was found between NS vs. CS or NS vs. MS.

The sixth limitation concerns narghile use. Four remarks concerning this issue should be raised. 1) Five methods of narghile-use quantification (run-years for ‘narghile runs smoked *per* days’ × ‘years duration’; narghile week [number of narghile *per* week]; narghile day [number of narghile *per* day]; hagar week [number of hagars smoked weekly]; and hagar day [number of hagars smoked daily]) were cited in eight studies (Tables 1 and 2). In front of the confusion about how to quantify narghile use, a specific international codification is immediately needed (6). 2) Information about the type of used tobacco was specified only in three studies (8, 13, 15). The lack of information about the different types of used narghile tobacco makes comparison difficult, because in the case of *tombak* or *jurak*, in comparison to *tabamel*, the pattern is different (6). In the future, the used narghile tobacco (*moassel* or *tabamel*, *tombak*, *jurak*) should be noted to allow comparisons between studies. 3) The level of exposure to narghile tobacco, mentioned only in seven studies, was very large and several definitions were applied to define light/heavy narghile exposures (Tables 1 and 2). This situation makes comparison between studies difficult. In the future, like as done for cigarette smoking, it is recommended to standardize the way in which narghile use is quantified. 4) Information about the last narghile use was lacking in all studies. This information is important in order to avoid confusion between the chronic and acute effects (4, 5) of narghile use even in oral health.

The seventh limitation concerns the number of implicated examiners, reported only in 10 studies (Tables 1 and 2). Despite the measurement of interobserver reproducibility (16, 18, 19) and the conduction of training sessions (12, 13), the duplicity/multiplicity of examiners may influence the precision of measurements. In future studies, where more than one examiner will be implicated, error of measurements and data reproducibility (34) should be noted.

The eighth limitation concerns the control groups (CS; non-smokers [non-S]; MS; non-NS) included in 10 studies (Tables 1 and 2). Two studies, aiming to evaluate the prevalence of oral mucosa suspicious lesions, have included smokers of narghile and other forms of tobacco (12, 13). It is important to highlight that the subjects included in the study of Ali (10) were all smokers of takhzeen al-qat and the non-NS group of Dangi et al. (12) included bidi and chewing tobacco users. These are two confusion factors concerning the effect of narghile use on oral mucosa (10, 12). In addition, the authors wondered what would be the scientific merit of including an MS group ($n = 25$) in the study analyzing the periodontal microflora without presenting and/or commenting their data (20).

The ninth limitation concerns the applied clinical approaches. Three examples can be highlighted. 1) The discrepancy between effects of narghile use on periodontal health could be explained by the number of sites of clinical recordings: all teeth except the third molar (18) or

only six representative teeth (21). 2) Al-Belasy did not specify the difficulty of the surgery, the oral hygiene, the preoperative infection, and the surgeon experience, which influence the dry socket incidence (35).

In conclusion, future studies should be made more rigorous by taking into account the various factors discussed here. Extensive epidemiological well-designed studies, preferably longitudinal, are needed to assess the effect of narghile use on oral tissues.

Authors' contributions

MK and HBS performed bibliographic research, collected published papers, and helped to draft the manuscript. LB and SR helped to draft the manuscript. All authors read and approved the final letter to the editor.

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Conflict of interest and funding

The authors have not received any funding or benefits from industry or elsewhere to conduct this study.

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