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WATERPIPE: A GLOBAL ALARMING PROBLEM

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WATERPIPE: A GLOBAL ALARMING PROBLEM

Abstract

Waterpipe popularity has increased significantly in the recent decades to become the major cause of death worldwide. This practice, which is also known as hookah, shisha and Narghile that is based on tobacco burning, increases the percentage of tobacco smokers especially among young people, due to several factors such as the attracting effect of sweetened tobacco, the marketing role and the social acceptance of waterpipe. A literature review was constructed using "Pub med" as a searching tool to confirm by studies the differences in adverse effects between waterpipe and cigarette by analyzing the toxicant's levels generated from them, evaluating the smoke volume which is affected by the duration of smoking, the puffing intensity, and investigating the factors which enhance the toxicity of waterpipe such as the type of the hose and charcoal used during smoking practice. In addition, highlighting the misconceptions regarding the protective effect of water bubbling which has been considered to be a filtering factor for removing several toxicants, showing the type of microorganisms which colonize the different parts of waterpipe device and how they can be transmitted between smokers, focusing on their health hazards and their effects on waterpipe smokers. Finally, emphasizing the importance of specific regulatory policies in controlling the widespread of waterpipe preventing its dangerous consequences and saving human life

Keywords

Waterpipe, Health effects, Bacterial contamination, Topography, Policy and regulations

1. INTRODUCTION

Waterpipe is a traditional apparatus for tobacco smoking (Yalcin et al., 2017), its popularity has increased remarkably in the Middle East and North Africa (Alzaabi et al., 2016).

Waterpipe smoking is considered one of the major causes of death worldwide, and according to the World Health Organization (WHO) which has reported that more than 8 million tobacco-related deaths occurred worldwide. The direct tobacco use was the reason behind the death of 7 million, while around 1.2 million were a second-hand smokers (Dadipoor et al., 2019). The prevalence of waterpipe smoking among youth has been recorded to be between 2.5% and 37.2% in Mediterranean countries, while in European countries showed prevalence between 2.2% and 22.7% (Nemmar et al., 2020).

The aim of this review is to examine the crises of waterpipe smoking and illustrate its serious health threat by detailing the toxic chemicals produced by its smoke and compared it by those generated by the cigarette, analyzing the factors affecting its toxic yield, studying the exposure of its different part to a variety of microbes and giving some examples of its effects on human health.

2. WATERPIPE TERMINOLOGY AND DESCRIPTION

Waterpipe smoking originated in India and Persia, about 400 years ago (Gupta and Jain, 2016), it is created by a physician called “Hakim Abul Fath” who studied each part of the waterpipe and how the process of smoking occurs especially the flow of air, and how the water plays a role in the filtration of the smoke as he thought (“WHO Advisory note,” 2015).

Waterpipe Terminology differs according to the region such as “Shisha”, “Boory”, Goza” in Egypt and Saudi Arabia, “Narghile” and “Arghile” in Jordan, Lebanon and Syria, while “Hookah” is used in Africa and Indian (Jukema et al., 2014).

The waterpipe apparatus is basically composed of: The head, body, bowl, and hose (see figure 1). The most common type of tobacco used is the sweetened type “Moassel” which’s placed in the head of waterpipe and covered in aluminum foil perforated with pinholes. To build the waterpipe apparatus, the head should be attached to the waterpipe using a tight seal which is linked in its turn to the body and bowl. The latter must be partially filled with water and a flexible hose that usually made up of leather or plastic is attached to the body (Ali and Jawad, 2017).

Waterpipe smoking starts when tobacco is heated by burning charcoal to generate smoke that passes through a column of water before being inhaled (Lai et al., 2016).

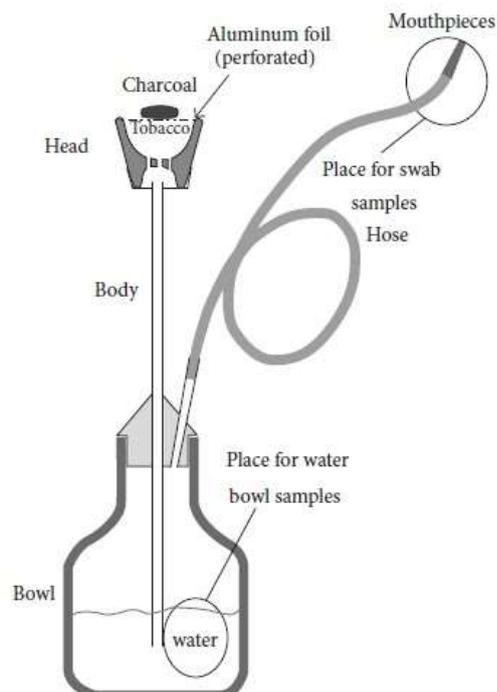


Fig.1: Schematic of a Narghile water pipe (Adopted from Monzer et al., 2008).

3. MONOGRAPH OF TOBACCO

Tobacco plant is perennial, erect glandular pubescent and robust little branched herb grows to heights between 1 or 2 meters it contains large green leaves, oblong lanceolate, acuminate, and long trumpet shaped white-shaped pinkish, rosy or reddish, all parts of it are sticky covered with short viscid-glandular hairs which release yellow secretion that contain an alkaloid known as nicotine. *Nicotiana tabacum* is its Latin name and habitat basically in America but it is cultivated throughout the world (Beebe, 1977). There are different types of Tobacco, Maasel the most used type nowadays, Ajami the pure dark tobacco taste and the new form of steam stone which is a healthy alternative to Tobacco (Günen et al, 2016-Ali & Jawad, 2017).

3.1 Taxonomic Classification

Scientific name: *Nicotiana Tabacum* Linn.

Kingdom: Plantae, Eudicots, Asterids

Division: Magnoliophyta

Class: Magnoliopsida

Order: Solanales

Family: Solanaceae

Genus: *Nicotiana*

Species: *Nicotiana tabacum*

Latin names: *Nicotiana tabacum*

Tobacco used in the medical field as relaxant and sialagogue, sedative, diuretic, expectorant and it increases the saliva secretion by causing irritation of the mucous membrane of the mouth. The plant introduced in France by "Jean Nicol" which is the genus name derived from.

Tobacco plant chemically constitute in the leaf several pyridine alkaloids and other organic acids as well as glucosides, thacilin and iso-quercitrin, 1-quinic, chorologenic, caffeic and oxalic acids.

Tobacco genus contains more than 70 species some of them: *Nicotiana tabacco* (South American origin), *Nicotiana rustica* (North America) and *Nicotiana bgelovii* (Indian tobacco). Tobacco plant is processed in order to be used is cut into bunched and then added to piles which are enclosed containers for the process of fermentation and some types of the commercial tobacco are mixed with flavors and glycerol (Beebe, 1977).

4. WATERPIPE PREVALENCE

Waterpipe is dramatically widespread, and its prevalence exhibits a wide variation especially among teenagers and college students of both genders this contributes troubling and alerting in the recent time.

Many studies were done in order to show how much waterpipe used in different countries as well as the elevation of its prevalence. One of them was in the Middle East and it shows a range of prevalence from 2% to 25% in school students, a higher prevalence recorded in university students for the usage of waterpipe by a value ranging between 6% and 28% (Abdullah et al., 2017).

The-alarming reports for the usage of waterpipe in Lebanon is 40% among adolescents (Ali & Jawad, 2017). In a study established to compare results between 13 countries, the highest was recorded in Viet Nam by 13.0% for male gender in 2010 while in Egypt was 6.2% in 2009 (Morton et al., 2014). Furthermore, a study conducted in Iran has revealed that women have more dependence on waterpipe smoking consumption than in men due to certain differences such as biological, psychological and psychological variations. As well as it indicated that the prevalence of waterpipe smoking among women in Iran was the highest with percentage of 10.3% compared to Lebanese and Pakistani women with 4% each (Dadipoor et al., 2019).

Another study done in the United State of America the waterpipe prevalence among adults of 18 years old was 9.8%. In addition, waterpipe increased in high school students in USA from 4.1% to 7.2%. A lot of national studies focused on the usage of waterpipe in Canada the results represented in 2010 was 4.1% currently use the waterpipe it increases sharply to become 14.3 % in 2013, and a younger population has a greater prevalence than older population (Abdullah et al., 2017).

Other statistics done in more than 100.000 students from 152 universities in USA the usage of waterpipe was more than 8% (Ali & Jawad, 2017). An online questionnaire from 2013 to 2016 for samples in age between 11 to 18 years in Great Britain lead to results by 1.7% used waterpipe tobacco at least monthly and 9.9% in their lifetime (Jawad et al., 2018).

The major factors contributing to the widespread of waterpipe use are: The Misconceptions about its health risk by the belief that the harmful substances arising from Tobacco are removed by water filtration process through the water bowl (Alzaabi et al., 2016), social popularity, absence of waterpipe prevention laws (Romani et al., 2020), and the availability of large number of shops and restaurants which facilitate the usage of waterpipe (Alzaabi et al., 2016) (Hessami et al., 2016).

Moreover, the introduction of the sweetened flavored tobacco (Maasel) in 1990s (El-Zaatari et al., 2015) played a huge role in attracting the youth for engaging in waterpipe smoking (Nemmar et al., 2020). In addition nicotine is another factor which promotes the widespread of waterpipe practice among youth due to its modulating effect on psychological level by reducing the depression and anxiety (Khalifeh et al., 2020). Furthermore, the role of marketing through all forms of social media with misleading labels present on some of Tobacco products trick consumers for trying it and consequently becoming addicted to the product (Günen et al., 2016).

5. WATERPIPE VS CIGARETTE SMOKE

Several factors can affect the amount of smoke produced by the waterpipe including: the type of coal, the quality of the tobacco, the volume of water used, the design of waterpipe itself, the number/duration/volume of the puffs/ and the length of the waterpipe sessions (Ali & Jawad, 2017).

The Large volume of waterpipe smoke is generated by the long session duration and the large number of high volume puffs taken during each session that may last 45 minutes or more, compared to 5 minutes taken to smoke a cigarette (Soule et al., 2015). As a result of these factors (time, puff numbers, puff volume), the volume of smoke inhaled by waterpipe users in a single session is between 39 and 172 times compared to the volume of smoke inhaled by tobacco cigarettes smoker (Soule et al., 2015).

Many studies indicate that the waterpipe smoke exposes the users to harmful substances such as: The carbon monoxide, nicotine, Polyaromatic hydrocarbons, volatile organic compounds, particulate matter, volatile aldehyde, tobacco specific nitrosamines, and radionuclides (Al-Kazwini et al., 2015).

Several toxicants in the waterpipe smoke which are produced from a single session are found in higher concentration than in smoke generated from a single cigarette (Eric K. Soule et al, 2015).

For example, the main chemical component present in several forms of tobacco and constitute the major cause of tobacco dependence is the nicotine (Fagerstrom K et al, 2012). The amount of nicotine in the inhaled smoke is affected by the intensity of smoke, for example the increase in number and/or volume of each puff and/or the drop in inter-puff interval (Shihadeh A et al, 2005).

After starting waterpipe smoking, the level of nicotine triples in the first 5 min and continue to increase significantly until it reached after 45 min four times the pre-smoking level, which is greater than the level of nicotine reached after 45 min by smoking a single cigarette (Cobb et al., 2011). The end-expiratory carbon monoxide (CO) levels increase by around 8 times compared to pre-smoking levels following a single waterpipe session (Maziak et al., 2009). As well as, the levels of CO is directly proportional to the amount of charcoal used, so the CO levels are reduced when less coal was used (Ali & Jawad, 2017). In addition, Nicotine toxicant level is four-fold higher in waterpipe emitted smoke than cigarette smoke (Khalifeh et al., 2020). The waterpipe associated CO have been reported with the level of carboxyhemoglobin (COHb) in plasma, and one study shows that the level of COHb among the smokers who engaged a waterpipe smoke session (WTS) increased from 0.8% to 4.5% compared to 0.8% to 1.1% after smoking a single cigarette (Soule et al., 2015).

Polycyclic aromatic hydrocarbons (PAH) are organic pollutants that are generated by incomplete combustion of organic materials such as the tobacco (Jacob et al., 2011).

One laboratory study indicates that a single WTS session generates an average of 2.5 times more phenanthrene, 8.2 times more fluoranthene, and 5.0 times more chrysene compared to the amount of toxins found in the smoke from a single cigarette (Soule et al., 2015).

Moreover, there is evidence of the association of many of these compounds with carcinogenesis as well as: Lung cancer (Shen et al., 2015).

Another study found that the level of formaldehyde in the mainstream smoke in a single WTS session is 16.6 times higher than what is produced from smoking a single cigarette (Soule et al., 2015).

Overall, the waterpipe tobacco smoke contains greater levels of harmful substances like: CO, PAH, and nicotine than cigarette smoke and these levels are reflected by the biomarker in blood samples of waterpipe smokers (Ali & Jawad, 2017).

6. WATERPIPE TOPOGRAPHY

People become addicted to nicotine due to the repetitive waterpipe smoking practice. For instance, nicotine metabolism plays a role for this behavior, but also factors involving behavior of smoking such as waterpipe puffing topography like total puffing, number of puffs, and total smoke inhaled (Halpern-Felsher and Kim, 2018).

This study focused on the CO level and compared it between pre-smoking and post-smoking using standardized and ideal components for the water pipe apparatus. Total puff volume and peak flow rate are recorded to be not stable, the average waterpipe number of puffs is 75 whenever a small variation occurs in puff intensity and puff volume leads to a difference in CO exposure (Halpern-Felsher and Kim, 2018). Another study was done for COHb concentration according to puff topography was analyzed within 2 min after venous blood sampling, it showed that the HIGH users took more puffs and higher frequent puffs compared to LOW users recording higher level of COHb and more nicotine exposure whenever the intensity and number of puffs increases which is associated with more combustion for the tobacco and releasing their toxicant chemicals (Cobb et al., 2015). An additional study was conducted to examine the filtering effect of water bubbler by quantifying emitted toxins, concluded that waterpipe bubbler does not significantly reduce PAH, CO or NO, which are the major classes of toxicants that lead to health complications, thus this confirms that the filtration process by the water is misleading perception adopted by waterpipe smokers (El Hourani et al., 2020).

The hose type is another factor and differs between a plastic hose and a leather hose. Plastic hoses have shown to increase CO and particulate matter (sum of all solid and liquid particles suspended in air) delivery (Shihadeh and Saleh, 2005).

Another factor is the presence of several types of charcoals, briquettes are one kind and are formed by compressing pulverized charcoal in a press with a binder (e.g. starch), or by pyrolyzing extruded logs formed from biomass particles (e.g. ground coconut shells). Some briquette products are “easy-light” and contain an ignition agent. Lump charcoal another type, in contrast, comes in a variety of irregular shapes traceable in form to the original biomass used to make it (e.g. tree branches) (Stumpe-Viksna et al., 2008) (See table 1).

Table 1: comparison of yield ratio between leather and plastic hose
(Adopted from Shihadeh and Saleh, 2005)

	Leather	Plastic	Yield ratio	
Infiltration rate, SLPM	3.8	0	–	Not reported
Tobacco consumed, g	3.6	5.1	1.2	4.7
TPM, mg/session	1180	2860	2.4	1380
CO, mg/session	99	242	2.4	143
Nicotine, mg/session	6.06	5.23	0.9	2.96
CO:nicotine	16.3	46.3	2.8	48.3

*SLPM: The standard liter per minute

* TPM: Tobacco Particulate Matter

7. HEALTH EFFECTS OF WATERPIPE SMOKING

The misperception toward the safety of waterpipe smoking has been refuted by several studies that indicate the presence of toxicant substances and carcinogens inhaled by the smokers, whereas not filtered by passing through the water (El-Zaatari et al., 2015).

Effects on Cardiovascular system: waterpipe significantly increases the heart rate and blood pressure (Qasim et al., 2019), while decreasing the baroreflex sensitivity, exercise capacity and heart rate variability (El-Zaatari et al., 2015) For the short term effects of waterpipe on cardiovascular system, several studies measured the heart rate and blood pressure after one smoking session and reported that the systolic and diastolic blood pressure levels significantly increased after smoking (systolic: 119.5 vs 132.0 mm Hg, diastolic: 74.8 vs 83.0 mm Hg), accordingly heart rates increased from 80.4 to 96.6 beats/min (Ali and Jawad, 2017). For the long-term effects of waterpipe, studies have reported the association of waterpipe smoking with heart diseases (ischemic heart disease or heart failure) reported the association of waterpipe smoking with heart diseases (ischemic heart disease or heart failure) (El-Zaatari et al., 2015).

Effects on Respiratory System: Several studies focused either on the effect of waterpipe on overall pulmonary function parameters, or the components of pulmonary functions such as Forced Expiratory Volume (FEV). These studies reported that the waterpipe smokers have lower scores on overall pulmonary function (Boskabady et al., 2014) and the FEV decreased after waterpipe smoking compared to non-smokers (Meo et al., 2014)

Other study indicates that several unspecified respiratory symptoms such as: shortness of breath, chronic cough, and bronchitis are significantly greater in waterpipe users (Tageldin et al., 2012).

Lung related diseases: waterpipe smokers show a cough and sputum abnormalities due to: apoptosis induced in 1) basal and ciliated cells, 2) increase of secretory cells (secreting excess of mucus) compared to non-smokers. These apoptotic cells are indicated by the endothelial microparticles which are in higher percentage (45%) in waterpipe smokers compared to non-smokers (Strulovici-Barel et al., 2016).

Moreover, waterpipe smoke causes oxidative stress, inflammatory responses and compromises the ventilatory capacity of the lungs decreasing its function (Javed et al., 2017).

Oxidative stress, immunity, and cell cycle interference outcomes: A study examined cellular changes in alveolar and aortic cells, noting a cellular damage via apoptosis and cell cycle arrest (Shihadeh et al., 2015).

Another study has explored levels of inflammatory marker (cytokines) in the “exhaled breath condensate” (EBC) of active waterpipe smokers, indicating that the anti-inflammatory cytokines (interleukin 4-10 and 17) decreased after waterpipe smoking (Bentur et al., 2014).

Effects on pregnancy and male infertility: A study was conducted in Iran to assess the correlation between the adverse effects of hookah smoking and pregnancy in women. A total of 512 “pregnant and hookah” smokers women were enrolled in this study, it was found that there is a direct relationship between preeclampsia, preterm labor, placental abruption, birth weight with hookah consumption during pregnancy (Mosharraf et al., 2019).

To investigate the effects of waterpipe smoking on semen parameters and hormone levels in men, a study was conducted in Egypt on 42 waterpipe male smokers. The results showed an increase in COHb level and a significant decrease in the percentage of sperm motility in comparison to nonsmokers. Moreover, higher levels of testosterone, Follicle-Stimulating Hormone (FSH), and Luteinizing Hormone (LH) were detected among smokers. Thus, waterpipe smoking induces adverse effects to the reproductive system in males (Fawzy et al., 2011).

Effects of waterpipe on cancer outcome: Several studies have matched waterpipe smoking with different types of cancer such as: lung cancer, esophageal carcinoma, bladder carcinoma, pancreatic cancer, prostate cancer, keratoacanthoma, gastric carcinoma and squamous cell carcinoma (Waziry et al., 2016).

Studies among Lebanese and Indian populations indicated that waterpipe smokers have a six-fold greater risk to develop lung cancer. Other studies conducted in Northern India showed a two-fold greater risk of developing esophageal cancer among waterpipe smokers (Awan et al., 2017).

8. BACTERIAL CONTAMINATION

Several studies showed that waterpipe components exhibit a good environment for bacterial growth, due to the factors of low temperature and moist environment compared to cigarette smoke (Markowicz et al., 2014).

Analyzing results from several experiments presented a wide spectrum of gram-positive and gram-negative strains, hypothesizing that waterpipe is associated with high risk of bacterial transmission resulting in infectious diseases (Masadeh et al., 2015).

In order to assess the health consequences related to the usage of disposable and fixed mouth pieces as well as water, bacterial growth was studied in different media (eosin methylene blue, Blood agar, and MacConkey agar). The fixed mouthpiece had the highest frequency of microbial contamination (see figure 2).

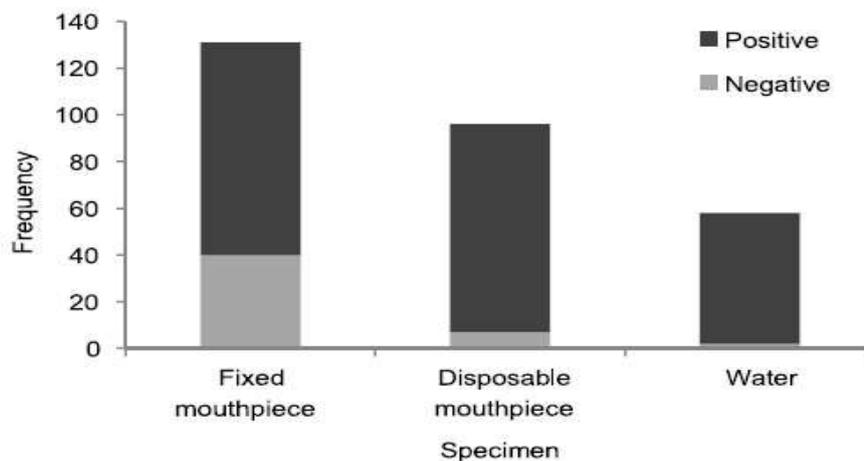


Fig.2: Microbial contamination of different segments of a waterpipe (Adopted from Safizadeh et al., 2014).

Multiple strains of microorganisms have been detected in waterpipe components (gram-negative and gram-positive bacteria), (see table 2). The highest number isolated from fixed and disposable mouthpieces are coagulase-negative *Staphylococcus* and *streptococcus* spp, whereas in water bowl are *Escherichia coli* and *Klebsiella* spp.

Coagulase-negative *Staphylococcus* is one of the major causes of infections in cardiac valves and urinary tract, present in the skin and mucous membranes. While *Streptococcus* causes various health complications like meningitis, skin infection, and streptococcal pharyngitis. On another hand, *Klebsiella* spp grows in humid environment that's why it was found in water bowl causing pulmonary infections (Safizadeh et al., 2014).

Klebsiella pneumonia, *Pseudomonas putida*, and *Pseudomonas aeruginosa* showed a high resistance in antimicrobial tests, they will be drawn to the smoker's body through the contaminated mouth pieces. In addition, Tar component leads to increase the bacterial colonization due to their adherence characteristic to epithelial cells consequently causing serious infectious diseases (Alaidarous et al., 2017).

Table 2: frequency of gram-negative bacteria isolated from waterpipe components
(Adopted from Alaidarous et al., 2017).

<i>Escherichia coli</i>
<i>Klebsiella oxytoca</i>
<i>Klebsiella pneumoniae</i>
<i>Pseudomonas putida</i>
<i>Pseudomonas aeruginosa</i>
<i>Sphingomonas paucimobilis</i>
<i>Comamonas testosteroni</i>
<i>Enterobacter cloacae complex</i>
<i>Stenotrophomonas maltophilia</i>
<i>Bordetella bronchiseptica</i>
<i>Cupriavidus pauculus</i>

9. POLICY AND REGULATIONS

The majority of waterpipe smokers are unaware of the health hazards associated with waterpipe smoking, as well as the tobacco control policies don't address the waterpipe smoking, allowing the tobacco companies to market and sell waterpipe products, this leads to the increase of waterpipe prevalence among young adults (Haddad et al., 2015).

The growth in waterpipe popularity indicates a need for waterpipe-specific regulatory policies, and update of existing tobacco laws (Jawad et al., 2015) that include:

- Policymakers in public health must verify that the health warning labels for waterpipe products should be shown to consumers at the point of sale or upon entering the waterpipe cafes (Haddad et al., 2015). In addition, the waterpipe tobacco products should be labeled with accurate information about the ingredients of tobacco including the levels of nicotine and tar (Gathuru et al., 2015).
- Policy actions should concentrate on giving information concerning the health risks of waterpipe smoking to enhance the awareness among the adults (Gathuru et al., 2015).
- The websites are considered one of the reasons that promote the prevalence of waterpipe via sharing misinformation associated with its use, so the health education and policy measures may be valuable to counter this fact (Erdöl et al., 2015).
- Governments should enforce the smoke-free legislations to protect people from the health dangers of second-hand tobacco smoke by creating a full smoke-free environment (World Health Organization and Bloomberg Philanthropies, 2017).
- Offering help for people to quit smoking and overcoming the nicotine dependence by cessation advices provided by mobile technologies such as sending text messages and through free telephone helplines which are estimated to increase quit rates by about 4% (World Health Organization and Bloomberg Philanthropies, 2017).
- Finally, raising taxes on waterpipe tobacco product is the most cost-effective way to lower the waterpipe tobacco consumption

10. CONCLUSION

Waterpipe smoking becomes a serious threat due to its considerable prevalence especially among adults who're unaware of its huge and terrible health effects leading to the rise of mortality incidence in North Africa and Middle East regions.

The difference in the smoking behavior such as the puffing topography and the distinct use of hose and charcoal type between waterpipe smokers affect the chemical yield generated from the smoke resulting in differential health effects between smokers.

The limitation of waterpipe smoking is challenging due to different factors ranging from the smokers-dependent factors such as the addiction concern and unwariness of smoking influence to the role of marketing-dependent factors in the attraction process by affording a wide variety of waterpipe products to the smokers.

Thus, the growth in Hookah popularity requires a “waterpipe-specific regulatory policies”, and an updating of existing tobacco laws to minimize the spread of this terrible practice in order to save the existing and new generation’s life.

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