ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 9, Issue, 7(D), pp. 27983-27990, July, 2018

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

WATERPIPE SMOKING AND LUNG CANCER: A REVIEW

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DOI: http://dx.doi.org/10.24327/ijrsr.2018.0907.2371

ARTICLE INFO

Article History:

Received 4th April, 2018
Received in revised form 25th May, 2018
Accepted 23rd June, 2018
Published online 28th July, 2018

Key Words:

Waterpipe, Shisha, Hookah, Narghile, Argileh, Bong, Smoking, Hubble-Bubble, Cancer, Lung cancer.

ABSTRACT

Waterpipe smoking has become a common practice in lots of countries with a growing number of smokers, especially among the youth. It is widely believed to be less harmful than other types of smoking. Yet, several studies have indicated that water pipe smoking may cause serious health consequences including lung cancer. This study aimed to review the literature on the association of waterpipe with lung cancer. Searches on electronic databases were conducted using various combinations of the following keywords:Waterpipe/Hookah/Narghile//Shisha/Bong/Hubble-Bubble/Cancer, and Lung cancer. Studies not related to lung cancer were excluded. A total of eight eligible studies were found between 1989 and 2018. All of the evidence showed negative effects of waterpipe on lung cancer. Despite limitations of the studies, the association of waterpipe with lung cancer was demonstrated fully. Future well-designed studies should be carried out to develop evidence on the similar nature of waterpipe with other tobacco products.

INTRODUCTION

The World Health Organization (WHO) in its Fact Sheet about cancer dated 1 February 2018 stated: "Cancer is the second leading cause of death globally, and was responsible for 8.8 million deaths in 2015. Globally, nearly 1 in 6 deaths is due to cancer; Tobacco use is the most important risk factor for cancer and is responsible for approximately 22% of cancer deaths". The same facts indicated that around one- third of deaths from cancer are due to the 5 leading behavioral risks and tobacco use is one of them (WHO, 2018).

The WHO Fact Sheet about Tobacco dated 9 March 2018 stated: "The tobacco epidemic is one of the biggest public health threats the world has ever faced, killing more than 7 million people a year. More than 6 million of those deaths are the result of direct tobacco use while around 890,000 are the result of non-smokers being exposed to second-hand smoke.

The highest prevalence of waterpipe use in the world, especially among young people is in theMiddle Eastern and North African countries (WHO, 2015). The highest prevalence of waterpipe smoking as resulted in one of the system review studies was among school students in the United States, especially among Arab Americans, the Arabic Gulf region, Estonia, and Lebanon. The prevalence of waterpipe smoking among university students was highest in the Arabic Gulf region followed respectively by the United Kingdom, the United States, Syria, Lebanon, and Pakistan. The prevalence of waterpipe smoking among adults was highest in Pakistan, followed respectively by the Arabic Gulf region, Australia (in Arab speaking adults), Syria, and Lebanon. Group waterpipe smoking was highest in Lebanon and Egypt (Akl *et al* 2011). Another study about smoking habits in the Middle East and North Africa found out that the use of waterpipes was most frequent in Saudi Arabia (Khattab, 2012).

Another study found out that the prevalence estimates among adults were highest in the Eastern Mediterranean, and among youth were about equal between the Eastern Mediterranean and European regions. Ever use was highest among Lebanese youth in 2002 and Lebanese university students in 2005. Regular or occasional use was highest in among Iranian university students, and daily use was highest among Egyptian youth in 2005. Increased use over time among youth was also reported. (Jawad *et al*, 2018).

Using the waterpipe for tobacco smoking has been commonplace in Asia and North Africa for centuries. Its popularity has grown in Europe and North America in the last two decades. The proportion of adolescents who have ever

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smoked waterpipe tobacco was very high in Africa, Asia, USA, and in some UK communities. Waterpipe tobacco use amongst young youth is increasing with similar patterns in Jordan, Lebanon, Canada, and the US. (Singh *et al*, 2018; Jawad *et al*, 2016; Maziak *et al*, 2015; CDC, 2012; Akl, *et al*, 2011; Chan *et al*, 2011; Minaker *et al*, 2015; Arrazola *et al*, 2015). This has become a growing social experience in bars and cafes where young people are provided with waterpipe to share the same apparatus during their use (Kates, 2016). There is a long history of smoking tobacco through "bong" waterpipes in the Western Pacific Region. In 2010, the highest rate of waterpipe tobacco smoking among males was found in Viet Nam, the rate being higher than that in Egypt and in Turkey in 2008. The highest prevalence of waterpipe smoking in Viet Nam was followed by China and Malaysia respectively. The traditional bong waterpipes appear to be used by older, rural, less educated men in those countries (WHO, 2015; Ministry of Information and Communication, 2015).

The literature is scarce about waterpipe in Vietnam. One study indicated that Shisha smoking cessation is encouraged in the absence of waterpipe prohibitions or restriction. (Kumar, 2017) and smokers are aware of its hazards (Minh *et al*, 2013; Drizen, 2016) and they have intentions to quit (Duc *et al*, 2018). The Vietnamese Tobacco Control Law (2012) defines tobaccos as products made, in part or in whole, from tobacco raw materials, and processed in the form of cigarettes, cigars, pipe tobacco, wild tobacco or others (National Assembly 2012).

Smokers use various tobacco products, including waterpipe, also known as hookah, shisha, bong, hubble-bubble, argileh or narghile (Maziak *et al*, 2005, WHO, 2018; Kumar *et al*, 2018; Hadidi and Mohammed, 2004).Waterpipe is available in different sizes, shapes, structures, and types with different flavors by region (Shihadeh, 2003; Kumar *et al*, 2018). Waterpipe is generally structured with a base, a stem, and a hose with a mouthpiece. A sweet fragrant tobacco product is placed on the top of the waterpipe and burned when the smokers inhale through a hose that burns coal gas, and a hot air flows through the tobacco product, producing smoke, which passes through the bowl and then the hose to the mouthpiece (Shihadeh, 2003). In Vietnam, despite some imported waterpipe patterns from other countries around the world, there are some typical waterpipe types, such as the Farmer's Pipe (Figure 1) and the Pipe and Bowel (Figure 2) that are made of bamboo, metal or porcelain with similar structures and uses as those in China. The bong (Figure 3) is the type that is commonly used in China and the Mediterranean type Shisha or argileh that is commonly used in the Middle East (Figure 4) (WHO, 2015). The Shisha or argileh is another type in which tobacco is placed in the head and might be covered with perforated aluminum foil; burning charcoal is placed on top of the foil. Water half fills the bowl that is connected to a tube through which smoke enters. One end of the hose is connected to the tube through which smoke leaves. Thus, the other end of the hose is where the smoker inhales producing a vacuum in the air filled space of the water bowl, causing smoke to pass through the water (WHO, 2015; Akl *et al*, 2011).

Figure 1 Farmer's Pipe

Figure 2 Pipe & Bowel

Figure 3 Bong

Figure 4 Shisha/Argileh

Due to the rapid growth of waterpipe smoking, today it has been a global issue as well as a potential health threat. Waterpipe was suggested by the WHO to be considered similar to cigarettes and other tobacco products in the Tobacco Control Law (WHO, 2005). However, very few specific studies found in the literature that reveals the association of waterpipe with lung cancer. The composition of inhaled smoke mostly includes Carbon Monoxide and nicotine among some other carcinogens such as Naphthalene, Acenaphthylene, Acenaphthene, Fluorine, Phenanthrene, Anthracene, Fluoranthene, pyrene, Benzo[a]anthracene, Chrysene, Benzo[b + k]fluoranthene, Benzo[a]pyrene, Benzo[g,h,i]perylene, Dibenzo[a,h]anthracene, and Indeno[1,2,3-cd]pyrene (Maziak 2011; Sepetdjian *et al*, 2010). Meanwhile, several clinical studies have indicated an increase

in carcinoembryonic antigens (CEA) for waterpipe smokers or the risk of exposure to chemicals/heavy metals contained in waterpipe, causing some diseases such as melanoma, cardiovascular diseases, congenital malformations and infectious diseases, through the share of waterpipe smoking among different groups (Sajid *et al*, 2008; Shihadeh and Saleh 2005; Steentoft *et al*. 2006).

Tobacco smoking is a big problem all over the world (PAHO WHO 2018, Yach, 2018). Waterpipe smoking is a social phenomenon in so many different countries of the world and the literature highly supports its harmful effect to the health status of the smokers (WHO, 2015; Kumar *et al*, 2017; Husain *et al*, 2016; Wong *et al*, 2016; Roskin *et al*, 2009; Maziak *et al*, 2005; Drizen *et al*, 2016; Momenabadi *et al*, 2016; Kadhum *et al*, 2015; Awan *et al*, 2017; Mamtani *et al*, 2017; Haddad *et al*, 2016; Kates *et al*, 2016; Akl *et al*, 2011; Akl *et al*, 2010; Akl *et al* 2015; Wang *et al*, 2015; Shishani *et al*, 2014; Eissenberg *et al*, 2009; Cobb *et al*, 2012; Rozema *et al*, 2018; Javed *et al*, 2018; Syed *et al*, 2015; Primack *et al*, 2016; CDC, 2018; Koul and Chaouachi, 2011; Maziak, 2011).

Thus, this study has aimed to show the association of waterpipe with lung cancer.

METHODS

Search Strategies and Eligibility Criteria

A literature review was conducted by retrieving from electronic databases such as PubMed, Medline, Tobacco Control, Science Direct, CINAHL, Cochrane Library, and Research Gate. Original studies were searched for including cohort studies, case-control, and cross-sectional studies referring to waterpipe in English language using the following keywords: "Waterpipe", "Hookah", "Narghile", "Argileh", "Shisha", "Hubble-Bubble", "Bong", "Cancer", and "Lung cancer" in various combinations with unlimited search time. Studies reported the association between waterpipe smokers and non-waterpipe smokers and lung cancer outcome were included in the review. Case reports, review articles, letters to the editor, epidemiological studies, studies on air quality in waterpipe smoking environments, unpublished articles, non-English written papers, human and animal clinical studies on waterpipe use, and those with no distinction between waterpipe and other forms of tobacco smoking were excluded from the scope of this study.

Three reviewers independently searched and screened titles and abstracts of studies based on the aforesaid protocol. The Newcastle - Ottawa Scale (NOS) was used to assess the quality of the studies(Wells GA, *et al*. 2009). For case-control studies, a maximum of four points was given for the selection of cases and controls, two points for the comparability of cases and controls on the basis of the design or analysis, and four points for the ascertainment of exposure (water pipe smoking). For cohort studies, a maximum of four points was given for the selection of cohorts, two points for the comparability of cohorts, and three points for the assessment of outcome (Wells GA, *et al*. 2009). For the ease of analysis, all the selected studies were systematically synthesized in a table that contained information on the participants' characteristics (age, gender, and location), study objectives, design, methods, and major results.

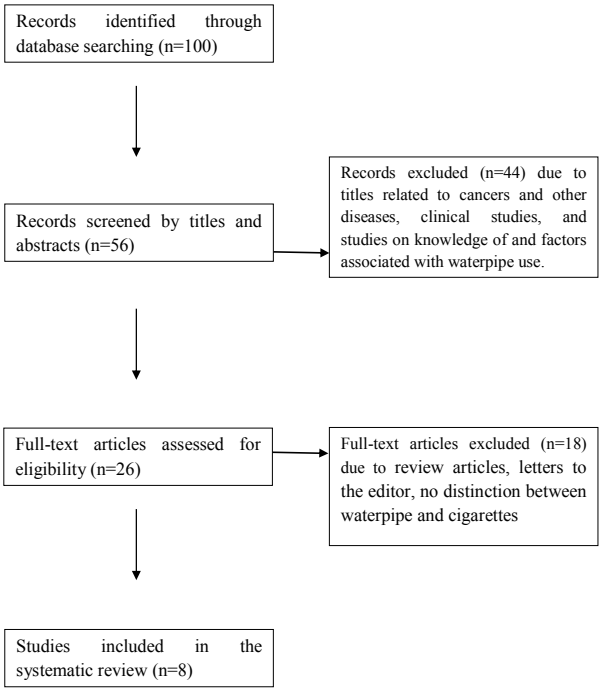

Figure 5 Flowchart of identification and selection of studies for inclusion in the review

RESULTS

Study Characteristics

A total of 8 studies meeting the eligibility criteria were included in this review. Seven of them were case-control studies (Lubin *et al*, 1990; Lubin *et al*.1992; Aoun *et al*. 2013; Hsairi *et al*. 1993; Koul *et al*. 2011; Qiao *et al*. 1989; Gupta *et al*. 2011) and one was a retrospective cohort study in which patients were monitored for 10 years (Hazelton *et al*. 2001). Among those eight studies, three case-control studies and one retrospective cohort study were conducted in China (Lubin *et al*, 1990; Lubin *et al*. 1992; Hazelton *et al*. 2001; Qiao *et al*. 1989) while the other case-control ones were done in Lebanon (Aoun *et al*. 2013), India (Gupta *et al*. 2011; Koul *et al*. 2011), and Tunisia (Hsairi *et al*. 1993). All of the studies were published between 1989 and 2013 in English. There were a total of 2267 lung cancer cases and 13458 controls in the seven case-control studies.

Study Assessment

Quality of the selected studies was assessed using the Newcastle-Ottawa Quality Assessment Scale (NOS) ranging from 5 to 9. Three out of the eight studies had the NOS of ≥ 7 and were highly assessed because of matching criteria such as the lung cancer patients confirmed by hospitals through medical records; the gender and age-matched controls selected in the community with no lung cancer as well as other medical problems; the data analysis included only waterpipe smokers without being confused with other waterpipe users who smoke cigarettes and/or other tobacco products; the equal assessment of exposure in both controls and cases; and control of the confounding variables. Studies with the NOS of < 7 which studied the controls in the hospitals presented no information on the management of the confounding variables and applied a single-variable model.

Table 1 Characteristics of Included Studies

Author (year)	Study design, time and location	Study objectives	Sample size, participants' characteristics and methodology	Results
Aoun et al (2013)	Case-control study conducted in Beirut, Lebanon. March-June, 2012	To identify the association of several risk factors, including waterpipe smoking with lung cancer.	• Cases: 50 cases of lung cancer patients; average age: 59.58 years old (±6.03) • Controls: 100 people with no medical problems agreed to join the study; average age: 59.82 years old (±6.31). Hospital controls and visitors • Questionnaire, controlled and adjusted	The univariate model results showed that waterpipe smokers had a six-fold higher risk of developing lung cancer than nonsmokers. (95% CI: 1.78-20.26) OR (95% CI)= 60 (1.78-20.26)
Koul et al (2011)	Case-control study conducted in Kashmir, India. 2005-2006	To identify waterpipe's association with lung cancer	• Cases: 251 cases of lung cancer. 209 males and 42 females. • Controls: 500 people. 328 males and 72 females. • Matched age. Mean age 58.4 for males and 56.5 for females. • Waterpipe ever smokers: 120 cases and 100 controls. • Interview questionnaire, not controlled, not adjusted	Waterpipe smokers had a six-fold higher risk of developing cancer than controls (OR 95% CI = 5.83) (3.95-8.60, p <0.0001)
Hazelton et al (2001)	Retrospective cohort study conducted in Gejiu city, Yunnan Province, China (1976-1988)	To look at the relationship between exposure to arsenic, radon, cigarettes, and waterpipe, and lung cancer	• Sample: 12,011 males • 983 deaths of lung cancer • 1,303 males • smoking waterpipe only	Waterpipe smokers had a 4.39-fold higher risk of developing lung cancer (95% CI: 3.82-5.04) than controls.
Gupta et al. (2001)	A case-control study conducted in Chandigarh, North India. Jan 1995-June 1997	To determine risk factors for lung cancer	• Cases: Historically confirmed 265 lung cancer patients (235 males and 30 females) • Controls: 525 people without lung cancer (435 males and 90 females). • Age and sex matched • Self developed questionnaire, no standardization. Controlled for cigarette smoking and adjusted for confounding variables. Adjusted for age and education	Waterpipe smokers had a 1.94-fold higher risk of developing lung cancer (95% CI: 0.85-4.44) than controls. Number of women is small to derive risk estimates
Hsairi et al (1993)	Case-control study conducted in Tunis, Tunisia. 1988-1989	To determine risk factors for lung cancer	• Cases: 110 lung cancer patients • Controls: 110 people without lung cancer. • Matched on sex, age (± 5 years), cigarette (± cig/day) and cannabis use	Waterpipe smokers had a 5.7-fold higher risk of developing lung cancer (95% CI: 1.20-7.60) than controls.
Lubin et al. (1992)	Case-control study conducted in Shanghai and Shenyang, North Eastern China 1984-1988	To have a closer look at the effects of tobacco products on lung cancer	• Cases: 427 lung cancer patients; Average age: 62.1 years old (Shanghai) and 62.5 years old (Shenyang). • Controls: 1011 people without lung cancer; Average age: 62.6 years old (Shanghai) and 62.9 years old (Shenyang). • Two controls per case. All males. • Self developed questionnaire, no standardization. Controlled and adjusted. Adjusted for age (± 5 years), residence, type of respondent and years of work. No control for long term pipe smoking	Waterpipe smokers had a 1.78-fold higher risk of developing lung cancer (95% CI: 0.80-4.20) than controls.
Lubin et al. (1990)	Case-control study conducted in Gejiu city, Yunnan Province, China. 1985	To investigate the effects of tobacco products and exposure to radon on lung cancer	• Cases: 74 lung cancer patients • Controls: 74 people without lung cancer • Average age of both group: 62 years old (range 35-80 years old). • All work in same place. • Self -developed questionnaire, no standardization, not controlled for cigarette smoking, not adjusted for other confounding variables	Waterpipe smokers had a 3.6-fold higher risk of developing lung cancer than controls. OR compared with no tobacco smoking. Higher risk with cumulative exposure.
Qiao et al. (1989)	Case-control study conducted in Yunnan Province, China. 1985	To assess the relationship between radon and tobacco products and lung cancer among workers at Yunnan Tin company	• Cases: 107 lung cancer patients; Average age: 61 years old (49-78 years old) • Controls: 107 peoples agreeing to join the study; Average age: 62 years old (47-79 years old). • Adjusted for age • Interviews were conducted to obtain information on lung cancer risk factors including a detailed history of employment and tobacco use.	Waterpipe smokers had a 1.9-fold higher risk of developing lung cancer (95%CI: 0.40-9.40) than controls.

Association with lung cancer

The negative association of waterpipe with lung cancer was reported in all of the 8 studies (Lubin *et al* 1992, Auon *et al* 2013, Hsairi *et al*, 1993, Koul *et al*, 2011, Hazelton *et al*, 2001, Qiao *et al*, 1989, Lubin *et al*, 1990, Gupta *et al* 2001) among which three studies indicated a 6-fold greater risk of developing lung cancer for waterpipe smokers (Auon *et al* 2013, Hsairi *et al*, 1993, Koul *et al*, 2011); however, the association was not adjusted for confounding factors or became insignificant after adjustment in two out of the three studies, and only the rest study adjusted the multivariable model by age, sex, consumption of tobacco and cannabis. Three other studies showed a nearly twice elevated risk of developing lung cancer from waterpipe smoking (Lubin *et al*, 1992, Qiao *et al*, 1989, Gupta *et al*, 2001) after adjusting for age (Qiao *et al*, 1989); age, place of residence, and number of working years (Lubin, 1992); age and educational level (Gupta *et al*, 2001). One study used RR; one used a crude odds ratio; and neither of them adjusted confounding factors (Lubin *et al*, 1990, Hazelton *et al*, 2001).

DISCUSSION

The present article systematically reviewed the studies on the association of waterpipe with lung cancer. Despite a small number of studies on this topic, all of the included studies reported an important association of waterpipe with lung cancer. Tobacco products used in waterpipe were indicated to contain several toxins known as the causes of lung, intestinal and oral cancers (American Lung Association 2007, Cobb *et al*, 2010). Once tobacco products are burned, health will be affected by carbon monoxide, heavy metals, and carcinogens. Even when filtered through the water, the smoke from waterpipe still contains high concentrations of toxins (Cobb *et al*, 2010). Moreover, the combination of fruit flavoring agents and tobacco products has increased the risk of oral cancer (El-Hakim and Uthman 1999).Unlike cigarettes, waterpipe consumption is rather difficult to be accurately quantified, impeding the accurate measurement of the relationship between waterpipe consumption/use and lung cancer. Waterpipe consumption was hardly reported in the included studies due to different session a day and different amount of tobacco used in each session, which could not be as easy to measure as cigarettes. Only the study conducted by Gupta *et al*,2001quantified the consumption of tobacco by rating 1 as equivalent to 1 cigarette, 0.5 as bidis and 4 as hookah(Gupta *et al*, 2001).

In this study, the quality of the evidence was not highly appreciated due to limitations of research methodology. Some studies were carried out at coal mines, where many other environmental factors, other than waterpipe, such as radioactive substances, radon, and arsenic; hence, the authors may have incorrectly concluded what caused lung cancer to the subjects (Lubin *et al*, 1990, Lubin *et al*, 1992). In addition, some neglected the control of the confounding variables (Lubin *et al*, 1990), selected subjects at the same health facilities (Aoun *et al*, 2013), failed to adjust individual confounding factors such as age and gender, had a significantly higher percentage of survey respondents among cases than that of controls (87% versus 42%) (Lubin *et al*, 1992), presented no data collection tools as well as cumulative exposure calculation (Hazelton *et al*, 2001), had no standard exposure measurement instruments (Lubin *et al*, 1990), had a much smaller sample size of waterpipe smokers than the total number of study participants due to the association of waterpipe smoking with lung cancer as a small variable in such studies (Lubin *et al*, 1992, Aoun *et al*, 2013, Qiao *et al*, 1989). As a result, such shortcomings may affect the quality of the included studies.

All the included studies did not address specific types of tobacco used in waterpipe. Meanwhile, most of them were conducted in China and India, where unprocessed tobacco has been used directly by lighting with charcoal. Further, such studies reported no information on the use of flavoring agents which themselves may cause health threats (El-Hakim and Uthman 1999); thus there may be a simultaneous effect of both tobacco and flavoring agents on lung cancer outcome. Another limitation is that the Scopus database which is a huge material resource was not accessible due to the literature search in Vietnam. Therefore, other studies that matched the eligibility criteria from this resource were omitted.

To overcome these limitations, prospective cohort studies are required. Also, these studies should investigate some other variables such as the number of inhalations, duration of waterpipe smoking, added flavoring agents, effects of passive waterpipe smoking, quantification of the specific amount of tobacco used.

Regardless of the aforesaid limitations, the association of waterpipe with lung cancer was clearly demonstrated. This knowledge should be communicated to the public, giving them a proper perception of waterpipe's harms in the context that waterpipe has become an epidemic among young people worldwide (Maziak, 2015; WHO, 2015) due to the misconception about its safer use than cigarettes because of the passage of the smoke through water before inhalation (Aljarrah *et al*, 2009); its lower cost than cigarettes (Nakkash *et al*, 2011); the communication with others through the use of waterpipe at venues where indoor smoking bans have not applied (Tee *et al*, 2015);the development of media; and the lack of waterpipe regulations (Maziak *et al*, 2015). Hence, according to the FDA regulations on waterpipe, starting from 2018 tobacco products containing nicotine and promotion of such products must have the words warning that this product contains nicotine, nicotine is addictive. For non-nicotine products, there must be a warning that this product is made from tobacco (US Food and Drug Administration, 2016).

Waterpipe epidemic among Vietnamese youth is not an exception to the rest of the world (Ministry of Information and Communication, 2015), hence, in the future, more in-depth studies on the types and shapes of waterpipe in Vietnam; the association of waterpipe smoking with cancer and other diseases; the cultural and social impacts on initiating and sustaining the use of waterpipe in young people; the relationship between the use of waterpipe smoking and the use of other drugs; the prevalence and knowledge of waterpipe among young people and the health implications of waterpipe to develop scientific evidence for waterpipe to be included like other tobacco products in the Tobacco Control Law; and intervention programs are necessary.

CONCLUSION

Findings of this review study suggest the association of waterpipe/shisha/hookah/narghile/argileh,/bong/hubble-bubble with lung cancer, consolidating the message that tobacco products are not safe for humans in all forms of use. However, the quality of the studies included in the review was not high due to some limitations on the methodology. Waterpipe epidemic is demonstrating a surge in a world scale, severely affecting the health of the population. Thus, close collaboration among scientific researchers, educators, lawmakers, and health workers is required to push back the "waterpipe epidemic".

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How to cite this article:

Duc,TQ *et al.* 2018, Waterpipe Smoking and Lung Cancer: A Review. *Int J Recent Sci Res.* 9(7), pp. 27983-27990.
DOI: http://dx.doi.org/10.24327/ijrsr.2018.0907.2371

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