Tobacco use in shisha

Studies on waterpipe smoking in Egypt

World Health Organization
Regional Office for the Eastern Mediterranean

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Preface

The rules and regulations stipulated by the WHO Framework Convention on Tobacco Control (WHO FCTC) apply to all tobacco products and not only cigarettes. Fourteen Member States of the WHO Eastern Mediterranean Region are now Parties to the Convention. Consequently when Articles 10 and 11 call upon countries to regulate tobacco products, that regulation will include tobacco consumed by use of the waterpipe, a traditional form of smoking common to the Region. The regulation of tobacco products includes health warnings, information about contents and emissions, as well as packaging and labelling. All these elements and others indicated in Articles 10 and 11 of the WHO FCTC are pertinent to the waterpipe as they are to all methods of tobacco consumption.

This publication comprises a series of studies conducted by the Egyptian Smoking Prevention Research Institute (ESPRI). The studies were commissioned by the WHO Tobacco Free Initiative as the basis for discussion during the second meeting of the WHO Study Group on Tobacco Product Regulation in 2005, which led to the issue of the TobReg Advisory Note *Waterpipe tobacco smoking: health effects, research needs and recommended actions by regulators*. Use of the waterpipe, or *shisha*, has traditionally been considered to be less harmful and less addictive than cigarettes; worse, in the eyes of many users it was, and is still, not even considered to be a form of tobacco smoking. We know now that this is not true. These studies show the reality behind this false premise. The waterpipe is as harmful and as addictive as cigarettes. The WHO Regional Office for the Eastern Mediterranean hopes, through the publication of these studies, to convey the message to decision makers, health professionals and the public in the Region that use of the waterpipe is indeed harmful. It is just another of the many disguised forms of tobacco consumption and not a safe alternative to cigarettes.

Chapter 1 comprises a summary of the structure, history and composition of the waterpipe, the types of tobacco used in waterpipes and the attributes and magnitude of waterpipe smoking. Six studies are reported: a national survey on waterpipe use and other risk factors for cardiovascular disease; a national survey on cigarettes and waterpipe smoking; epidemiology of waterpipe smoking; comparison of cigarette and waterpipe smoking among female university students; behavioural and biological aspects of waterpipe smoking; and the micronucleus test in buccal mucosa cells for assessment of the genotoxicity of waterpipe smoking.

While the studies were undertaken in Egypt and the results are relevant and applicable to the national reality in Egypt, the results should also motivate other Member States in the Region to compile data on waterpipe use and make it available to the public. The results should give guidance to decision makers, health professionals and the public on the importance and urgency of regulating waterpipe use, just as other forms of tobacco use are regulated. It is hoped that this publication will be the first step towards changing the social acceptance of the waterpipe in the Region, use of which is increasing daily.

WHO would sincerely like to thank ESPRI for taking the lead in conducting these studies and in joining forces with the WHO Tobacco Free Initiative in this area. We are sure that this work will be a landmark in control of waterpipe tobacco smoking in the Eastern Mediterranean Region, as well as worldwide.

Summary

The waterpipe (also known as *gouza, narghile,* hubble-bubble, hookah or *shisha*, depending on the local tradition) has been used for smoking tobacco for centuries in the Eastern Mediterranean Region. Formerly associated almost exclusively with older males, usually of lower socioeconomic level, waterpipe smoking is now spreading to other segments of society in the Region, particularly young men and women, and those from higher socioeconomic levels. Recent surveys from Lebanon, Saudi Arabia and Egypt, as documented in this monograph, have begun to study the characteristics, knowledge, beliefs and attitudes of waterpipe users. This literature review reveals that surprisingly little information is actually available on the level of human exposure to the harmful constituents of the tobacco smoke from these devices, and even less is known of its impact on public health.

1. Many differences are apparent when comparing waterpipe to cigarette smoking. In general, compared to cigarette smoking, waterpipe smoking is characterized by less frequent exposure (one to four sessions per day) but with a much more intense exposure per session which varies between 15 and 90 minutes. The uptake of tobacco nicotine is equivalent to 2–12 cigarettes per portion of tobacco used (*hagar*). A regular user of waterpipes usually smokes several *hagar* per session and on average smokes 2–3 sessions per day. This translates into an intake of nicotine equivalent to more than one pack of cigarettes per session for most waterpipe smokers. However, it is known that waterpipe smoking produces more smoke than cigarette smoking, and it has been estimated that smoke exposure could be as much as 100–200 cigarettes per session. Therefore the types and magnitudes of health hazards of waterpipe smoking are likely to be different from those of cigarette smoking, and there is a need to standardize exposure measurements for the proper assessment of health hazards related to this particular kind of tobacco exposure

2. In addition, the temperature of burning tobacco in waterpipes is much lower than that in cigarettes, and the force needed to pull air through the high resistance of the water pathway permits the smoke to be inhaled very deeply into the lungs. Therefore the sites and patterns of cell injury in the oral and respiratory tracts are likely to be different from those due to cigarette smoking. This area requires further toxicological and pathological investigation and needs expanded research support. Indeed, the entire field of the health effects of waterpipe smoking is ripe for new and comprehensive research, including interdisciplinary approaches to the major questions raised in this review.

3. The prevalence of overall smoking among adult males in Egypt was estimated from a national survey in 2002 focusing on hypertension, obesity and diabetes prevalence to be 47% (34% cigarettes only, 10% waterpipes only, 3% mixed), while smoking prevalence among adult females was less than 1%.

4. Remarkably, this survey of 6950 adults revealed a significantly greater prevalence of abdominal obesity among waterpipe smokers compared to nonsmokers. The data further suggest that tobacco-related mortality and smoking prevalence are both increasing in Egypt, with a prominent decline in the younger cohort in the mean age of regular smoking initiation. If such trends continue, Egypt and other nations in the Region with similar patterns will experience longer lifetime duration of smoking among these young smokers, and consequently increases in the burden of smoking-related diseases.

5. A more recent national survey in Egypt carried out by the Egyptian Smoking Prevention Research Institute (ESPRI) in 2005 in 25 of the 27 governorates of Egypt revealed that, among males 18 years and older, 13.6% (95% confidence interval 10.3%–17.8%) in rural areas reported current use of the waterpipe, compared to 10.5% (95% confidence interval 7.0%–15.4%) in urban areas. These figures translate to approximately two million current waterpipe smokers in Egypt, confirming anecdotal and popular press reports of the rise in popularity of waterpipe smoking.

6. A detailed survey of waterpipe smoking in the rural areas of the Nile Delta, carried out by ESPRI in 2003–2004 in nine randomly selected villages (each with 10 000–20 000 residents) revealed that waterpipe smoking was inversely related to educational level, and that most users believed that it is less hazardous than smoking cigarettes. The survey found that more than 70% of male waterpipe smokers smoked in the presence of their children and wives at home, which calls attention to the unfortunate fact of indoor environmental tobacco smoke exposure.

7. Current smoking behavioural practices among females in Egypt are not well known, due to their reluctance to report their tobacco habits when interviewed at home in the presence of family members. A survey of 196 female university student patrons of cafés in Cairo that served waterpipes was carried out by the ESPRI team in order to obtain a better picture of current smoking behaviour among females where the women felt comfortable discussing smoking. It revealed that 27% reported smoking cigarettes exclusively, while 38% smoked tobacco using waterpipes exclusively, and 32% used both types of tobacco smoking method.

8. Most of the female waterpipe smokers had the perception of the waterpipe as fashionable, and believed that waterpipes are less harmful than cigarettes.

9. There is little research on waterpipe smoking and health; for example, waterpipe smoking is a source of heavy metal exposure to consumers, and evidence suggests that waterpipes concentrate these metals in the water chamber of the device. More work needs to be done in this area.

10. Biological markers of tobacco harm, such as carbon monoxide poisoning, have been scarcely studied in waterpipe users, and many questions remain to be explored in detail.

11. Special health concerns that distinguish waterpipe smoking from cigarette smoking include the possibility that waterpipe users are prone to infections due to the habit of sharing waterpipes without changing the mouthpiece.

12. Maternal and child health effects from exposure to second-hand waterpipe smoke at home are almost entirely unknown at present.

13. No reliable dependency scale for waterpipe tobacco smoking has been developed and validated, which is hindering efforts to understand the psychological and physiological aspects of waterpipe smoking behaviour.

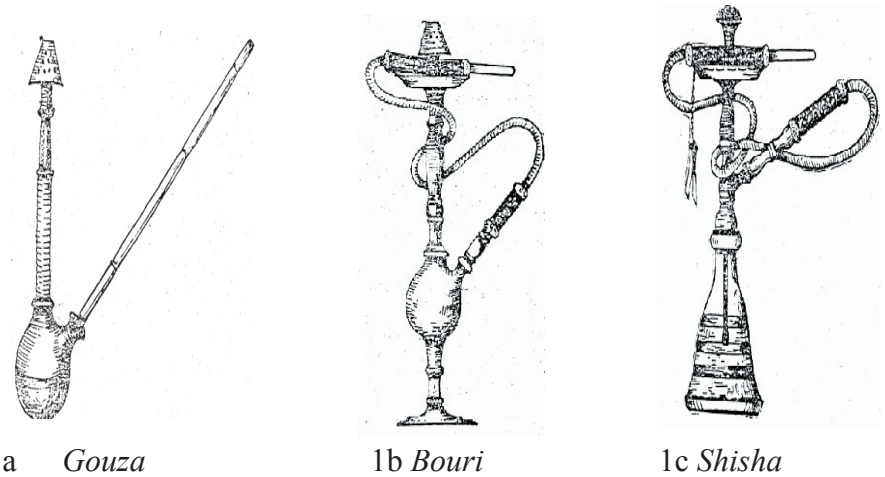
14. As an example of biomarker-based research strategies that are needed to evaluate possible genotoxic actions of substances in the waterpipe tobacco smoke, ESPRI conducted a study of micronuclei in oral mucosa cells (small DNA structures separated from the main nucleus of the basal epithelial layers and exfoliated into the oral cavity). It was found that the mean micronuclei level was significantly higher (more than twofold) among the waterpipe smokers compared to never smokers. Validation and standardization of such tests will permit the quantification of waterpipe tobacco–related exposure levels and early biological effects.

1 Introduction

1.1 General description of the waterpipe

There are three distinct types of waterpipe (Figure 1.1). The *gouza* is the oldest form of waterpipe. It has a small water container (about 200–500 ml) that is made of metal; coconut shell was formerly used. The *bouri* has a water container made of brass (about 200–500 ml). The authentic *shisha* is a larger (about 1000–2000 ml) and more decorated form of waterpipe, usually with a glass water container. However, it is common to see *shisha* water containers made of ceramics, rock-crystal or metal, including silver.

Note on terminology. Waterpipes come in different shapes in Egypt. The most famous one is the *shisha*. Other names, such as *narghile*, hubble-bubble and *hookah*, are not used in Egypt. They all share the structure of a small container half filled with water, which acts as a filter for the smoke drawn by suction from a funnel-shaped tobacco holder. The tobacco is usually burned by smouldering charcoal placed on top of it. We suggest the term *waterpipe* to cover all these different names for publication purposes, to have a common search name for this type of tobacco smoking.



1a *Gouza* 1b *Bouri* 1c *Shisha*

Figure 1.1 Different types of waterpipe

1.2 Structure of waterpipes

Parts are shown in the order of the smoke's pathway from tobacco to mouthpiece (Figure 1.2).

1. A holder to burn tobacco with charcoal on top, called a korsi. The tobacco load on the korsi is called hagar, which in the 1970s was almost equivalent to one cigarette.[1] Sometimes, a cover is used to keep the charcoal hot.
2. A stem pipe, connecting the korsi to the water container
3. Water container, the size of which may vary. Accordingly the degree of filtration depends on its size (the water is analogous to the filter in a cigarette). Sometimes juice or rose water is added to the water in order to add more flavours to the tobacco.
4. A pipe or hose, made of rubber in the *shisha* and *bouri* and a wooden hollowed stick in the *gouza*. It is connected to the top of the water container drawing air that comes off the water surface by suction from the mouthpiece.
5. A mouthpiece fixed to the hose, changed after each use, is used in cafés in urban areas to counteract a commonly expressed physician's belief that waterpipe may transmit infections through sharing.
6. A pair of tongs may be attached to the side of the korsi to manipulate the charcoal.

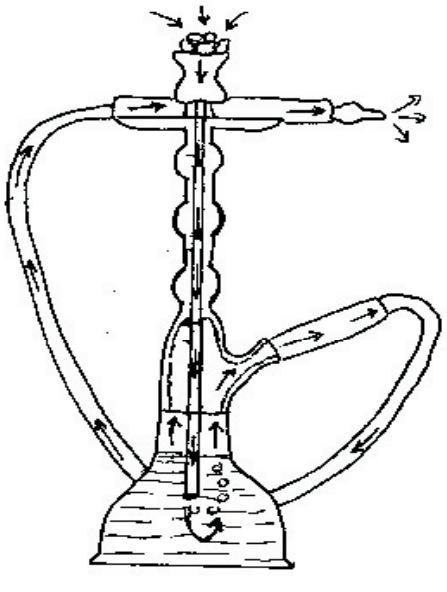


Figure 1.2 Pathway of smoke through waterpipe

1.3 History of the waterpipe

Waterpipes have been around for a long time, even before tobacco was introduced to the Old World. For more than five centuries in the east, especially India, the term *narjil* was used. [2] Early in history Indians started to cultivate hemp. They used this to produce cannabis oil from its seeds. Later on, its leaves were discovered to be intoxicant. Thus the word *hashish* was introduced. [2] Other plants and spices were mixed with the leaves to produce a paste, and by eating it they became intoxicated. In other forms, this paste was smoked in what was called a *narjil*. Narjil is a kind of coconut that grows in India. [3] The inner meat was removed and the shell was pierced, following which a straw was placed inside, resulting in the most primitive waterpipe. [2,3]

The *gouza* reached Egypt through various routes. The Ottomans carried it from Turkey to Egypt, [2,4] where its form was somewhat changed. For example, the body was made from a gourd rather than from a coconut shell. [2] In 1492, Christopher Columbus' journal described the indigenous peoples' habit of smoking tobacco leaves in the Americas. [5] A 16th century writer, Oviedo, wrote that they smoked the leaves through a Y-shaped, small wooden tube, called a *tobago*, two points of which were inserted in the nose, the other end in the burning leaves. [1] Others claimed that the Mexicans called the herb tobacco. [7] Tobacco reached Europe through Spain. [8] The French ambassador in Portugal, Jean Nicot, took its seeds from the Spanish to plant it in France. The genus *Nicotiana* and one of the most important derivatives of tobacco, nicotine, are named after him. [9] Tobacco smoking spread all over the world around the 17th century. The Turks introduced it into the Middle East and Africa through Egypt. [4,5]

It is not clear which came first to the Region, the waterpipe or tobacco. But it seems that the Ottomans introduced it in the 17th century, after tobacco had already arrived in the Middle East. [2] Great developments in the Turkish glass industry took place between the 16th and 18th centuries, [2,10] and glass started to be used in the manufacture of the shisha body. The evolution of the waterpipe was completed at this time. For example, the Ottomans added a clay bowl above the head and added a mouthpiece to the mouth end of the hose. [2] This form of waterpipe is used in north Africa, the Mediterranean region and parts of Asia. [11] The name *shisha* evidently came from the use of hashish as a drug added to the tobacco.

1.4 Composition and types of tobacco used in waterpipes

The most popular type of tobacco used in waterpipes is called *ma'assel*. It is a mixture of crude tobacco fermented with molasses (black honey). [12] Different fruit flavours are added to it (apple, strawberry, etc.). This is the most popular form, as was shown in a survey of cafés in Cairo. [13] In the Syrian Arab Republic it was rarely addressed in surveys before the early 1990s, and a Syrian review linked it to a waterpipe epidemic in Syria. *Tombak* is just another form of *ma'assel*. [12] *Jurak* is a different form, which is prepared by a more complicated process. It is moistened, dried and shaped before being used. Another name for it in the Syrian Arab Republic is *ajami*. Waterpipe smokers are less likely to use the latter form whether in Egypt [13] or in the Syrian Arab Republic. [14] In 2004, striking evidence of higher nicotine content in the tobacco used in waterpipe smoking was obtained. An analysis of 13 commercial types of pipe tobacco used in Saudi Arabia was carried out and a wide variation in nicotine content in all brands was noticed with an average of 8.32 mg/g tobacco (range 1.8–41.3 mg/g).

The average nicotine content in each waterpipe head (20 g) of unflavoured tobacco was said to be 713 mg/head and flavoured tobacco 67 mg/head. The result calculated in this reference seems to be wrong as we obtain the number 166 mg for an average 20 g head using this average of 8.3 mg nicotine/g tobacco, which should be 10 times that of the American cigarette. [15] In Saudi Arabia, the head is actually relatively large and is usually shared by several smokers at the same time. The addition of several additives: honey, glycerin and other flavours in the process of preparing the flavoured (*ma'assel*) tobacco helps to lower the nicotine content in each gram of flavoured tobacco. Smoking one head of flavoured (*ma'assel*) tobacco, which contains on average one-third of nicotine presented in 20 cigarettes (204 mg/pack), resulted in a 20% higher plasma nicotine level. [16]

In general, compared to cigarette smoking, waterpipe smoking is characterized by less frequent exposure (one to four sessions per day) but with a much more intense exposure per session which varies between 15 and 90 minutes. The uptake of tobacco nicotine is equivalent to 2–12 cigarettes per portion of tobacco used (*hagar*). A regular user of waterpipe, usually smokes several hagars per session and on average smokes 2-3 sessions per day. This translates into intake of nicotine equivalent to more than one pack of cigarettes per session for most waterpipe smokers. However it is known that waterpipe smoking produces more smoke than cigarette smoking and it has been estimated that smoke exposure could be as much as 100-200 cigarettes per session. Therefore the types and magnitudes of health hazards of waterpipe smoking are likely to be different from those of cigarette smoking, and there is a need to standardize exposure measurements for the proper assessment of health hazards related to this particular kind of tobacco exposure.

1.5 Attributes and magnitude of waterpipe smoking in Egypt

There are a small number of studies on waterpipe smoking in Egypt. One study recruited 635 secondary school students (416 males and 219 females with a mean age 15.5 ± 1 years), and found that 19% of them had tried a waterpipe. [17] This was much higher than was found in a household survey in a similar community, among a total of 2355 individuals, 1195 males and 1160 females aged 12–17 years). A much lower prevalence of waterpipe smoking was reported: 2% had ever smoked a waterpipe and less than 1% were smoking waterpipes regularly at the time of the survey. [18] The difference in reporting in the school survey and household survey reflects in part the difficulties in obtaining an accurate reporting in the presence of household members even if they are not listening to the interview. [19]

An adult survey in the same Lower Egypt villages (10 157 individuals above age 12, 4994 males, and 5163 females with a mean age of 36 ± 28 years), found that 34% of the men were current cigarette smokers, 9% smoked waterpipe and 1% smoked both. [18] Smoking prevalence increased with age for both cigarette and waterpipe smoking. For the cigarette smokers it peaked in the 40–50 age group (44%), while for the waterpipe the peak prevalence was detected above the age of 50 years (16%). Among females, only 0.3% reported smoking.In Assiut, in Upper Egypt, waterpipe smoking prevalence was much higher (46% of adult males), and 17% combined it with cigarette smoking. [20] In Beni-Suwayf (another governorate in Upper Egypt), medical students had the lowest prevalence of smoking generally. [21] In comparison, in Cairo, 9% of 5066 medical students smoked both waterpipe and cigarettes. An increasing prevalence of smoking from the first year through the final year was observed in spite

of being aware of smoking hazards. [22] Another much less educated group of 2782 soldiers, from Central Security in Cairo, revealed rates of 5% and 22% for prevalence of waterpipe use and combined cigarette and waterpipe use respectively (total waterpipe 27%). [23] This group especially reflects the role of education rather than residence as soldiers may be recruited from different parts of Egypt.

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2 National survey on waterpipe use and other risk factors for cardiovascular disease in Egypt 2002

2.1 Introduction

Prevention of disease and risk factors is the ultimate goal for all the efforts in the health sector. Elimination of risk needs a continuous assessment of risk factors in the community along with reduction of its causes. However, most resources are directed towards treating rather preventing diseases. [1] Smoking, high blood pressure, diabetes, underweight, and obesity are among the leading risk factors affecting the burden of disease in developing countries. [2] Egypt is one of the developing countries where all of the above risk factors need to be systematically assessed.

Tobacco consumption has been linked to a high death rate worldwide. [2] It is considered to be the second major cause of death in the world. It is currently responsible for the death of one in ten adults worldwide (about 5 million deaths each year). About one in two long-term smokers will die from a tobacco-related disease, many of them before the age of 65. [3]

High blood pressure, diabetes mellitus and obesity are three interrelated health disorders which aggravate each other. [4,5,6] Smoking is a completely preventable factor that aggravates the complications of both diabetes mellitus and hypertension. [7,8,9] As occurred with cigarette smoking in the period 1960–1970, waterpipe smoking is now becoming fashionable. [10,11] Some individuals argue that it is a less risky method of smoking, but much research is needed to estimate its risk for specific disease outcomes.

This work aims to outline the Egyptian national profile for hypertension, obesity, high random blood glucose and tobacco use among each age group and sex. Special emphasis was made on including data on waterpipe smoking. Since little is known about the prevalence of obesity and waist–hip ratio norms for Egyptian adults, this survey was designed to provide a national reference data set for these risk factors.

2.2 Subjects and methods

In 2002, a smoking and morbidity questionnaire accompanied a predesigned hepatitis C virus survey in order to identify the additional health hazards described above. A representative sample of six Egyptian governorates (of a total 27) was targeted, representing governorates in both Upper and Lower Egypt. Of the total population of 70 million, about 20 million citizens inhabit these governorates. [12, 13] A cluster sample technique was used to recruit individuals from each governorate. The sample comprised 6950 individuals.

An interview household survey was carried out. The questionnaire contained sections on the following topics:

- sociodemographic data
- smoking pattern, type, duration, and amount
- history of hypertension and intake of medication (to treat hypertension)
- abnormal high blood glucose and history of diabetes mellitus type 2.

All adults above 18 years old in the household were interviewed. Blood pressure, random blood glucose and anthropometric measurements were evaluated. The following steps were followed.

Field nurses and physicians were informed and trained on blood pressure measurement and other anthropometric measurements and tested for reliability of their work. Also the steps to be followed in the clinic were stuck on the wall as a reminder. Anthropometric measurements taken were weight, height, waist and hip circumferences (WC and HC). Body weight was measured by a regularly titrated balance. The height was measured by a scale against a wall from the lowest point at the heel to the highest point of the head with the subject standing upright and head not tilted.

Body mass index (BMI) was calculated using the following formula: weight divided by the square of the height (kg/m^2). It was further classified in adults into: [13,14].

Underweight	< 18.5 kg/m^2
Average	24.9–18.5 kg/m^2
Overweight	25–29.9 kg/m^2
Obese	≥30 kg/m^2

The WC was measured with a tape measure comfortably encircling the smallest abdominal area below the rib cage and above the umbilicus. A waist circumference of ≥102 cm and ≥88 cm among adult males and females, respectively, are considered to be an indicator of risky abdominal obesity. [15] The HC was measured with a tape measure placed around the most protruding part of the buttocks.

Waist–hip ratio (WHR) was defined as waist measurement/hip measurement. The cut-off point for abdominal obesity was considered 0.9 and 0.8 for adult males and females, respectively. [16,17] Blood pressure was measured twice using a regularly titrated, mercury sphygmomanometer by a physician with the subject in a seated position with the arm supported by a table at heart level. The average of the two readings was used to assess the blood pressure. Hypertension was defined as readings with systolic blood pressure ≥140 mmHg and diastolic blood pressure ≥ 90 mmHg. [18]

Fingerprick blood samples were tested for random blood glucose (RBG) using portable field equipment according to manufacturer's instructions (Accu-Check SoftClix, Roche Diagnostics GmbH, D-68298 Mannheim, Germany). Individuals with blood glucose level ≥ 140 mg/dl were classified as having high random blood glucose levels according to the American Diabetic Association guidelines. [19]

2.3 Statistical analysis

Birth cohorts were calculated by subtracting an individual's age at survey from the survey year (2002). The sample was divided into 10-year intervals but those born before 1930 were put in one group (the most recent cohort, born after 1980 included only those born before 1985). The regular smokers' age of initiation was compared among different birth cohorts.

Generally smokers were older than the nonsmokers, and analysis was stratified by age group to exclude age effect. The relationship of smoking to other health risk factors, high random blood sugar and hypertension was studied among adult males only because of the scarce number of smokers in female population groups. The effect of smoking cigarettes and waterpipe compared with nonsmokers was studied separately using a chi-squared test. The odds ratio was calculated using nonsmokers as the reference group. Those having combined systolic and diastolic hypertension were compared to normotensive individuals among each smoker group (cigarettes and waterpipe) separately and among nonsmokers in order to estimate the risk of being hypertensive. Mixed smokers were excluded from the analysis because of their small numbers and to avoid the confusion in attributing the effects to cigarette or waterpipe smoking.

2.4 Results and discussion

More than half of 6950 adult participants were female and they were on average younger than males (Table 2.1). The mean age for the sample population was only 38.17, reflecting the fact that Egypt has a young population in contrast to western populations. About half the adult females did not have any school education, being illiterate or barely able to read and write, versus one-quarter of adult males. Adult males were twice as likely as females to be university graduates (19% versus 10%; Table 2.2)

Table 2.1 Sex and mean age at survey of participants

Sex	No.	%	Mean age+ SD	*P* value
Adult males	3077	44	39.5 ± 14.8	$P < 0.001$
Adult females	3873	56	37.2 ± 14.6	
Total	6950	100	38.17 ± 14.7	

Table 2.2 Education of the adult male and female interviewees

Education level (%)	Males	Females	Total
No school education	25	48	38
School education	56	43	49
University or above	19	10	14

P < 0.001

Table 2.3 Prevalence of different smoking type among adult males

Type of smoker	Adult male (%)
Exclusively cigarettes	34
Exclusively waterpipes	10
Mixed smokers	3
Total	47

Smoking prevalence among adult females was less than 1% (this estimate is very liable to underreporting in a household survey) and thus all subsequent analysis focused on male smoking.

These figures are similar to those for adult males all over the world but much lower for adult females. In 2000, globally, just over 47% of men and 10% of women smoked, with a global prevalence rate of 29%. [20] In earlier reports these figures were estimated in Egypt for 2001 to be 40% and 18% among adult males and females respectively, with an overall prevalence of 29%. [21] This current study corrects these estimates for females and confirms that smoking is not a common habit among Egyptian females and young people, which agrees with other published studies. [22, 23, 24] Similarly, Table 2.3 shows smoking prevalence was 47% of adult males, which is close to the 48% that was reported in Alexandria among 1162 males. [24]

Cigarette smoking predominates other methods of smoking, and mixing waterpipe and cigarette smoking was infrequently observed (3%). Figure 2.1 shows that both waterpipe and cigarette smoking was most prevalent between the ages of 41 and 60 years. Cigarette smoking was lower among those between 18–20 years (16%). Waterpipe smoking represents 24%–30% of all smoking patterns in all age groups.ing.

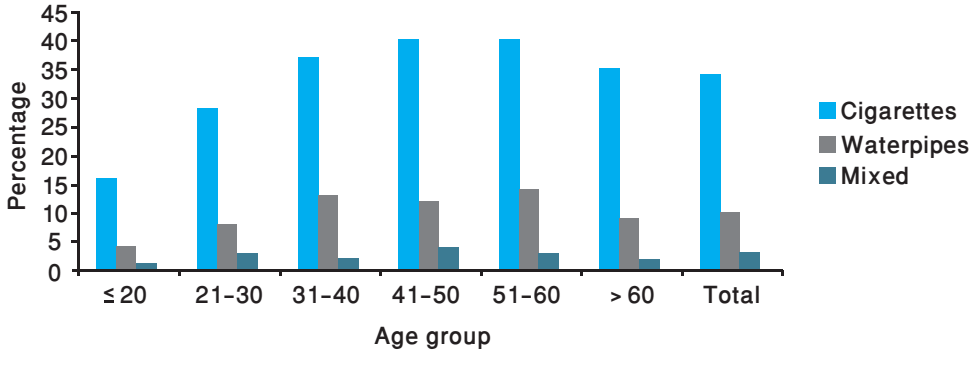


Figure 2.1 Smoking prevalence by age group of males

Smoking prevalence rises with age till 60 years, when a decline is observed (Figure 2.1). It is noticed that waterpipe smoking doubled in males for the 21–30 year age group compared with younger adults, probably due to employment and having independent housing. The decline in smoking rate after the age of 60 could be attributed to higher quitting rates or attrition of smokers by early deaths due to smoking-related diseases among this age group.

In the developed world, tobacco use has generally followed a four-stage model. While not all countries follow this model exactly, [26] it provides a good indication of the likely trends. The model is represented by two line curves: tobacco prevalence over time (100 years, 1900–2000) among males and females with a projection of tobacco-related mortality rates across the same time interval. The model starts by an increasing tobacco prevalence reaching below 20% and little evidence of tobacco-related mortality (stage 1). Both tobacco-related mortality and smoking prevalence increase in stage 2. Later, smoking prevalence starts to drop gradually while tobacco-related mortality increase in stage 3. The model assumes comprehensive tobacco control initiatives in stages 2 and 3, leading to a reported decline in prevalence. [27] The burden of disease attributable to smoking rises clearly in stages 3 and 4 because of the delayed effect of smoking even with the decline of smoking prevalence in the last stage. [25]

Egypt's smoking pattern among males is consistent with stage 2 of the model. The smoking prevalence is around 50% (no decline). [23, 24] What is prominent is a gradual decline in mean age of regular smoking initiation across different birth cohorts, which is a characteristic of stage 2 epidemic (Figure 2.2). This entails longer lifetime duration of smoking and consequently increases the burden of smoking-related diseases. For those born before 1930 (currently at 70 years and above) smoking waterpipes started earlier than smoking cigarettes.

Figure 2.2 shows that most cigarettes smokers born before 1950 started smoking in the 1970s after the 1967 and 1973 wars. Egypt has the highest cigarette consumption in the Eastern Mediterranean Region. In 1999, Egypt consumed 46 600 million cigarettes, or 24% of the total regional consumption, despite that Egypt only accounted for 21% of the Region's total population. Overall cigarette consumption in Egypt rose from 10 000 to 40 000 million pieces (~30 to above 60 packs per person 15 years and older) between 1970 and 1985 (Figure 2.3).

The age of initiation of waterpipe smoking continues to be higher for those born between 1950 and 1980 with a progressive decline for both waterpipe and cigarettes until the two lines met again for those born in the 1990s. An increase in waterpipe smoking was reported in this period in Egypt [11] and in other Arab countries such as the Syrian Arab Republic. [28] Waterpipe smoking prevalence was reported to be 7% in Alexandria in 2000 [24] and 13% in an unpublished national 2002 study.

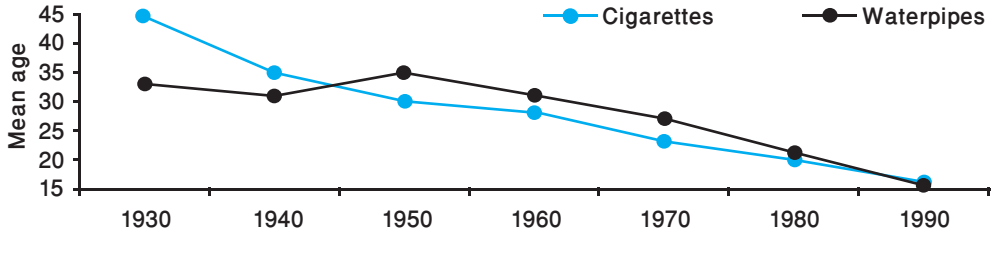


Figure 2.2 Mean age of regular smoking initiation across different birth cohorts

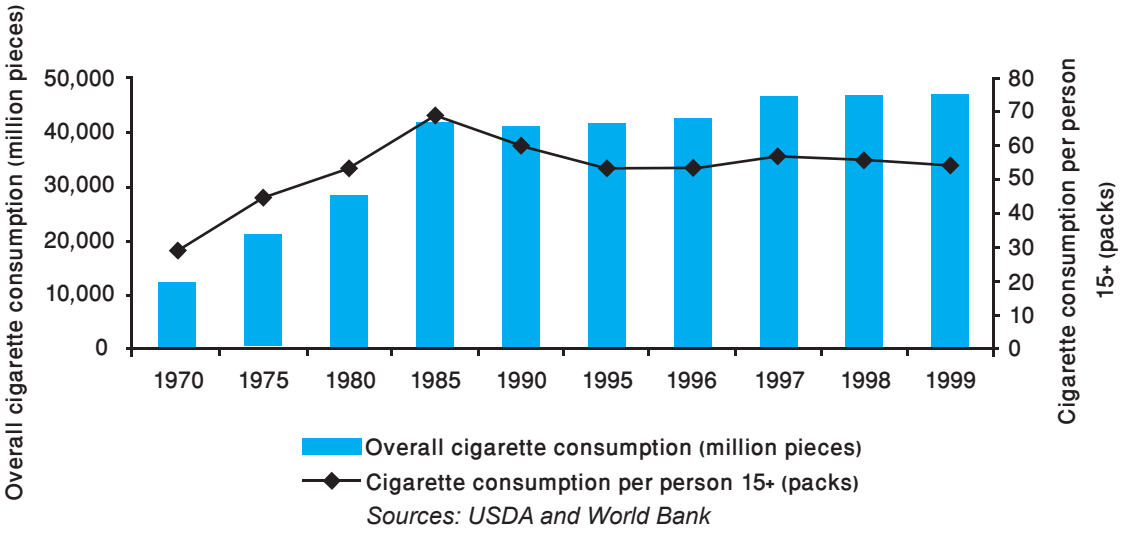


Figure 2.3 Cigarette consumption in Egypt, 1970–1999

In 1999 the Egyptian Ministry of Health and Population estimated the average daily cigarette consumption for smokers to be 13.7 cigarettes per day. [29] A 34% increase in daily cigarette consumption was detected in this study compared to the 1999 data (making about an 11% annual increase, with an average consumption of 19 cigarettes per day). The increase in the dose of tobacco consumption along with an increased number of smokers will be reflected in the future (stage 4 epidemic) by more disease burden according to Lopez et al. [28]

2.5 Smoking, hypertension, diabetes and obesity association

In Table 2.4 and Table 2.5 the association of other major risk factors (hypertension, diabetes and obesity) for many cardiovascular diseases is presented.

Table 2.4 Prevalence of different types of hypertension, tobacco use, high random blood glucose and obesity among adult males and females

Morbidity variable		Males (%)	Females (%)	Overall (%)
***n* =**		**3077**	**3873**	**6950**
Diastolic hypertension		21.8	21.6	21.7
Systolic hypertension *		13.1	15	14.2
Systolic or diastolic hypertension		25.2	24.9	25.1
High random blood glucose		8.9 (*n* = 2555)	10 (*n* = 3624)	9.6
Use of any tobacco product **		47 (*n* = 3040)	1.5 (*n* = 3831)	21.6
Abdominal obesity **		50.3 (*n* = 2686)	74.3 (*n* = 3402)	63.7
Risky waist measure **		25.2 (*n* = 3018)	58.4 (*n* = 3830)	43.8
BMI**	Overweight	33.6 (*n* = 2865)	30.8 (*n* = 3524)	32.0
	Obese	23 (*n* = 2865)	43.3 (*n* = 3524)	34.2

* P < 0.05, ** P < 0.01

Table 2.5 Hypertension, high random blood glucose and obesity among cigarette users and waterpipe smokers

Morbidity variable	All participants				
	Non-smokers	Cigarette smokers		Waterpipe smokers	
n =	1890	924		227	
	%	%	OR (95%CI)	%	OR (95%CI)
Diastolic hypertension	21.1	22.7	1.1 (0.93–1.25)	24.7	1.2 (0.9–1.5)
Systolic hypertension	12.8	13.3	1.04 (0.9–1.3)	15.4	1.3 (0.9–1.8)
Systolic or diastolic hypertension	24.0	27.4*	1.20 (1.00–1.43)	26.9	1.1 (0.89–1.41)
High random blood glucose	8.0	8.7	1.09 (0.82–1.45)	8.6	1.07 (0.67–1.72)
Abdominal obesity	49.7	56.7*	1.14 (1.05–1.23)	62.6**	1.70 (1.24–2.31)
Risky waist measure	9.6	11.1	1.18 (0.90–1.56)	12.8	1.39 (0.88–2.18)
BMI > 30 obese	24.2	20.6*	0.81 (0.66–0.99)	25.2	1.06 (0.76–1.46)

* P < 0.05, ** P < 0.01

Hypertension was reported to be 25.7%, 26.9%, and 26.3% among males, females and overall, respectively, in Egyptians above 25 years old in a previous national survey. [30] In comparison the current study shows that in this same age group, the estimates of prevalence of hypertension were slightly higher at 28.7%, 30.4%, and 29.6%, respectively (data not presented). Females had significantly more systolic hypertension (15%) than did males (13%), while both had a high proportion of diastolic hypertension (21.6% and 21.8% respectively). Table 2.4 shows that females were more likely to be obese by BMI (43.3%) and WHR (74.3%) and a risky waist measure 58.4%— abdominal type obesity, which has been associated with cardiovascular disease risk,—in comparison to males (23%, 50.2%, and 25.2% respectively). Tobacco use is still a predominantly male behaviour in Egypt. [11] It was observed that only a small fraction of females smoked (1.5%), which is consistent with previously reported research. [31,32,33, 34] It is worth mentioning that only 43.4% and 25.9% of males and females had a normal body weight.

There was an observed significant increase in the proportion of those having systolic high blood pressure and abdominal obesity among cigarettes smokers than among non smokers. A significantly greater prevalence of abdominal obesity was observed among waterpipe smokers compared to nonsmokers. In general, Egyptian males seem to have a high proportion of risky abdominal obesity (> 50%) and risky waist measures (> 9%) as well as obesity (> 24%).

Taking the nonsmokers as the reference group, the odds of developing hypertension were calculated for different smoker age groups. Below the age of 40 years, waterpipe smokers had non-significant higher odds of developing systolic**,** diastolic and overall hypertension than nonsmokers or cigarette smokers, while they had significantly more abdominal obesity and overall obesity than the other groups (Table 2.6). In the age groups 40–59 years and > 60 years (Tables 2.7 and 2.8), both smoker groups had similar prevalences of different hypertension types compared with nonsmokers.

Table 2.6 Hypertension, high random blood glucose and obesity among different smokers aged < 40 years

Morbidity variable	All participants				
	Non-smokers	Cigarette smokers		Waterpipe smokers	
***n* =**	**1048**	**424**		**110**	
	%	%	OR (95%CI)	%	OR (95%CI)
Diastolic hypertension	12.0	13.0	1.09 (0.78–1.53)	16.4	1.43 (0.84–2.45)
Systolic hypertension	5.2	5.9	1.15 (0.71–1.88)	8.2	1.64 (0.79–3.42)
Systolic or diastolic hypertension	13.5	15.3	1.16 (0.84–1.59)	18.2	1.42 (0.85–2.37)
High random blood glucose	1.6	3.2	1.98 (0.91–4.32)	2.9	1.79 (0.52–6.12)
Abdominal obesity	35.0	38.0	1.16 (0.90–1.50)	54.0**	1.57 (1.27–1.93)
Risky waist measure	5.8	4.6	0.78 (0.46–1.34)	10.5	1.81 (0.95–3.43)
BMI > 30obese	16.4	15.5*	0.75 (0.57–0.98)	21.2*	1.47 (1.03–2.73)

* P < 0.05, ** P < 0.01

Table 2.7 Hypertension, high random blood glucose and obesity among different smokers aged 40–59 years

Morbidity variable	All participants				
	Non-smokers	Cigarette smokers		Waterpipe smokers	
***n* =**	**645**	**410**		**94**	
	%	%	OR (95% CI)	%	OR (95% CI)
Diastolic hypertension	27.4	26.6	1.0 (0.7–1.3)	27.7	1.0 (0.6–1.4)
Systolic hypertension	17.8	15.1	0.8 (0.6–1.2)	21.3	1.0 (0.6–1.6)
Systolic or diastolic	31.6	32.7	1.1 (0.8–1.5)	29.8	0.58 (0.34–0.99)
High random blood glucose	14.4	11.0	0.77 (0.53–1.10)	12.6	0.88 (0.49–1.58)
Abdominal obesity	67.7	70.0	1.03 (0.94–1.13)	70.5	1.04 (0.89–1.22)
Risky waist measure	12.6	16.6	1.32 (0.95–1.82)	16.0	1.26 (0.73–2.18)
BMI > 30 obese	35.7	25.7	0.98 (0.81–1.19)	30.3	0.85 (0.61–1.19)

In Tables 2.6 through 2.8, association of smoking and prevalence of hypertension was observed among the younger age group although statistically it was not significant; this association was accompanied by lower odds ratios in older age groups. This denotes that the effect of other factors that are associated with increased blood pressure is much more powerful than smoking. It was clear that waterpipe smokers were generally more obese (below 40 years), especially in the abdominal type of obesity. Abdominal obesity has been linked to diabetes and hypertension. [35,36] Thus waterpipe smokers may be at higher risk in having high random blood glucose and hypertension, increasing disease burden. [37] This was observed in the group less than 40 years old where the odds ratio of high random blood sugar was 1.98

Table 2.8 Hypertension, high random blood glucose and obesity among different smokers aged ≥ 60 years

Morbidity variable	All participants				
	Non-smokers	Cigarette smokers		Water-pipe smokers	
n =	163	108		29	
	%	%	OR (95% CI)	%	OR (95% CI)
Diastolic hypertension	48.2	51.1	1.06 (0.83–1.36)	52.2	1.08 (0.71–1.64)
Systolic hypertension	36.5	40.0	1.09 (0.80–1.50)	26.1	0.71 (0.35–1.45)
Systolic or diastolic hypertension	54.4	60.0	1.10 (0.89–1.37)	56.5	1.04 (0.71–1.52)
High random blood glucose	21.7	24.3	1.12 (0.67–1.87)	21.1	0.97 (0.39–2.44)
Abdominal obesity	70.9	82.3*	1.16 (1.01–1.34)	72.2	1.02 (0.75–1.38)
Risky waist measure	20.0	18.4	0.92 (0.53–1.61)	10.5	0.53 (0.14–2.02)
BMI > 30 obese	28.7	21.4	0.75 (0.47–1.20)	23.8	0.83 (0.37–1.85)

(95% CI 0.91–4.32) among cigarette smokers and 1.79 (95% CI 0.52–6.12) among waterpipe smokers. Although smokers tended to be less obese in older age groups (Tables 2.7 and 2.8), they maintained the higher prevalence of abdominal obesity pattern.

Several points are important in examining these results.

Lifestyle is considered an important factor in smoking waterpipes. [11] Obesity is a natural outcome of a relaxing and steady life, which fits the lifestyle of waterpipe smokers in most cases. It is well known that most waterpipe smoking occurs in cafés with friends in a relatively non-stressful environment. Reversal of these criteria in older age may indicate that the obese are no longer smokers, as their disease has progressed more rapidly than the nonsmokers, forcing them to stop smoking.

In data that are not presented, we stratified the development of hypertension by abdominal obesity. Among individuals with no abdominal obesity above 60, waterpipe smokers were significantly more prone to develop hypertension (75% waterpipe smokers versus 18% nonsmokers, $P < 0.05$). Also, among those above 60 years old with abdominal obesity, there was double the rate of having either systolic or diastolic hypertension (37% versus 19%) than nonsmokers.

Elevated blood pressure above average in response to stressful conditions could be considered a step towards a persistent elevation. When we tested the effect of smoking on blood pressure reported from the first reading, a significant elevation of blood pressure was noticed among smokers compared to nonsmokers below the age of 40 years (5% among nonsmokers versus 8% and 11% among cigarette and waterpipe smokers respectively. [38]

In unpresented data, the lack of positive correlation of the current smoking dose and blood pressure measures may indicate a change in smoking pattern over time; hypertensive

individuals are cutting back the number of pipes smoked. This is an established step in the progression to quit smoking. [39]

Smoking duration was significantly positively correlated with systolic blood pressure among waterpipe smokers ($r = 0.2$, $P < 0.05$; non-presented data).

Among cigarette smokers smoking duration was significantly positively correlated with systolic ($r = 0.27$, $P < 0.001$) and diastolic blood pressure ($r = 0.21$, $P < 0.001$) along with the random blood glucose levels ($r = 0.15$, $P < 0.001$). Many believe cigarette smoking suppresses body weight. [40, 41] It was observed that cigarette smokers were less likely to be obese in comparison to waterpipe smokers. This may be due to a sedentary life associated with non-portable waterpipe smoking compared to cigarettes.

This study revealed a superadded risk factor for waterpipe smokers, which is obesity. Thus, they may be at a greater risk for other morbidities. Egypt, according to the tobacco epidemic curve, [25] has started to suffer smoking consequences at a community level. In the early 1990s, smoking-related mortality was estimated to be 704 deaths/100 000 among males and 287 deaths/100 000 among females, both above the age of 35. [42] Also, some differences are expected in developing countries, where life expectancy is low and premature mortality and chronic morbidity are high; smoking is likely to have wider health effects earlier than has been the case in developed countries. [43] Health education programmes should explain the risk augmentation for obese individuals who smoke: waterpipe smoking is no safer than cigarette smoking.

As was also documented in the Egyptian National Hypertension Project, [44] it is striking that those individuals who were aware of their hypertensive status constituted a minority of the detected cases and their hypertension was mostly uncontrolled (Tables 2.9 and 2.10). The newly diagnosed cases were much more often under the age of 40 years than other age groups (92% among females and 89% among males; Table 2.9). Thus at least 70% of the individuals in a given age group were not aware of being hypertensive.

Table 2.9 Proportion of hypertensives who were newly diagnosed

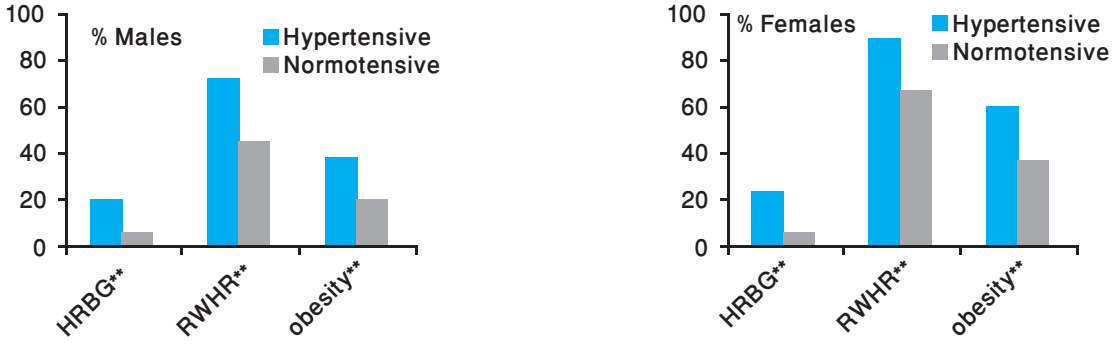
Proportion of hypertensive who were:		< 40 years	40–59 years	≥ 60 years	Overall
Male	$P < 0.001$	$n = 234$	$n = 385$	$n = 181$	
newly diagnosed		91.5%	81.3%	75%	83%
Female	$P < 0.001$	$n = 263$	$n = 497$	$n = 243$	
newly diagnosed		88.6%	74.6%	71.2%	78%

Table 2.10 Proportion of previously diagnosed hypertensives who were uncontrolled

Proportion of previously diagnosed hypertensive who were:	< 40 years	40–59 years	≥ 60 years	overall
Male	*n* = 20	*n* = 72	*n* = 45	
uncontrolled	15%	59%	38%	60%
Female	*n* = 30	*n* = 126	*n* = 70	
uncontrolled	70%	86.5%	84.3%	66%

Obesity (by BMI and WHR) and high random blood glucose were more prevalent among hypertensive individuals than the normotensives (Figure 2.4). Hypertensive males had OR = 3.5 (95% CI 2.4–5.1) and 3.1 (95% CI 2.3–4.1) for high random blood glucose (HRBG) and risky waist–hip ratio (RWHR) respectively. This was more apparent among females than males. They had OR = 5.9 (95% CI 4.5–7.8) and 3.3 (95% CI 2.4–4.6) for HRBG and RWHR respectively. The prevalence of obesity among hypertensive participants (Figure 2.4) was higher than the figures recorded by Egyptian National Hypertension Project that started in 1991. That project reported a 33% and 47% of obesity prevalence among adult males and females respectively. [45] This change may reflect an increase in obesity in the general population with change in dietary habits and rapid modernization.

Hypertension occupies the second place on the risk factors for overall health list in developing countries. [2] Isolated diastolic hypertension is more dangerous than the isolated systolic hypertension. Diastolic period is the time of maximum coronary perfusion, where blood flows to the heart tissues. Both systolic and diastolic hypertension increased with age, with diastolic hypertension more prevalent among each group, which carries a greater risk for cardiovascular complications. The effect of hormonal protection among females was demonstrated by the reversing sex trend after menopause (females had higher rates after 40 years and lower ones before this age. [46,47]



**P < 0.001 HRBG = high random blood glucose RWHR= risky waist–hip ratio

Figure 2.4 Comparison of the prevalence of high random blood glucose, risky waist hip ratio and obesity among hypertensive and normotensive adult males and females

2.6 Limitations of the study and recommendations

This study on tobacco habits accompanied another survey with a different health focus. Relatively few questions were asked about smoking, and therefore it is not possible to look in depth at important issues such as addiction, motivating factors, beliefs, or quitting behaviour. This survey investigated only current smoking status; former smoking patterns were not identified. Also, the cross-sectional design is useful for focusing on associations of interest that can be further studied in the future.

Among the contributions of this survey to existing knowledge of tobacco use in Egypt are the associations described above that suggest numerous differences between cigarette users and waterpipe users. It seems clear that, in addition to striking age- and sex-related patterns of behaviour and morbidity, the two types of tobacco user may differ strongly according to various markers of obesity which may be reflected in the pattern of cardiovascular disease associations with each type of tobacco use.

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3 National survey on cigarettes and waterpipe smoking in Egypt, 2005

3.1 Introduction

A multistage, random sampling method was used to recruit household persons from the general population of Egypt for a survey designed to generate estimates of tobacco use prevalence. Stage one was to obtain a random stratified cluster sample of the administrative districts of Egypt. The sampling frame was the list of administrative districts of Egypt (n = 323). These districts were stratified into six geographic and urban/rural strata as shown in the following table. Districts for each stratum were listed in an Excel spreadsheet in the same order as in the CAPMAS (Central Agency for Public Mobilization and Statistics). A one-fifth (20%) proportional stratified random sample of all districts was obtained using random number generation in Excel software. The 65 sampled districts were in 25 governorates of Egypt (out of 27 total governorates).

Geographic stratum	Districts	Sampled districts
Frontier areas	36 qism and markaz	7
Metropolitan areas	70 qism	14
Rural Lower Egypt	85 markaz	17
Urban Lower Egypt	38 qism	8
Rural Upper Egypt	68 markaz	14
Urban Upper Egypt	26 qism	5
Total	**323**	**65**

Qism is the Arabic for an urban district.
Markaz is the Arabic for a mainly rural district.

Stage two obtained a clustered random sample of local villages (for the sampled rural districts) and local areas within cities (for the sampled urban districts). The sampling frame for rural districts (*markaz*) was the list of villages from the same CAPMAS reference, and we randomly selected two villages to represent each district.

The sampling frame for urban districts (*qism*) was the list of police jurisdictions (*shiakha*), and we randomly selected two such jurisdictions for each urban district. This process resulted in

the random selection of 122 total sites. The previous two stages were done in the office. The following stages were designed in the office and implemented in the field.

Stage three obtained a cluster random sample of neighbourhoods within the 122 field sites. For this stage, the cluster is defined as a street. Two streets were to be selected from two different areas, one central area and another in a peripheral area. The central area was identified by a certain landmark in the village or city site (such as a bus or train terminus, Ministry of Health and Population health unit, school, mosque or church). Streets in this central area were numbered, and instructions were given to field staff to start numbering at the right hand side and go anticlockwise. For the purpose of random selection of the street, random number tables were prepared using Excel software. The peripheral area was selected as far as possible from the central area, and the same procedure of street sampling was followed. This random selection was done by the field supervisor; the random number that was used was then crossed out in the random number tables, not to be used again.

Stage four obtained a clustered random sample of buildings within the selected streets. The number of buildings in the sampled street were either counted or estimated (in the case of long streets). For the systematic sampling procedure, the sampling fraction was calculated to allow for seven to eight buildings to be sampled in each street. The first building was selected from the same random table. This random selection was done by the field supervisor, and the random number used was crossed in the random table, not to be used again.

In stage five, a clustered random sample of households was obtained. We selected one household from each building: these were almost always flats in the case of urban streets. Using random number tables, the flats were numbered starting at the first floor going up, starting on the right hand side. In village streets, the families in single-family houses were numbered as the families were identified by the interviewer. This random selection was done by the interviewers, and the random number used was crossed out in the list, not to be used again.

Stage six was a random sample of individuals, stratified by age and sex. The family members in each randomly selected household were listed by code or relation in the household (e.g., father, daughter) into four categories (strata) as follows: a) males, 18 years of age and older; b) females, 18 years of age and older; c) males, between 12 and 17 years of age; d) females, between 12 and 17 years of age. We selected one person from each category whenever available, depending on random number tables. This random selection was done by the interviewers, who crossed out the used random number in the list, not to be used again. They then interviewed the randomly selected individuals about the smoking habits using a standard questionnaire. A salivary cotinine test strip was used to validate the self-reported smoking habits.

3.2 Results

The sample response rate was very good for the overall group; however for males, both adults (18 years and above) and adolescents, the response rate was less than females, because most of them were unavailable for two interview visits. Also, a large proportion was working for more than two months outside the place of interview (either abroad or in another governorate). Table 3.1 shows the age, sex and urban/rural status of the surveyed individuals.

Table 3.1 Age, sex and residence distribution of sample subjects and estimated represented population

Age and sex	Rural		Urban	
	Sample	Estimated population	Sample	Estimated population
Male 18 years and older	751	8 678 336	750	8 742 049
Female 18 years and older	970	9 074 143	897	9 737 041
Male younger than 18 years	255	2 158 328	214	1 435 342
Female younger than 18 years	273	2 731 193	180	1 586 576
Total	**2249**	**22 642 002**	**2041**	**21 501 009**

Group 1: current shisha smokers

The next series of tables describes persons who stated they had tried shisha and were current shisha smokers at the time of interview (any day during the four weeks prior to interview day). Tables 3.2 present some basic findings of this group. The prevalence of shisha use among males was somewhat higher in the rural areas compared to urban areas, although the confidence intervals of the two estimates overlap (Table 3.2c).

The following data (Table 3.3) apply only to the sampled individuals (not to be projected to the national level). Among the 212 current smokers of shisha the following parameters give an idea about the number of *korsi* or *hagar* (see Section 1 for terminology) they smoke on the day of shisha use. No statistically significant differences in these parameters were found between rural and urban users (using Mann–Whitney U and Wilcoxon tests). The exposure level of waterpipe tobacco smoking in terms of average number of *hagar* per day is only 2.8 +2.7 (range 1–20/day).

Table 3.2a Prevalence of shisha smoking distributed by age, sex and residence

Age and sex	Rural		Urban	
	No.	%	No.	%
Male 18 years and older	115	15.3	82	10.9
Female 18 years and older	1	0.1	2	0.2
Male younger than 18 years	8	3.1	4	1.9
Female younger than 18 years	0	0.0	0	0.0
Total	**124**	**5.5**	**88**	**4.3**

Table 3.2b Estimated population of current shisha smokers in Egypt

Age and sex	Rural	Urban
Male 18 years and older	1 183 266	916 056
Female 18 years and older	3773	8247
Male younger than 18 years	80 498	40 873
Female younger than 18 years	NA*	NA*
Total	**1 267 537**	**965 177**

*Data on female shisha smoking cannot be estimated due to lack of participation of high socioeconomic families in the national survey.

Table 3.2c Projected population prevalence (%) of current shisha smokers with 95% confidence interval

Age and sex	Rural		Urban	
	%	CI	%	CI
Male 18 years and older	13.6	(10.3–17.8)	10.5	(7.0–15.4)
Female 18 years and older	0.0	(0.0–0.3)	0.1	(0.0–0.4)
Male younger than 18 years	3.7	(1.5–9.0)	2.8	(0.9–8.6)
Female younger than 18 years	NA*		NA*	
Total	**5.6**	**(4.3–7.3)**	**4.5**	**(3.0–6.6)**

*Data on female shisha smoking cannot be estimated due to lack of participation of high socioeconomic families in the national survey.

Table 3.3 Number of *korsi* or *hagar* smoked on day of shisha use

n		212
Mean		2.834906
Median		2
Mode		1
Standard deviation		2.681534
Minimum		1
Maximum		20
Percentiles	25	1
	50	2
	75	4

It is very well shown that there is a 10- year earlier shift for first trial of waterpipe smoking among those 12-17 years, which will add 10 years to the lifelong duration of tobacco use and could be reflected in related increase in smoking associated morbidity. Table 3.4 shows the average age at the time that shisha was first tried, stratified by age group and sex. The younger age group currently started waterpipe smoking 10 years earlier than older smokers. Table 3.5 shows smoking prevalence according to highest educational level attained, and Table 3.6 shows prevalence by age and location.

Table 3.4 Age at first shisha smoking

Age and sex	Number	Mean	Standard deviation
Male 18 years and older	499	24.8	9.6
Female 18 years and older	22	23.6	13.5
Male younger than 18 years	17	14.4	2.7
Female younger than 18 years	2	13.0	1.4
Total	**540**	**24.4**	**9.8**

Table 3.5 Smoking prevalence according to educational level (highest attained)

Highest education level attained	Never used shisha	Not current user	Smoker	Total	Prevalence (%)
Not reading or writing	165	36	40	241	16.6
Read and write	155	57	47	259	18.1
Primary school	67	34	17	118	14.4
Preparatory	60	22	20	102	19.6
Azhar preparatory*	2	2	0	4	0.0
Secondary	43	11	5	59	8.5
Azhar secondary*	6	5	1	12	8.3
Technical secondary	245	69	39	353	11.0
Institute	56	19	11	86	12.8
University	176	47	15	238	6.3
Higher degrees	19	7	2	28	7.1
Total	**994**	**309**	**197**	**1500**	**13.1**

* Azhar teaching system is exactly the same as general education system with added religious courses.

Table 3.6 Adult males prevalence of shisha smoking by age

Age group	Never used waterpipe	Experimental*	Waterpipe Smoker	Total	Never used waterpipe (%)	Prevalence of current smoking (%)
Rural						
18–19	71	9	8	88	80.7	9.1
20–	6. 57	11	14	82	69.5	17.1
25–	46	14	11	71	64.8	15.5
30–	62	17	8	87	71.3	9.2
35–	70	17	16	103	68.0	15.5
40–	51	8	15	74	68.9	20.3
45–	46	9	6	61	75.4	9.8
50–	30	10	14	54	55.6	25.9
55–	22	12	10	44	50.0	22.7
60–	22	10	7	39	56.4	17.9
65–	13	3	4	20	65.0	20.0
70–	7	4	1	12	58.3	8.3
75–	10	1	1	12	83.3	8.3
80+	3	1	0	4	75.0	0.0
Total	**510**	**126**	**115**	**751**	**67.9**	**15.3**
Urban						
18–19	53	12	7	72	73.6	9.7
20–	60	19	9	88	68.2	10.2
25–	49	18	12	79	62.0	15.2
30–	48	12	10	70	68.6	14.3
35–	61	25	7	93	65.6	7.5
40–	43	31	11	85	50.6	12.9
45–	45	19	9	73	61.6	12.3
50–	31	17	7	55	56.4	12.7
55–	38	11	4	53	71.7	7.5
60–	25	9	2	36	69.4	5.6
65–	8	5	3	16	50.0	18.8
70–	12	4	1	17	70.6	5.9
75–	8	0	0	8	100.0	0.0
80+	4	1	0	5	80.0	0.0
Total	**485**	**183**	**82**	**750**	**64.7**	**10.9**

* Experimental subject who smoked at least once but did not continue to be a regular smoker.

Group 2: non-current waterpipe smokers

Members of a second group of waterpipe users in this national survey (group 2) stated that they had smoked waterpipe, but did not smoke waterpipe for a single day during the four weeks prior to interview day. Tables 3.7 summarize our findings and estimates of total non-current waterpipe smokers.

Table 3.7a Percentage of non-current waterpipe smokers in the sample distributed by age, sex and residence

Age and sex	Rural		Urban	
	No.	%	No.	%
Male 18 years and older	126	16.8	183	24.4
Female 18 years and older	9	0.9	10	1.1
Male younger than 18 years	4	1.6	1	0.5
Female younger than 18 years	2	0.7	0	0.0
Total	141	6.3	194	9.5

Table 3.7b Estimated population of non-current waterpipe smokers

Age and sex	Rural	Urban
Male 18 years and older	1 578 275	1 394 250
Female 18 years and older	94 599	74 874
Male younger than 18 years	46 462	2839
Female younger than 18 years	7765	0
Total	1 727 102	1 471 964

Table 3.7c Projected population percent of non-current shisha smokers with 95% confidence interval of the estimate

Age and sex	Rural		Urban	
	%	CI	%	CI
Male 18 years and older	18.2	(12.6–25.6)	15.9	(12.2–20.6)
Female 18 years and older	1.0	(0.5–2.4)	0.8	(0.3–2.2)
Male younger than 18 years	2.2	(0.6–7.1)	0.2	(0.0–1.4)
Female younger than 18 years	0.3	(0.1–1.1)	0.0	
Total	7.6	(5.3–10.9)	6.8	(5.3–8.8)

Limitations of this study

Interpretation of these findings presented should consider the preliminary nature of these results. The final results are not yet available. The country representation of the sample will be examined and some adjustments to the national prevalence figures for tobacco use will be available with the final results.

Acknowledegment

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4 Epidemiology of waterpipe smoking in the rural areas of the Nile Delta

4.1 Introduction

Globally, 4.9 million deaths each year are attributed to tobacco use, and this annual toll may increase to 10 million within the next 20 to 30 years. Of these deaths, 70% are likely to occur in developing countries. [1]

The waterpipe is an old smoking method that is attracting new customers. In the countries of the Eastern Mediterranean Region, waterpipe smoking is spreading. In Egypt, early in the 1970s, a chest professor conducted some studies on this phenomenon [2,3,4] and predicted an increase in this smoking method in Egypt. [5]

Syrians reported the upward increase in its consumption from the early 1990s. [6] In Asia, where—traditionally—the waterpipe was born, an increase in its popularity has also been reported. [7] Waterpipe smoking is also increasing in Egypt with a progressively wider distribution of cafés attracting new customers, yet the epidemiology of waterpipe smoking has never been studied precisely in Egypt. Public health authorities lack basic information on which to base interventions, regulations, laws, and other forms of tobacco control policies for waterpipes.

The aim of this study is to study the prevalence of waterpipe smoking (shisha, as named in Egypt) among rural Egyptians and to define the determinants of shisha smoking in these areas.

4.2 Methods and participants

Selection of villages

Qalyubiyah governorate is the closest rural governorate to Cairo and very similar to all rural areas in lower Egypt and thus was selected to be surveyed. All villages in the Qalyubiyah governorate in the Nile Delta were identified. Nine villages were selected randomly.

Selection of households

Representative household systematic random samples were selected from each village after mapping. The smaller villages (1500 to 2000 households) were slightly oversampled (1:6 or 250 to 300 households), while the sample was 1:8 or 325 to 375 households from the larger villages (2500 to 3000 households).

Selection of subjects within the households

All household members 12 years of age and older were invited to participate. Informed consent was initially obtained from the head of the household and then from all studied participants individually.

Data collection procedure

The survey was carried out between 2003 and 2004 using interview-administered questionnaires. Two standardized interview questionnaires were administered by trained social workers. One of these questionnaires was designed for adults (18 years and above), while the other was designed mainly for children (12–17 years). These questionnaires were designed to assess:

- household characteristics and socioeconomic characteristics
- demographics including age, sex, level of education, occupation
- knowledge and attitudes related to smoking.
- smoking behaviour: type of smoking (cigarette or waterpipe), initiation of smoking, current pattern of smoking, number of cigarettes/*hagar* smoked per day, duration of smoking, place of smoking, quitting (previous attempts, intention and ability to quit), as well as smoking addiction (the Fagerström addiction scale for cigarette smokers was used)
- knowledge, attitudes and behaviour towards exposure to second-hand smoke
- tobacco-related morbidity.

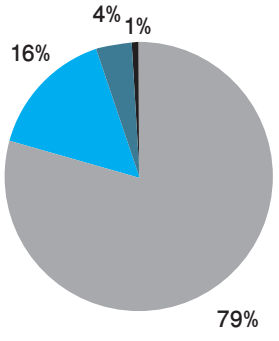
The Arabic version of the questionnaires were back-translated into English in order to ensure their validity. Role-playing was used to ensure the reliability of each question. Piloting was used to test and modify the questionnaires before administration.

4.3 Results

The average response rate was 86% in the nine villages. Adults (18 years and above) totalled 10 161 participants, of whom 49% were male and 51% were female. A total of 2358 subjects, aged between 12 and 17 years, finally participated with 51% male and 49% female.

Waterpipe smoking patterns among rural Egyptians

A total of 10 161 individuals were surveyed; cigarette smoking and waterpipe smoking were reported by 16% and 4% of the participants respectively and only 1% reported smoking both (Figure 4.1). Among females, only 0.3% reported smoking, so further analysis was focused on males.Among 4994 males interviewed, 34% were current cigarette smokers, 9% smoked waterpipe and 1% smoked both types of tobacco (Figure 4.2).



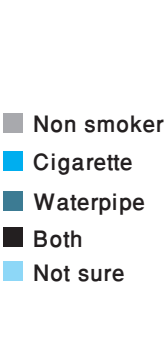


Figure 4.1 Overall smoking pattern among rural Egyptians 2004

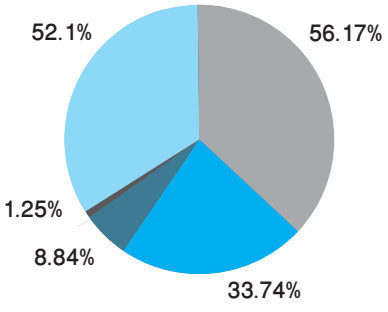


Figure 4.2 Smoking pattern among rural Egyptian males 2004

Smoking prevalence increased with age for cigarette and waterpipe smoking. For the cigarette smokers it peaked in the 40–50 age group while for the waterpipe the peak prevalence was detected above the age of 50 years (Figure 4.3).

A steady decrease in the mean age of smoking initiation in successive birth cohorts were observed among cigarette and waterpipe smokers (Figure 4.4).

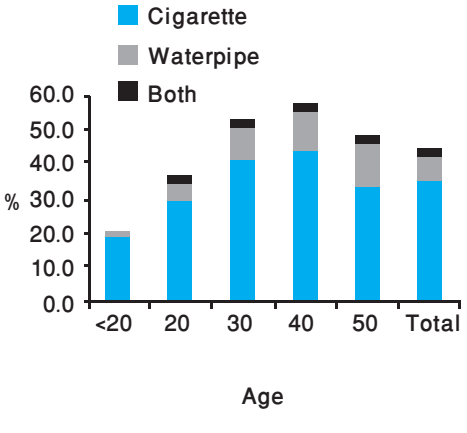


Figure 4.3 Smoking pattern among rural Egyptian males in relation to their age

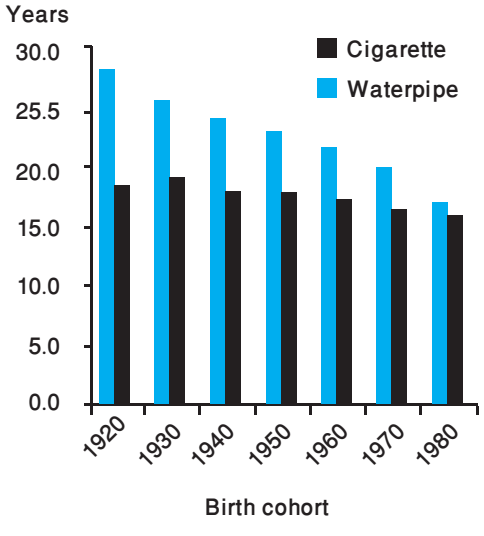


Figure 4.4 Average age of smoking initiation of rural Egyptian men in relation to their birth cohort

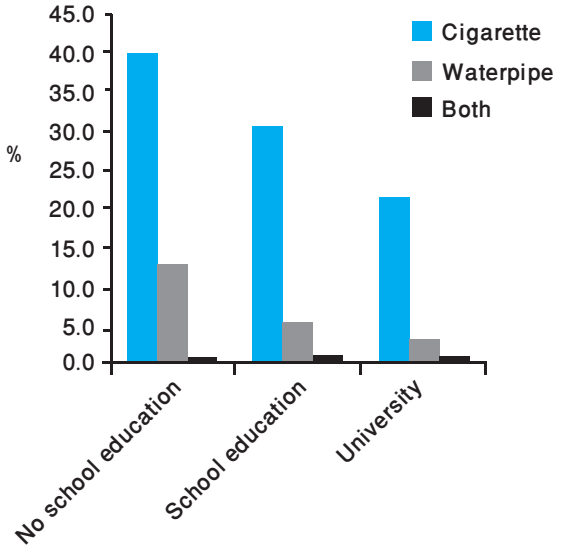


Figure 4.5 Rural Egyptian smoking patterns in relation to education

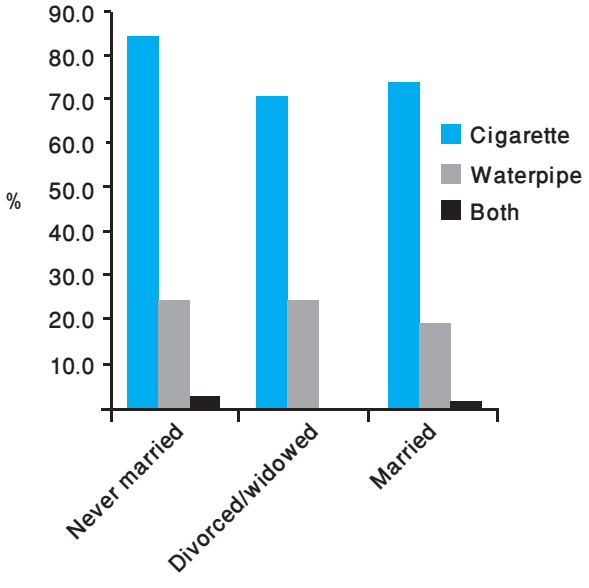


Figure 4.6 Rural Egyptian smoking patterns in relation to marital status

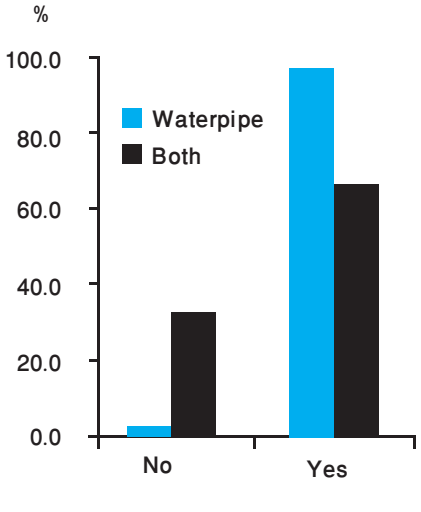


Figure 4.7 Owns a waterpipe at home

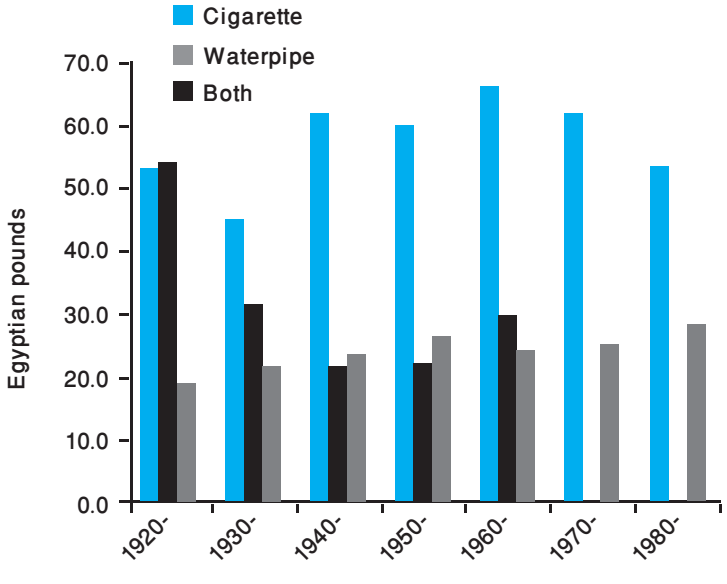


Figure 4.8 Average rural Egyptian male expenditure on smoking in relation to date of birth

Waterpipe smoking and cigarette smoking were significantly higher among less educated rural Egyptian men (Figure 4.5). The prevalence of waterpipe smoking was higher among the divorced and widowed, while cigarette smoking was more prevalent among the never married (Figure 4.6).

Waterpipe smoking practice in rural Egypt

Most of the rural males who smoked waterpipe owned their own waterpipe at their homes (Figure 4.7). A minority of exclusive waterpipe smokers as well as mixed smokers smoked in cafés (15% and 32%, respectively).

A gradual increase in the expenditure on waterpipe smoking in successive birth cohorts was clear (Figure 4.8), being highest in the youngest birth cohorts (28.7 Egyptian pounds/ month).

A minority of waterpipe smokers avoided smoking around their wives and children (by smoking in another room or outside the house; Figures 4.9 and 4.10).

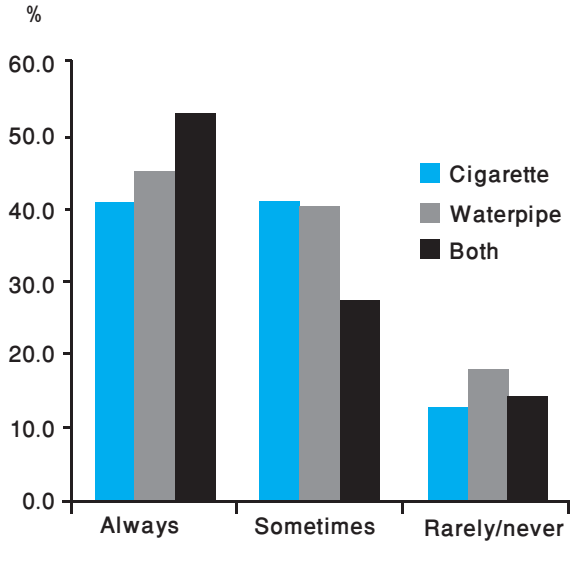


Figure 4.9 Rural Egyptian smoking practice in relation to presence of wives at home

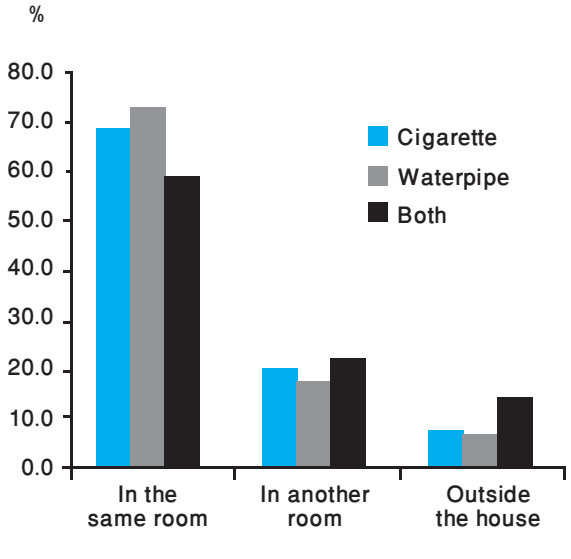


Figure 4.10 Rural Egyptian smoking practice in relation to presence of children

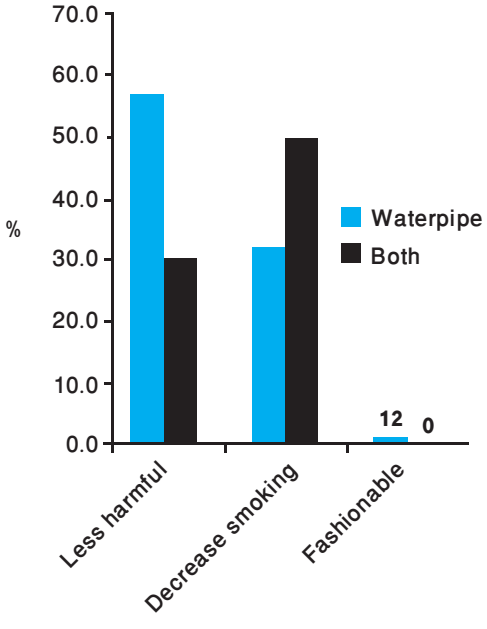


Figure 4.11 Rural Egyptian waterpipe smokers' reasons for preferring waterpipe smoking

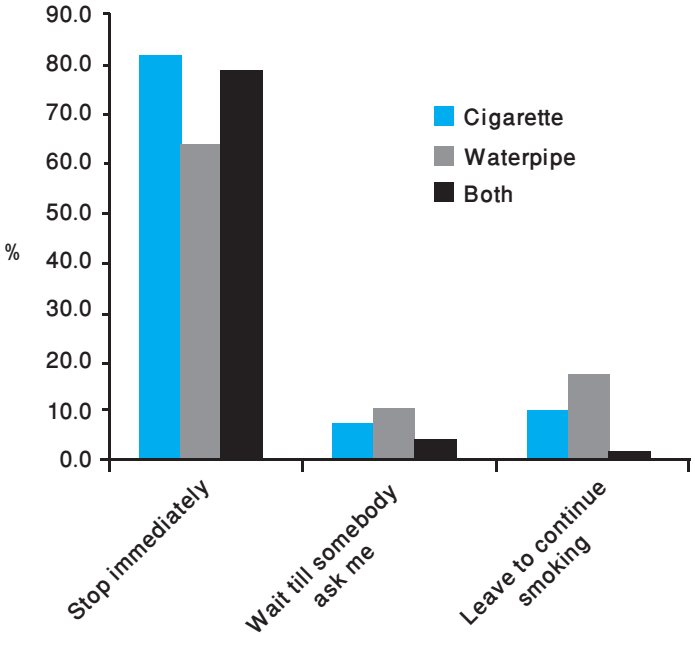


Figure 4.12 Practice of rural Egyptian smokers in no-smoking areas

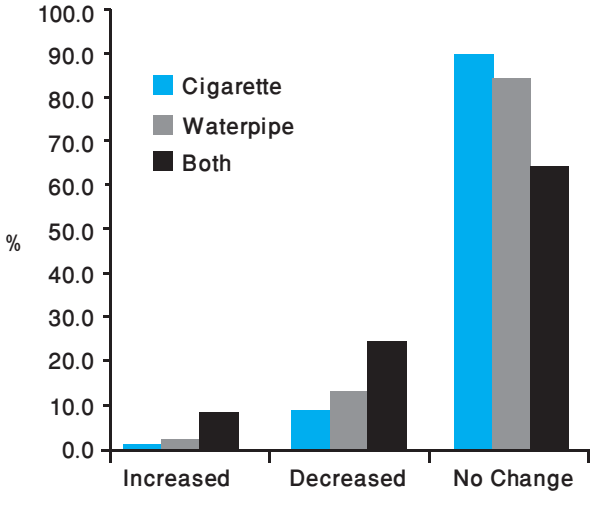


Figure 4.13 Change in smoking pattern during the year prior to the survey among rural Egyptian smokers

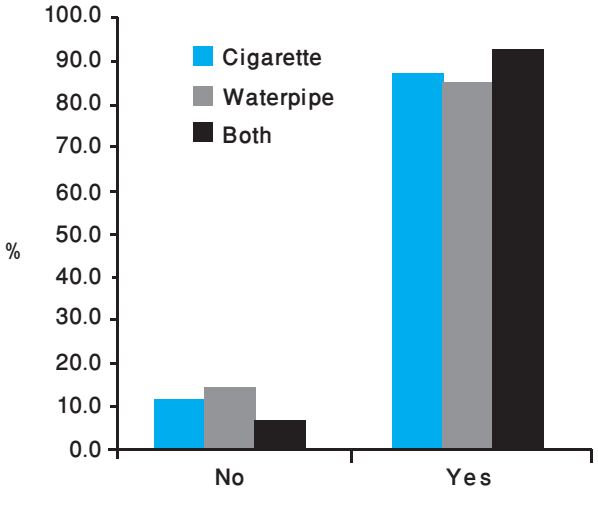


Figure 4.14 Willingness to quit smoking among rural Egyptians

Many waterpipe smokers (57%) have a misconception that it is less harmful than cigarette smoking. Even those who do not think this way reported that waterpipe smoking decreases the amount of cigarette consumption (Figure 4.11). Most of the participants showed respect for nonsmoking areas (Figure 4.12).

The changes in individual smoking patterns reported among rural Egyptian smokers were mostly minimal (Figure 4.13).

Quitting waterpipe smoking among rural Egyptians

Most of the smokers interviewed were willing to quit (Figure 4.14). Many of them stated that they could quit whenever they wanted (Figure 4.15). However, only a few had tried to quit during the year before the study (Figure 4.16). The most common reason for quitting smoking was to improve health.

Most of the smokers interviewed who had attempted to quit reported that they had received help. It was mainly provided by a family member (Table 4.1)

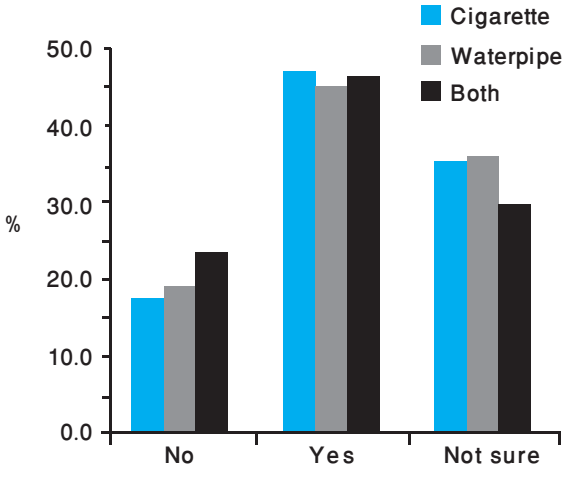


Figure 4.15 Perceived ability to quit smoking among rural Egyptians

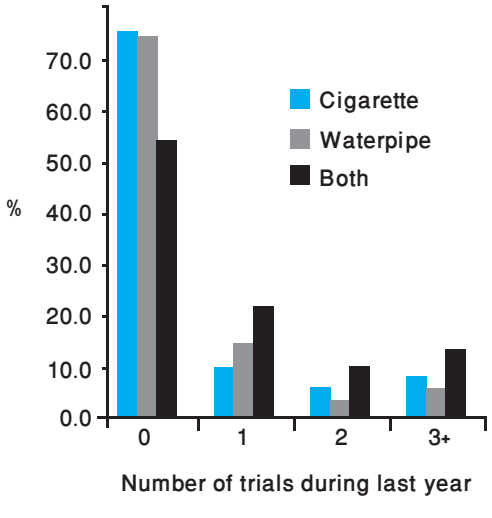


Figure 4.16 Smoking quitting attempts among rural Egyptians

Table 4.1 Proportion of smokers who received help to quit smoking and the source of help among different types of smoker (%)

Receiving help to quit	Cigarette	Waterpipe	Both	Total
No	27.8	40.0	21.7	30.1
Yes	72.2	60.0	78.3	69.9
From whom this help was given:				
Health care professional	16.7	20.2	25.0	17.4
Friend	9.0	4.2	0.0	8.1
Family member	71.3	74.4	62.5	71.7
Imam or priest	2.4	1.2	12.5	2.3
Others	0.6	0.0	0.0	0.5

Table 4.2 Planning to quit smoking (during the year next to the survey) among rural Egyptians (%)

Planning to quit next year	Cigarette	Waterpipe	Both	Total
No	16.2	16.5	20.0	16.3
Yes	31.7	28.0	28.3	30.8
Not sure	52.1	55.5	51.7	52.8

Table 4.3 Exposure of rural Egyptians to anti-smoking messages during the six months prior to the survey (%)

No of times of exposure to anti-smoking messages	Cigarette	Waterpipe	Both	Total
Never	12.6	10.4	30.0	12.7
Once	16.0	10.6	10.0	14.7
2–5	44.4	43.5	28.3	43.7
6+	27.0	35.5	31.7	28.9

Table 4.4 Opinion of rural Egyptians on raising taxes on cigarettes to prevent children smoking (%)

Opinion on raising taxes on cigarettes	Cigarette	Waterpipe	Both	Total
Yes	1.5	2.1	1.7	1.7
No, it is already high	23.4	11.5	3.3	20.4
No, it is not the way to stop them	73.9	82.1	95.0	76.2
Not sure	1.1	4.0	0.0	1.7

Nearly one-third of all smokers were planning to quit smoking in the year after the survey (Table 4.2).

Most of the Egyptian villagers had been exposed to antismoking messages (Table 4.3). They knew about the fatwa: 80.5%, 78.8% and 65% of waterpipe smokers, cigarettes smokers and mixed smokers respectively. This fatwa was a religious ruling by the highest clerical authorities in Egypt, stating that smoking is sinful and should not be practised by Muslims. Most of the respondents personally believed that smoking is a sin: 90%, 89% and 73% of waterpipe, cigarettes smokers and mixed smokers respectively.

Interviewed smokers thought that raising taxes on cigarettes would not help in keeping children away from smoking (Table 4.4).

4.4 Discussion

Shisha smoking is becoming increasingly popular in Egypt and other Arab countries. [8,9] This study was carried out in rural Egypt in nine villages in one of the Nile Delta governorates. The prevalence of cigarette smoking was found to be higher than waterpipe smoking in rural Egypt as in other areas of Egypt. [10,11,12,13,14] However, most of the previous research focused on cigarette smoking, indicating the real gap of knowledge about the epidemiology of waterpipe smoking. [2,15,16,17,18]

In the current study and in previous studies, [9,19,20] waterpipe smokers reported that they smoke waterpipe only. We found that the prevalence of those smoking waterpipe only was 9%, while the number of those who smoked both waterpipe and cigarettes was much less (1%).

In Egypt, few studies have been conducted to determine the prevalence of waterpipe smoking among different groups, or compared urban and rural populations. One study [21] compared smoking patterns between medical students and physicians. They found higher rates of smoking among physicians (18.2 % compared with 24.3%). When asked about other types of tobacco use, medical students had reported more waterpipe smoking than physicians (35.3% compared with 15.1%, $P < 0.001$). This would show the increased popularity of waterpipe smoking among the younger generation. On the other hand, another study [22] showed that only 1% of 41 Egyptian final-year medical students were waterpipe smokers, although most of them (83%) were cigarette smokers.

Considering geographic patterns among tobacco smokers, Salem and colleagues [23] found that the more rural an area is, the more waterpipe use there will be. They found that from urban to semi-rural to rural the cigarette to waterpipe prevalence was 87%:11%, 73%:26%, 64%:31%, respectively, among teachers in Giza governorate. The authors attributed these differences to local culture. A systematic random survey that was carried out in a rural village in Upper Egypt showed a different finding. Waterpipe smoking prevalence was nearly double the rate of cigarette smoking: 9.4% and 4.9% respectively. [24] Upper Egypt is different culturally and socioeconomically from Lower Egypt. The Upper Egyptian village where that study was carried out is one of the poorest villages. Most of the inhabitants (78.1%) were classified by the authors as having very low socioeconomic status. These results agree to some extent with ours as it is obvious that our villagers' expenditure on smoking showed that waterpipe smokers are spending nearly half what the cigarette smokers do on smoking, The average number of tobacco *hagar* for the waterpipe smokers in Egypt is 2 *hagar*/day compared to an average of

20 cigarettes per day for cigarette smokers. While the cost for a *hagar* of tobacco is between 0.5 and 2 Egyptian pounds (a total cost of 1–4 Egyptian pounds per day; US$1 ≈ 5 Egyptian pounds) while the range cost of 20 cigarettes is between 3 and 6 Egyptian pounds (Figure 4.8). Our study also showed that smoking in general (waterpipe and cigarette smoking) in rural Egypt is more prevalent among the less educated people (Figure 4.5). Those populations spend less money as they are usually poorer than the better educated. Most of them have their own waterpipes in their houses. These results are supported by another publication of Salem and his colleagues [25] using a small sample (156 persons), which found that farmers and labourers (who are usually less educated) were more likely to smoke waterpipes.

Reviewing the age cohort of waterpipe smoking initiation (Figure 4.4) showed that the age of initiation of cigarette smoking dropped less than three years (from 18.5 to 15.9 years) in 60 years where at the same time the age of initiation of waterpipe smoking dropped 11 years. This would explain the result of a 2001 study carried out among university students that showed an increase in the prevalence of waterpipe smoking among this age category [21].

Other Arab countries also showed an increasing prevalence of waterpipe smoking much more than that observed in Egypt. In the Syrian Arab Republic, about half of university students report having ever used a waterpipe, and about a quarter of males currently smoke it. [8] In Lebanon, 30.6% of male students and 23.4% of female students at Beirut universities reported current, weekly waterpipe use in 2001. [9] Data from a national survey in Kuwait show that 57% of men and 69% of women had used waterpipes at least once [26].

In a Syrian study, [6] the time of initiation of waterpipe use and cigarette smoking was compared across several birth cohorts in Aleppo. They found that cigarette initiation displays an age-related pattern with peak initiation of participants occurring during their twenties; most waterpipe initiation and for all birth cohorts began in the 1990s. Other studies done in Lebanon have also demonstrated increasing prevalence of waterpipe use with time. [27,28] Waterpipe smoking has been observed among Egyptian schoolchildren; the desire to imitate adults would partly explain this phenomenon. [29]

Attitudes and beliefs about tobacco use may shape behaviour. [30] The belief that the waterpipe is less risky could be a major contributing factor to its increasing popularity. In the current work waterpipe smokers were found to prefer waterpipes mainly because they thought them safer (Figure 4.11). This would also explain why the majority of waterpipe smokers smoke in the same room in the presence of their wives (Figure 4.9) or children (Figure 4.10). Perceived health effects may be of particular interest, as the experience in developed countries has been that tobacco products that are identified as “less risky” dominate the market. [31] The same kind of perception has been observed among Syrians. [6,8]

This would also explain the false feelings that waterpipe smokers are willing to quit smoking (Figure 4.14) and their feelings that they are able to do (Figure 4.15) while few of them really try to quit (Figure 4.16). Asfar and her colleagues (2005) assessed the beliefs and attitudes related to waterpipe smoking that were likely to contribute to the increase in its popularity among young Syrians. [32] One of the results that was, contrary to our finding, that more students (49.7%) believed waterpipes to be more harmful to health than cigarettes, compared with 30% who believed the opposite. This result is even contrary to those described by the same group a year before.

In the present study the prevalence of waterpipe smoking among ex-cigarette smokers (19%) was higher than among current smokers (6.7%). These results could again be explained by the fact that many cigarette smokers have a false belief that waterpipe smoking is a way to quit cigarette smoking [33] and that waterpipe smoking is safer than cigarette smoking, as described before. [34,35]

We concluded that waterpipe smoking is a growing epidemic. Any intervention programme to prevent this new threat must disabuse the public of the notion that waterpipes are less risky than cigarettes. However, it should be noted that the variability in quantification and lack of standardization of the definitions used for waterpipe smoking are still the main obstacles in waterpipe surveys. These obstacles make the comparison of the prevalence rates across the different studies difficult and inaccurate.

Acknowledgement

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5 Comparison of cigarette and waterpipe smoking among female university students in Egypt

5.1 Introduction

The recent increase in the use of waterpipes for tobacco smoking (synonyms: *shisha*, *gouza*, *nargileh*, hookah) in the Eastern Mediterranean Region, particularly Egypt, Lebanon and the Syrian Arab Republic, represents both a modern renaissance of an old public health threat and the emergence of a new tobacco epidemic.[1] Recently, waterpipe smoking has been adopted more widely by various age groups of all social classes and has become more socially accepted for females than smoking cigarettes. It is believed to promote social and family gathering.[2]

During the late 1960s and early 1970s, worldwide sales and advertising of cigarettes were increasingly targeted at women and resulted in a sharp increase of smoking initiation among girls aged 12–17. In addition, teenage girls are vulnerable to pressures to adopt smoking in order to avoid weight gain, and they may also seek to identify themselves as independent and glamorous.[3] However, in many Muslim societies it is considered improper and shameful for women to smoke cigarettes, especially in public. Therefore, the prevalence of the habit remained low until very recently. Now, with the increasing affluence and independence of women in these societies, loosening of former societal restrictions on women's public behaviour, the increased presence of women in the job market, the expanded marketing of tobacco products and the emergence of waterpipe cafés as trendy places for young people to spend time, young women in the Eastern Mediterranean Region and elsewhere are adopting waterpipe smoking as a socially acceptable form of tobacco use.

Despite the published studies citing oral cavity cancer, heart disease, tuberculosis and respiratory diseases as results of waterpipe smoking.[4,5] female university students appear to have poor knowledge of these health problems,[6] and there are few such published studies on their knowledge and awareness of waterpipe-associated health risks. Additionally, an ambivalent picture may be presented by professors who smoke in public, which

could encourage smoking or experimenting with different tobacco products.[1] While many universities, especially medical schools, teach about tobacco-related health problems, it is not clear that students in other disciplines receive adequate education about tobacco. In addition, as demonstrated in one study, they may already have formed an addiction to tobacco prior to entering the university.[7]

Current smoking behavioural practices among female university students in Egypt is not well known. In addition, past surveys are likely to have underestimated its prevalence among women, given social norms that would be expected to inhibit truthfulness about their current and past behaviour. Current data on women's attitudes, beliefs, and practices toward tobacco products need to be gathered and disseminated so that comprehensive tobacco control policies can be applied to the entire population, not just males. Therefore, a better picture of current smoking behaviour among female university students, and their knowledge, attitudes and beliefs about tobacco, might be obtained by surveys conducted within establishments such as cafés, where they feel more comfortable discussing smoking. With this goal in mind, we conducted a study of female university students patronizing cafés outside two universities in Cairo.

5.2 Method

An anonymous, self-administered questionnaire was distributed during 2004 in nine waterpipe cafés serving coffee, tea, cold drinks, snacks and waterpipes. These establishments were located in the vicinity of two universities, Cairo University and Sixth of October University, a public and a private institution, respectively. The owners of these cafés were approached for permission to talk to their female patrons about smoking and health, and all of them agreed. A total of 100 female medical students attending Cairo University and 96 female undergraduate science students from Sixth of October University participated in the study. All of the students approached agreed to participate in the study (100% participation rate).

The questionnaire included 62 questions that inquired about demographic factors and about attitudes, knowledge and practice of waterpipe and cigarette smoking. All of the questions were close-ended. Frequency of smoking, age at initiation, reasons for smoking, and quitting attempts were assessed. The questionnaire presented eight tobacco-health related statements, where participants indicated whether they believed the statement to be true or false. We then created a knowledge score for the health hazards of smoking, corresponding to the number of correctly answered questions. This score was summarized into three categories: 0–2, represented poor; 3–5, average; and 6 and above, good knowledge of the health hazards of smoking.

The questionnaires were double-entered into a Microsoft Office Access database. The data was analysed using SPSS (version 11) in order to obtain the median, mean and standard deviation for continuous variables. Exploratory analysis used *t*-tests in order to assess group differences in these variables. Categorical variables were summarized by contingency tables, and exploratory analysis for group differences used chi-squared tests. Adjusted odds ratios, 95% confidence intervals and *P* values were obtained from logistic regression models.

5.3 Results

Study population

The mean age of the medical students was 21 (standard deviation [*SD*] 0.28) and for the science students the mean age was 20 (*SD* 0.43). The distribution of knowledge scores were not significantly different between the two groups of students: 13% of Sixth of October University students had scores in the good range, compared to 14% of the Cairo University students, while 32% and 42%, respectively, had scores in the poor range.

A total of 53 students (27%) reported smoking cigarettes exclusively, while 74 (37.8%) smoked tobacco using waterpipes exclusively, and 69 (35.2%) used both types of tobacco smoking method. Thus waterpipe smoking among this group is more popular than cigarettes (73% compared with 62%). However this does represent only those student patrons of cafés in Cairo.

Of those smoker students who were living at their parents' home, 48% reported absence of father from home and 20% did not have their mothers at home.

There were no significant differences in the distribution of type of smoking between the two groups of students. Approximately half of the students reported that their fathers did not supervise their time at home. The majority did not participate in sports, and >97% reported that some or all of their friends were current smokers. There were no significant differences between the public and the private university students for any of these variables. Therefore the two groups were combined for subsequent analysis.

Smoking habits

Among exclusive cigarette smokers, the mean age was 21.1 (SD = 2.7) compared to 20.2 (SD = 1.7) for exclusive waterpipe smokers and 20.9 (SD = 2.3) for smokers who used both types of tobacco products ($P > 0.50$). There were no significant differences in the mean age at initiation of smoking, which was 17 among the cigarette smokers, 18 among the waterpipe smokers and 17 among the users of combined products.

Waterpipe smokers reported smoking 2–7 times per week, and they visited the café 1 to 12 times per week. Each visit lasted approximately 1–2 hours. Cigarette smokers reported smoking daily, with 1 to 6 visits per week to the café, lasting approximately 1 hour each visit.

Waterpipe smoking characteristics: 16% of 143 university women who used waterpipes had a waterpipe at home, and 18% showed an increase in the amount smoked since the previous year. Most of the subjects were encouraged to start smoking waterpipes by a female friend (61%) while 36 had an introduction by a male friend.

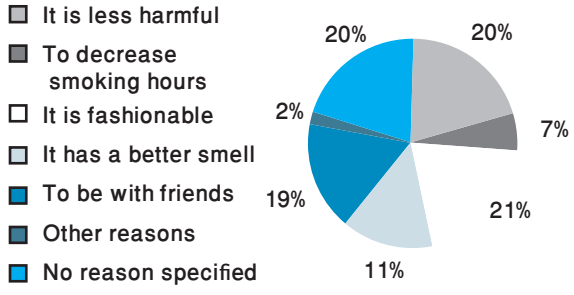

Figure 5.1 Reasons for smoking waterpipes

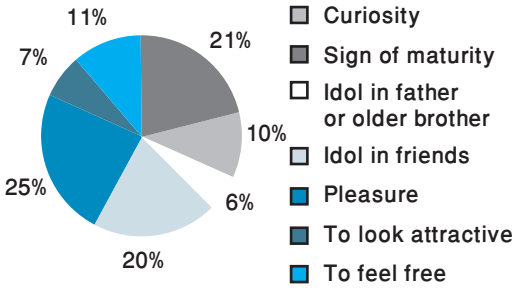

Figure 5.2 Reasons for smoking

Only 16% smoked at home with family members and another 34% in a private room away from family. Family members did not know of the female student's smoking in 76% of the responders; 34 % of female students reported having health problems due to smoking.

Among the reasons given for smoking waterpipes instead of cigarettes, the most common responses were the perception of the waterpipe as fashionable (21%), the belief that waterpipes are less harmful than cigarettes (20%), and the desire to be with friends in the cafés (19%; Figure 5.1).

Attitudes and beliefs of smokers

Pleasure, curiosity and following the example of their friends were the most common reasons reported for why these female university students smoked tobacco (Figure 5.2). Other reasons included a desire to look attractive and mature, and to feel free to make their own lifestyle decisions. Over half of the subjects reported smoking primarily away from home, and 23% reported admitting to smoking to family members. One-third of them reported smoking-related health problems.

Quitting attempts

While 53% reported that they wish to stop and 61% think they can stop anytime, only 30% reported having such attempts in the past. However only 1/3 had a quitting attempt more than one month and only 5% stopped for more than 6 months.

Among these 58 women who had tried unsuccessfully to quit, the major motivating factors were health concerns (71%), the expense of smoking (40%), and religious beliefs (31%). Only one-quarter had received advice from a physician.

5.4 Discussion

The present study is one of the few from the Eastern Mediterranean Region that focuses on female university students and their tobacco smoking habits. Especially noteworthy in this study population is the popularity of using waterpipes to smoke tobacco. In conservative societies, the family value system exerts an important influence on the behaviour and attitudes of young women.[8] Studies related to family structure often conclude that intact two-parent families are protective against smoking initiation. In this study, as in previous surveys in the region, the parents' presence at home, time of returning home and high socioeconomic level

were associated with smoking initiation among young women.[9] Moreover, the current social and economic liberation of young females, the influence of Western culture, and the notion of smoking to denote social status and prestige have been documented as important factors for initiation and maintenance of tobacco use.[10]

In our study, most of the university students had friends who were smokers and who introduced them to smoking. Numerous studies have shown that the single most direct influence on smoking among young people is how many of their five best friends smoke.[11] In addition, interviews with adolescents who have begun smoking showed that a large majority (80%) of initial cigarette experimentation episodes occur in the presence of other adolescents who are smoking.[12] In fact, smoking is usually a shared activity with important socialization functions for young females.[13] Although it is difficult to determine if female adolescents model their behaviour after friends or select peers with similar behaviour, studies have reported that same-sex friends are influential in the smoking behaviour of female adolescents.[10] The association between parent and daughter smoking has also been found to be significant in some studies.[14]

The median age of initiation in our survey for cigarette smokers was 17 years, and for waterpipe smokers 18 years. These results coincide with the recent cross-sectional study done among female students at the American University of Beirut, where the mean age of initiation for waterpipe was 18 (17–25) years.[15,1] Our results also demonstrated an apparent female preference for waterpipe over cigarette smoking. Social and cultural acceptances were among the reasons reported for this preference. Waterpipe smoking in Egypt is less expensive than cigarettes, which may be a particularly important factor for a student population. The most important motivation for waterpipe smoking in our study, statistically, was the belief about its effects: the vast majority of the students in our study believed that waterpipe smoking is less harmful than cigarette smoking. This was also reported by the Lebanese students in Chaaya's study [1] and Saudi Arabian students in several other studies.[16,17] Limited knowledge about the chemical composition of waterpipe smoke may partly explain the misconception of its harmlessness when compared to cigarette smoking.[2] Nicotine level intake in a standard waterpipe session is similar to that of a single cigarette, yet the tar intake is 20 times greater than that of a low-tar cigarette. Compared with cigarette smoke, waterpipe smoke contains higher levels of arsenic, chromium and lead.[18] Moreover, the evidence indicates that, compared with cigarette smoking, waterpipe smoking causes higher levels of carboxyhaemoglobin in blood.[6]

The act of smoking has been linked to self-esteem improvement. Subjects report smoking makes them appear mature, cool, sociable and sexually attractive.[19] Charlton and Blair (1989) found that the relationship between the attraction of smoking and the initiation of smoking to be significant only for young females.[20] Although most female teenagers believe that long-term smoking is a health hazard, their own smoking is believed to be unrelated to the chronic smoking habits of adults.[3] Even teenagers who are aware of the risk of tobacco use may have a limited capacity to use the information wisely.[21] This may explain why quitting is so difficult among young smokers, with high rates of failure and recidivism, as shown in our study.

Our study revealed that these university students, even those in medical school, had only an average knowledge of tobacco related health hazards. A surprisingly low percentage of this

population was aware that smoking is a major cause of coronary artery disease, lung cancer, and diabetes. In their study at the American University of Beirut,[1] reported that the majority of students were knowledgeable about the adverse health effects of smoking, yet they lacked information about its mechanism of action. These discrepancies reflect the general failure of university systems in this region to effectively teach about tobacco's harms. In order for medical students to become effective agents for reducing smoking, the medical curriculum should stress awareness of tobacco-related diseases.

It remains a challenge to investigate the effects of waterpipe smoking on health. It is known that waterpipe smoke contains more tar than cigarettes, and that the manner of smoking differs, yet there still remains much to understand. Global tobacco control communities need to be sensitized to this new epidemic and conduct interventions that are more aggressive than standard public health awareness campaigns. Successful interventions for young men and women should address the misconception that waterpipes are harmless and glamorous and focus efforts to reduce its popularity, particularly among young persons. Concurrently, healthy and positive activities such as sports, volunteering and hobbies should be encouraged to help them change their behaviour.

Acknowledgement

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6 Behavioural and biological aspects of waterpipe smoking in Egypt

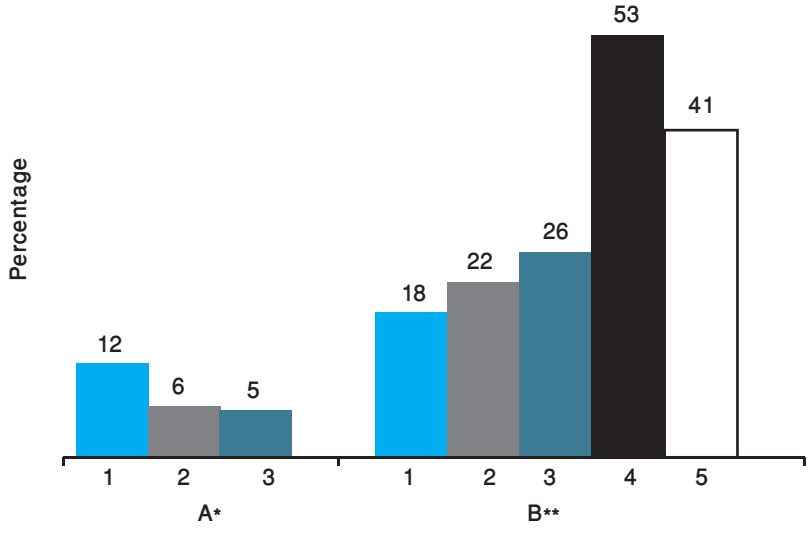
In this section we will describe the profile of waterpipe smoking in Egypt and elsewhere focusing on tobacco addiction, by comparison with cigarette smoking. Since many of the research studies in Egypt could not be found on the internet, we comprehensively searched several data sources not available on the internet, such as libraries of major Egyptian academic medical institutions and the local networks of the Egyptian Scientific Research Academy. For articles published elsewhere we present a synthesis of the issues raised, methods of investigation and summaries of results with appropriate discussion.

6.1 Relationship between cigarette smoking and waterpipe smoking

In a study among a large cohort of adult males [1] in Lower Egypt, the following data in Figure 6.1 relate cigarette and waterpipe smoking and the level of tobacco dependence (A) as measured by the Fagerström scale or experimentation level (B).

Some smokers use waterpipes hoping to quit cigarettes. This is a very dangerous belief as they may get used to the new habit and find it difficult to quit waterpipe smoking later. This brings the issue of dependence, as discussed in other studies. [4,5]

A study in Egypt that surveyed 548 industrial workers, showed 18% and 12% for the prevalence of smoking exclusively waterpipes and smoking both waterpipes and cigarettes respectively (30% total prevalence of waterpipe smoking). This varied by level of smoking, which was classified into: light (≤10 cigarette equivalent), moderate (11–20 cigarette equivalent), and heavy (>20 cigarette equivalent) considering a *hagar* equivalent to 2 cigarettes. Forty-seven percent of the heavy smokers smoked waterpipes (either exclusively, 22.5%, or with cigarettes, 24.5%). These numbers declined to 41% and 32% among the moderate and light smokers. [6]



Numbers are shown as percentages of the total population.

Figure 6.1 Prevalence of waterpipe smokers in different cigarette smokers' populations

A*: Current waterpipe smoking among different grades of cigarette dependent smoker by short-form Fagerström scale: 1: lightly dependent; 2: moderately dependent; 3: heavily dependent. [2] Lightly dependent smokers used waterpipes more than other dependent levels.

B**: Ever smoked waterpipe among cigarette smokers in different stages of smoking behaviour change (included 1921 adult males): 1: pre-contemplation (1075 individuals); 2: contemplation (390 individuals); 3: preparation (200 individuals); 4: action (47 individuals); 5: maintenance (209 individuals). [3]

6.2 Interplay between social factors and waterpipe smoking

In the latter industrial worker study, smoking in men was viewed with a strong sense of social acceptance, social bonding and tradition and was seen as a "normal" part of "being a man". Sex, age, religion and tradition are the four dominant highly interrelated themes influencing smoking behaviour. [7] In spite of the rapid modernization and urbanization in Egypt, smoking is more prevalent among males, similar to other countries. [8,9] Social norms in Egyptian society regard smoking among females as misbehaviour. All the above studies reflect this very clearly. Among males it was 26%, [17] 3%, [19] and 21% [18] in school, youth households and adult households' surveys respectively. In the same order, prevalence among females was 5%, [17] 0.1%, [19] and 0.5%. [18] The numbers can speak by themselves on the effect of sex and tradition on the habit of waterpipe smoking.

Many young females in Egypt (of high social class and highly educated) are starting to smoke waterpipes. This may alter the social norm of the Egyptian community to accepting waterpipe smoking generally and especially among females. This observation may be still limited to the Egyptian community. However, studies in the Syrian Arab Republic [10] and Lebanon [11,12] showed unexpectedly higher numbers of females smoking waterpipes. These increasing numbers may grow to form an epidemic unless suitable health education programmes are tailored to combat waterpipe smoking among these age groups specifically.

What people do to earn their living affects their life pattern and leads them to adopt certain behaviour. Smoking as a behaviour is of particular interest, as it affects health, and in

turn, health is affected by occupation. Also, the nature of a job may push some groups to smoke more than average. [13] Outdoor and night jobs could increase the prevalence of waterpipe smoking. This was observed among 100 fisherman who significantly smoked waterpipes more than a control group. [14]

Some occupations carry a direct risk to the respiratory system, causing impairment in pulmonary function and may lead to serious complications, such as cancer. Smoking synergizes this effect. It was astonishing to notice an increased in waterpipe smoking among workers exposed to asbestos [15] and others working in a fertilizer company [16] compared with control groups. Those workers may be unaware of the health consequences of waterpipe smoking as it was significantly associated with pulmonary disorders. A special health programme is recommended to increase their awareness of waterpipe smoking hazards.

6.3 Studies on biological indicators of toxicity on waterpipe smoking

Animal studies

There has been little research on waterpipes at the laboratory level. This type of work would be of great benefit as it would elucidate the chemical components of tobacco and smoke and measure the amounts that would be produced under controlled and ideal conditions. The disadvantage is actual smoking patterns differs from one smoker to another. Consequently, it affects exposure patterns.

Animals have been used in some studies to reveal the effect of exposure to waterpipe smoke that is impossible to do in human beings. In Egypt, distinct research questions have been addressed. One study examined the effect of acute tobacco smoke exposure on dogs. Significantly, pulmonary hypertension was more likely to follow waterpipe smoke exposure than cigarette smoke, and many changes were reported in blood levels of oxygen and carbon dioxide (PaO_2, $PaCO_2$), and ECG changes (arrhythmia and ischaemic S-T and T wave changes). [17]

Passive smoking was studied in 36 rabbits divided equally into three groups. Two groups were exposed to either cigarette or waterpipe smoke with the third group acting as a control. The levels of histamine, serotonin and leukotrienes in plasma and pulmonary lavage fluid were significantly higher among the exposed groups than the control one. [18]

In attempt to test the possible harm of waterpipe smoke on the oral cavity, the materials extracted from waterpipe were dissolved in chloroform and acetone. The product was applied twice weekly to three groups of albino rats, 12 and 3 months. A fourth control group was included. Clear pathological damage was observed among the exposed groups in different areas of the oral cavity. [19] Similarly, epithelial hyperplasia and weigh loss were noticed among rats painted with same extracts and absent among the control rats. Moreover, three of the experiment rats died during the first month. No tumours were reported or internal organs affected. [20]

Table 6.1 Lead content (µg/dl) in cigarette versus waterpipe

	Pre-smoking	Post-smoking/1st korsi	2nd korsi	P
Cigarette tobacco	7.39 ± 0.6	2.82 ± 0.28		<0.001
Waterpipe tobacco	2.125 ± 0.142	1.48 ± 0.09		<0.001
Cigarette filter	0.52 ± 0.032	1.0 ± 0.19		<0.001
Water in the waterpipe	2.13 ± 0.14	3.48 ± 0.11	3.93 ± 0.12	<0.001

Heavy metal exposure and waterpipe

Lead causes many psychomental effects. Tobacco is a source of lead for many humans. [21] Measurement of mean lead content in the water (in 12 waterpipes) and 12 cigarette filters before and after smoking, revealed higher levels of lead in the water than in cigarette filters. The authors of this work reported that water was a more powerful filter than the regular cigarette cellulose filter. [22] A similar announcement has been made on waterpipe filtration on nicotine [23] and other carcinogenic substances. The nicotine trapping property was confirmed later in Lebanon. [24] Nonetheless the limitations of water's filtering capacity have been illustrated in other studies. Waterpipe smoking can deliver high levels of carbon monoxide. The carbon monoxide levels were related to the type of charcoal too. [25]

Table 6.1 shows an interesting phenomenon. The water retained about 1.36 µg of lead as mean concentration difference after the first *korsi*. The concentration difference drops to 0.45 µg after the second *korsi*. The authors of the previous study worked in a laboratory environment. In real life, smokers do not change the water with each *korsi*, especially in cafés. Further research is required on the filtering capacity of water.

6.4 Biological indicators of waterpipe smoking

Two main indicators of tobacco use are identified. Carbon monoxide is a primary output of burning tobacco and charcoal in waterpipe. It can be measured in the exhaled air or in the blood as carboxyhaemoglobin. The other indicator is cotinine, which is the direct metabolite of nicotine, the major derivative of tobacco which gives the pleasure sensation and may lead to dependence. [26]

Cotinine level as biological indicator

Cotinine is one of the major metabolites of nicotine. Thanks to its long half life (19–40 hours) compared to nicotine (2 hours), it is a more reliable measure of tobacco exposure. [27] The measurement of cotinine in the system fluids (saliva, blood or urine) is a specific marker of the intensiveness of smoking and of passive smoking exposure, and it could be used in monitoring of nicotine therapy in smoking cessation. [28]

Unfortunately, we found no research in Egypt on cotinine levels among waterpipe smokers. However, the Egyptian Smoking Prevention Research Institute has designed a study to compare the cotinine levels among 200 waterpipe smokers and 400 cigarette smokers with 100 nonsmokers as a control. Participants are still being enrolled (March 2006).

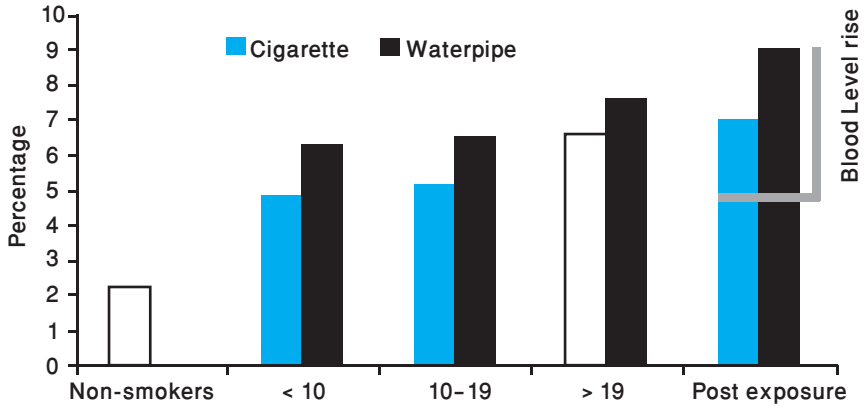


Figure 6.2 Carboxyhaemoglobin levels (measured in %) in waterpipe smokers, cigarette smokers and nonsmokers

An experimental controlled study was done in Jordan to estimate the plasma, urine and saliva levels of nicotine and cotinine. Fourteen waterpipe smokers who had smoked for an average of three years were asked stop smoking for 48 hours. The nicotine and cotinine levels were estimated at zero point and after smoking for a period of 48 minutes. Plasma nicotine and cotinine rose significantly from 1.1 ng/ml and 0.8 ng/ml to 60 ng/ml and 52 ng/ml, respectively. It is of value to say that the maximum cotinine levels were achieved after 3 hours. The mean amount of nicotine and cotinine after 24 hours were 74 ng/ml and 249 ng/ml respectively. A significant elevation in the saliva was detected too. [29] Nevertheless, it is interesting that regular waterpipe smokers have higher (but insignificant) range values than the cigarette smokers, as shown in Lebanon (waterpipe range 70–3300 ng/ml and cigarette range 120–2200 ng/ml). [30] The authors of the study did not mention the smoking behaviour of either group, so no clear inference could be drawn from this observation.

Carbon monoxide

Carbon monoxide exposure increases the level of carboxyhaemoglobin in the blood. This in turn increases the red blood cells' affinity for oxygen and causes tissue hypoxia. [31] Some studies have revealed the relationship of waterpipe smoking to carboxyhaemoglobin levels. In Egypt, a comprehensive study showed that smoking one *hagar* increased carboxyhaemoglobin levels significantly more than smoking one cigarette from baseline levels (4% compared with 2%; Figure 6.2). [32] The same authors concluded that waterpipe smoking increased carboxyhaemoglobin at any smoking level, as shown in Figure 6.2 (one *hagar* was considered equal to one cigarette).

Confirmatory results were found in a study conducted in Saudi Arabia. [33] The higher carboxyhaemoglobin levels are attributed to the effect of the burning charcoal.

6.5 Health hazards associated with waterpipes

There is a common belief that waterpipe is less harmful than cigarette due to the water filter, which supposedly traps most of smoke gases and nicotine. [34,35] This fact may subconsciously increase the daily frequency of waterpipe smoking. Subsequently, smokers will be exposed to more toxic substances.

Waterpipe smoking may affect different systems either directly by contact or the smoke itself (as in the respiratory system, [36] lips, [37] oral cavity [38] and hand skin [39]) or indirectly by the metabolites of tobacco products.

Respiratory effects

The respiratory system is the primary target of the smoking habit. Smokers inhale the smoke down through their respiratory passages, transferring highly toxic and mutagenic substances. The outcome of smoking varies from alteration of normal physiology to manifest clinical conditions. In one study of 35 healthy Egyptian volunteers (20 cigarette smokers, 5 waterpipe smokers and 10 nonsmokers), evidence of more significant inflammatory process in the waterpipe smokers were demonstrated by the following facts [40] (broncho-alveolar lavage and serum levels were inspected for different variants).

- Total protein, albumin and globulins of broncho-alveolar lavage were significantly higher than in the nonsmokers. Inflammation caused increased protein content through serum transudation in the cells. [41]
- Neutrophils were observed more in the broncho-alveolar lavage of waterpipe smokers than of cigarette smokers and nonsmokers. This indicates more destructive changes among the waterpipe smokers.
- Increased microphage activity in the bronchial tree among the waterpipe smokers—more than the other groups.

However, some authors claim that water filtration may permit less toxic substances to reach the respiratory passage, [42] and generally waterpipe smoking has no effect on bronchial reactivity (among 10 asymptomatic waterpipe smokers). [43] An observation of mucosal metaplasia, loss of cilia, anthracosis and fibrosis were found to be more frequent among cigarette smokers (45 individuals) than in waterpipe smokers (10 individuals). But, in the same study, sebaceous gland hyperplasia and loss of alveolar septa were found nearly equally in both groups. In spite of reporting that waterpipe smokers were more likely to develop basal and goblet cell hyperplasia with increase in inflammatory cell infiltration, the authors ignored these findings in their conclusion.

Trace elements in broncho-alveolar lavage have been linked to increased or decreased susceptibility of chronic obstructive pulmonary disease (COPD). A study compared healthy cigarette smokers (17 individuals) and waterpipe smokers (4 individuals) with smokers with COPD regarding their broncho-alveolar lavage trace elements. The smokers with COPD had significant higher levels of zinc (115 ± 7 µg/dl compared with 93 ± 4 µg/dl in health smokers, $P < 0.05$) and iron (36 ± 4 µg/dl compared with 39 ± 4 µg/dl in healthy smokers, $P < 0.05$) in broncho-alveolar lavage. [44] The authors of the previous work discussed different results from similar work outside Egypt. Yet, they give no logical or consistent explanation of the elevated zinc levels. The increased iron level was attributed to an increase in alveolar macrophage content of iron and ferritin. Also, iron plays a critical role in oxygen radical-mediated tissue injury by catalysing the formation of highly reactive hydroxyl radicals via the Hober–Weiss reaction, which may be one of the mechanisms by which smoking induces airway obstruction. [45] In the same study the copper (19 ± 5 compared with 20 ± 3 µg/dl) and magnesium (1 ± 0.3 mg/dl in

both groups) levels in broncho-alveolar lavage were insignificantly different. By examining the levels of the above elements among the healthy waterpipe (4 individuals) and cigarette smokers (17 individuals).

Waterpipe smokers have to inhale more deeply than do cigarette smokers. Also, the time of exposure for a single use of waterpipe is about 50 minutes compared with 5 minutes [46] for a cigarette. The waterpipe smokers have to take puffs more frequently in order to keep the charcoal hot, unlike cigarette smokers, who may take few puffs from a single cigarette. These dynamic factors of waterpipe smoking were thought to produce smaller airway function reduction than cigarette smoking.

Smoking has been shown to cause an accelerated decline in lung function. [47] Moreover, starting to smoke in adolescence affects both level and rate of growth. [48, 49] As a consequence, lower maximum peak for pulmonary functions are achieved. [50,51] Tager and colleagues estimated the FEV_1 to be, on average, 390 ml lower for boys who smoke and 360 ml for girls. [52] Unfortunately, no longitudinal studies were found to demonstrate the effect of early waterpipe smoking on maximum levels of pulmonary function.

Two Egyptian doctoral theses describe the prevalence of some chest conditions according to the smoking status of patients encountered at different chest dispensaries at Cairo. They included 236 and 324 cigarette smokers, 15 and 25 waterpipe smokers, 67 and 59 mixed smokers, and 84 and 169 nonsmokers. The nonsmokers were considered the reference group in calculating the odds ratio. The odds of developing each condition are not expressive of the odds in the community as these are hospital studies. **α**-1 antitrypsin has been linked to lung emphysema. Among waterpipe smokers, the **α**-1 antitrypsin was significantly higher in the bronchial lavage than in non smokers, while antitrypsin levels were insignificantly different in cigarette smokers and nonsmokers. [53]

Waterpipe smoking and cardiovascular risk factors

Disturbance in the blood lipids carries high risk for atherosclerosis and cardiovascular disease. A slight elevation of total plasma lipids was found to be associated with waterpipe smoking. [1] In a study of high-density lipoprotein levels, waterpipe smokers had significantly lower levels. This fraction of lipoproteins is responsible for clearing the blood of cholesterol. [54] High levels of sialic acid and lipid peroxides are risk factors for vascular intimal injury and atherosclerosis. Further, sialic acid is considered a long-term predictor of congestive heart disease in clinically free individuals. [55,56,57] On the other hand, blood vitamin B6 level is inversely related to coronary artery disease risk and improved prognosis of myocardial infarction outcome. [58,59] Sialic acid and lipid peroxides were found to be elevated, while vitamin B6 was lower among waterpipe smokers by comparison with nonsmokers ($P < 0.05$). [60] The heart is directly affected by changes in the lung (especially the right side). More aggressive pulmonary obstruction, pulmonary hypertension, right ventricular hypertrophy and deterioration of right ventricular function were noticed among heavy waterpipe smokers by comparison with cigarette smokers. [61]

Waterpipe smoking and susceptibility to infection

Waterpipe smokers are liable to repeated infections due to lowered immunity and the habit of sharing waterpipes (sometimes without even changing the mouthpiece). Systemic lowered immunity was explained by lower levels of serum globulin (3040 mg/dl compared with nonsmokers (3350 mg/dl), [62] Broncho-alveolar lavage of waterpipe smokers showed elevated levels of globulins (8.2 mg/dl compared with 0.53 mg/dl in nonsmokers) which is thought to be the underlying reason for the low serum levels. The alveolar macrophages were more activated among waterpipe smokers than among cigarette smokers and nonsmokers. This was inferred from lower glucose levels in broncho-alveolar lavage (due to consumption by the macrophages) and an increased level of iron in broncho-alveolar lavage.

Tuberculosis is one of the re-emerging diseases in Egypt. Many scientific discussions have reported increased numbers of tuberculosis patients resistant to the classic therapy with more pulmonary manifestations. The humid closed hose may act as a source of tuberculosis infection among public waterpipe users. The common use of one waterpipe, usually among consumers with low understanding of symptoms like cough and expectoration, is a possible risk factor for cross-infection. [63,64]

Waterpipe smoking and cancer

There is very little information linking waterpipe tobacco use and lung cancer in Egypt. A current epidemiologic study of mortality and smoking in Egypt by ESPRI is underway and will provide a first assessment of this association. In India, waterpipe smokers were found to have similar odds for lung cancer as cigarette smokers. Ever-smokers had an odds ratio of 5 (CI 3.11–8.04). [65]

Blood hormones and the immune system

Blood levels of different regulatory hormones were reported to be disturbed among waterpipe smokers. Insulin showed a delayed response to the increased blood glucose. [66, 67] The specific tobacco ingredient that affects insulin and glucose metabolism is still not fully understood. Also, a significant elevation of serum epinephrine, norepinephrine and cortisol was observed among waterpipe smokers.

Nicotine is a major immunosuppressive component of tobacco smoke. [68] Tobacco smoke alters both cellular and humoral immunity. [69] A central effect on the immune system was hypothesized through the nicotine receptors in the brain. Non-significant lower levels of IgG, IgA, and IgM were reported among waterpipe smokers in comparison to nonsmokers. [70] However, the T cells were significantly lowered. An increased IgA level was detected in extrinsic allergic alveolitis cigarette smokers. [71] As waterpipe smokers show the same trend in immunoglobulin levels, it may also apply to them. Elevated IgE levels, especially among atopic waterpipe smokers may confirm this theory. [72] Systemic mediators of atopy—eosinophils, serotonin and leukotrienes—were elevated too. [73,74] One of these studies found non-significant elevated leukotrienes among waterpipe smokers compared with cigarette smokers. The increased liability to atopy, in spite of having a general immune depression, among smokers needs further explanation. A possible explanation is the local effect of the smoke on the respiratory system. The risk of atopy among waterpipe smokers in comparison

to cigarette smokers needs further research. Individual scattered cases of allergy such as skin eczema have been reported among waterpipe smokers. [75]

Studies on waterpipe and environmental tobacco smoking

Passive smoking or environmental tobacco smoking (ETS) in relation to waterpipe smoking has been addressed in a very limited number of studies. Yet, there is strong evidence that exposure to waterpipe smoking is as harmful as the exposure to cigarette smoking, if not more harmful.

Maternal smoking could be considered second-hand smoking with respect to the fetus, especially among actively smoking pregnant women. It is one of the most important causes of poor pregnancy outcome. An increased risk of spontaneous abortion, low birth weight, premature delivery and infant death from perinatal disorders and sudden infant death syndrome have been well established as being associated with maternal smoking. [76] Significantly (P = 0.006) lower levels of fetal blood catecholamine among 21 pregnant smokers compared to 30 nonsmokers was observed. [77] The study used the cut-off point of 20 ng/ml to validate the smoking status. Catecholamine release is a primitive response in neonates for surviving hypoxic challenges in, for example, sleep apnea. [78] This response disappears gradually with age and differentiation of the adrenal medulla. [79] Nicotine stimulates early differentiation of the medulla, increasing the risk of cardiorespiratory failure among infants. [80] In recent research, waterpipe smoking had the odds of 2.94 (CI 1.08–8.06) of being associated with apnea/hypopnea index (AHI) > 5 than in cigarette smokers. [81]This may lead to a query: does ETS from waterpipes have more hypoxic effects on infants than has been shown with ETS from cigarette smoking? Waterpipe ETS effect on pregnancy outcome was studied among 106 waterpipe smokers and 512 nonsmokers in Lebanon. The odds ratio of having low birth weight among waterpipe smokers was 1.89 (CI 0.67–5.38). The risk increased to 2.62 (CI 0.9–7.66) among those who started smoking in the first trimester. Apgar score and respiratory distress showed an alteration in newborns of waterpipe smokers. [82] An interesting article debated the relationship between parental smoking status and the sex of the offspring. The author inconclusively suggested fewer males were born to smokers compared to nonsmokers. He encouraged further longitudinal studies to prove this finding. [83] If this hypothesis is proved to be true, it will be of a high value in cultures where people still favour having a boy.

Waterpipe and combined waterpipe and cigarette smoking have shown a significant association with asthma among 1000 Egyptian children (0–13 years). Parental smoking was more likely to be associated with early onset of asthma, severer atopic manifestations, higher levels of serum IgE, and reduced value of the predicted peak expiratory flow rate for age. Parental smoking was an important risk factor compared to other environmental pollutants. Also, the asthma was more severe if both parents were smokers. [84] Similarly, parental waterpipe smoking was more prevalent among infants and children with chronic cough than in the control group. [85] In adults, ETS had a statistically significant reduction in the expected pulmonary functions among 80 apparently healthy passive smokers compared to 20 unexposed individuals ($P < 0.001$). History of recurrent upper or lower respiratory tract infection was more likely to be reported among the passive smokers group ($P < 0.001$). Pulmonary dysfunction was directly correlated with the level of urinary cotinine ($P < 0.001$). [86] Thus, there is evidence of harmful effects associated with waterpipe smoking. More research is required to identify other hazards associated with ETS of waterpipe smoking.

Sleep disorders

Sleep consists of a series cycles of average length 90 minutes. [87] Apnea is defined as a complete cessation of air flow for at least 10 seconds, while hypopnea is a reduction in air flow of less than 50%, accompanied by, in at least 4 % of study time O_2 blood saturation less than 90% and/or arousal from sleep. [88] This could be reflected in a higher Epworth Sleepiness Scale (ESS) [89] score during the day time. Cigarette smoking has been associated with sleep disturbance. [90] In a work from 2001, apnea/hypopnea index > 5 was more likely to occur among waterpipe smokers (60%) than in cigarette smokers (33%, OR 2.94, 95% CI 1.08–806, $P < 0.05$). There were no significant differences between the two smokers' groups, who had AHI > 5, with respect to age, BMI, ESS, snoring index and number of attacks during night. Although statistically insignificant, waterpipe smokers had a higher mean of time percentage with O_2 saturation less than 90% (12.25 ± 23.16 compared with 4.85 ± 3.63) and AHI/hour (17.5 ± 15.66 compared with 13.11 ± 8.42) than cigarette smokers. That relationship was demonstrated by a significant correlation between O_2 saturation and AHI among the waterpipe smokers ($r = 0.87$, $P < 0.001$) and insignificant correlation of the two variables among the cigarette smokers ($r = 0.1$). The age was significantly correlated with AHI in the cigarette smokers group only ($r = 0.39$ compared with $r = 0.36$ in waterpipe smokers). This may give an impression that waterpipe smoking played a more effective role in the pathogenesis of the AHI than did the cigarettes. This conclusion is strengthened when the fact that the mean smoking index was significantly lower in the waterpipe smokers compared to the cigarette smokers to have AHI > 5 (190.83 ± 100.86 compared with 417.41 ± 312.6). People consume tobacco thinking it will help them to relax and elevate their mood, especially waterpipe smoking. We think delivering the message that this is not so may be helpful in health education programmes.

Waterpipe smoking and dependence

No reliable dependency scale for waterpipe tobacco smoking have been developed comparable to cigarette smoking. There is a need to start this research to facilitate behavioural interventions and waterpipe smoking control programmes. Thus, dependence could be applied to waterpipe too. This is manifested by craving, withdrawal and difficulty quitting. [91,92,93]

A Syrian-published work discussed this issue. It found similar results to those presented in Section 4.4 above. Cigarette smokers who want to quit smoke waterpipes because they think waterpipes will wean them from cigarettes. In an Egyptian dependence study on cigarette smokers, light cigarette dependents were more likely to smoke waterpipe. This raises the need for a moderation to the Fagerström scale, taking waterpipe smoking (or other method of tobacco use) into consideration. A solid proof of high nicotine content in the waterpipe *hagar* was provided by chemical analysis of variant commercial types. [16] This may indicate a higher nicotine intake from each *hagar* compared to cigarettes.

Genetic damage and cancer among waterpipe smokers

Humans are exposed to a large number of genotoxicants via ingestion, respiration or absorption through the skin. [94] Tobacco smoking is one of the easiest toxicants to be controlled. Tobacco has been linked to mutations in the p53 tumour suppressor gene. A mutant p53 tumour suppressor gene leads to uncontrolled cell division and is found in over 50% of all human tumours. [95] Other researchers assessed genetic damage in different populations including traffic policemen [96] and Egyptians with chronic schistosomiasis [97] and found a

significant association between tobacco consumption and increased genetic damage among the exposed groups.

One study compared chromosomal aberration among five waterpipe smokers, five cigarette smokers and five controls. A significant increase in chromosomal breaks, chromosomal terminal deletions and polyploidy was observed among the smoker groups (no significant difference was noticed between the smoker groups). [98] This is consistent with a study from India, where 35 occupationally nonexposed waterpipe smokers were compared with a matched number of nonsmokers. The dose and duration of waterpipe use showed a direct effect and significant increase in mitotic index, chromosomal aberrations, sister chromatid exchange and DNA satellites. [99]

ESPRI conducted a study to detect the early genetic damage that may be linked to waterpipe use (see Chapter 7). It was hypothesized that exfoliated cells from the oral cavity was the optimal sampling place for two reasons: first, the cells are in direct contact with carcinogenic substances in the smoke; secondly, like other cells in the body they will be exposed to the systemic effect of the smoke (it has a dual effect on the oral cavity). The micronucleus assay will be adopted as a biomarker of the genetic damage. It is a simple yet valid [100,101,102] and sensitive technique. [103,104]

Micronuclei (MN) originate from chromosome fragments or whole chromosomes that are not included in the main daughter nuclei during nuclear division, as in Figure 6.3. Thus, MN assay provides a measure of both chromosome breakage and chromosome loss. It has been shown to be at least as sensitive an indicator of chromosome damage as classical metaphase chromosomal analysis. [106,107,108] The key advantage of the MN assay is the relative ease of scoring and the statistical power obtained from scoring larger numbers of cells than in other typical techniques. [109,110] The findings are presented below.

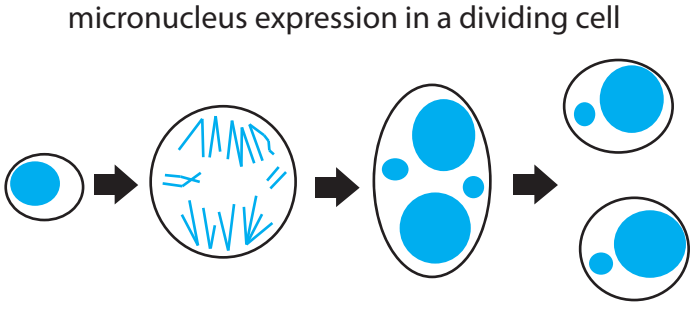


Figure 6.3 [105] The origin of micronuclei from lagging whole chromosomes and eccentric chromosome fragments in a dividing cell. Each daughter cell contains the original nucleus plus peripheral micronucleus (reprinted with permission from the authors)

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7 The micronucleus test in buccal mucosa cells for assessment of the genotoxicity of waterpipe smoking

7.1 Introduction

Waterpipe smoking is a type of tobacco smoking widely practised in the Eastern Mediterranean Region countries. Studies have linked waterpipe smoking to oral, oesophageal, gastric, lung and bladder cancer, although much work remains to confirm these studies and to characterize the dose–response relationships between waterpipe smoking and cancer risks. [1,2,3]

One of the most rapid and efficient techniques to study the impact of environmental and life-style factors on genetic stability in human populations is the micronucleus (MN) test. [4] The use of the MN test to detect and quantify the genotoxic action of carcinogens is well established in vitro and in vivo, its sensitivity being compared to the analysis of chromatid breaks and exchanges. [5,6] Investigations of MN frequencies support the widely accepted assumption that the MN are products of early events in human carcinogenic processes, especially in the oral cavity, which is directly exposed to cigarette and waterpipe smoke. [6,7,8] Epidemiological studies have demonstrated an increase in MN among smokers with oral carcinoma. [9,10] The MN test has therefore been used for early identification of the carcinogenic process. [8]

MN in exfoliated human oral cells are small intranuclear DNA structures separated from the main nucleus of the basal epithelial layers. [11] The daughter cells containing the micronuclei migrate up through the epithelium and are exfoliated into the oral cavity. [12] The average reported healthy population MN frequency is 1–3 per 1000 cells. [13] Increases in the MN frequency in exfoliated oral cells have been observed as a result of exposure to pesticides, neoplastic drugs, [14,15] radiotherapy, [16,17] cigarette smoking, [14,18,19] arsenic in drinking water [17] and chronic infection. [20] Aim of the study

This study tests the hypothesis that waterpipe smoking increases MN levels in exfoliated oral cells relative to MN levels in the oral cells of those who have never smoked. Secondly, we aim to determine the extent to which this cytogenetic damage is influenced by the smoking behaviour (intensity, duration, morning smoking and inhalation of waterpipe smoke).

7.2 Subjects and methods

The Egyptian Smoking Prevention Research Institute (ESPRI) carried a recent study on 149 current adult male (18 years of age and above) waterpipe smokers (who smoked waterpipe at least once per week and had smoked fewer than 100 cigarettes in their lives) and 78 male never smokers (never tried waterpipe or cigarettes in their lives). All eligible subjects were recruited from a baseline household smoking prevalence survey that has been conducted in nine villages in Qalyubiyah governorate in the Nile Delta region in Egypt. They completed a questionnaire and provided buccal smears for MN scoring. The questionnaire elicited demographic data (age, marital status, education and occupation), smoking behaviour (frequency of waterpipe smoking, numbers of *hagar* [waterpipe tobacco units] smoked daily and weekly, and smoking more frequently in the morning), quitting behaviour, the degree of inhalation of tobacco smoke, and current exposure to occupational chemicals that could affect the MN frequency.

Exfoliated cells of the buccal mucosa were obtained from the subjects by scraping the buccal mucosa with a wooden spatula using a rolling motion. [4,21,22] For each individual, two slides were prepared by smearing the cells immediately onto the centre of clean glass slides. The slides were immediately submersed in 95% ethanol for fixation. [23]

A modified Papanicolaou method was used for staining. [23] For this method the smears were fixed in 95% ethanol and hydrated by running a tap water wash. We applied nuclear stain (DNA related) Mayer hematoxylin for 4 minutes, followed by a rinse in a stream of gently running water for 15 minutes. Dehydration by 10 dips each in 70% and 95% ethanol was then performed. Cytoplasmic stain (orange–green) was applied for 1 minute, followed by a rinse in 95% ethanol for 5 minutes. Cytoplasmic and nucleolar stain (RNA specific) by EA polychrome was applied for 1.5 minutes, followed by a rinse by 95% ethanol (×2), 10 dips each. The next step was dehydration by absolute ethanol (×2) for 10 dips, and then clearing by absolute ethanol and xylene (1:1) for 1 minute. The preparation was mounted using a standard mounting medium.

Screening for MN was performed under an oil immersion lens (×1000), followed by phase-contrast microscopy for confirmation of MN according to established methods. [18, 22, 24, 25] At least 1000 intact epithelial cells per individual were scored to achieve the average percentage micronucleated cells.The opaque extranuclear-intracytoplasmic bodies examined by oil immersion lens and phase-contrast were considered micronuclei whereas binucleated cells, fragmented nuclei (karyorrhexis), karyolysis and nuclei like broken eggs were not considered MN. [24,6,10,21] The frequency of MN was estimated as total number of MN (TMN) and the number of cells with MN (CMN) per individual because some cells had more than one MN. [6]

The TMN and CMN of smokers and nonsmokers were compared initially by *t*-tests, and then by using multiple linear regression to adjust for covariates (age, education, occupational exposure). Means and standard deviations of TMN and CMN were calculated for each level of the smoking behaviour variables. All statistical analysis was performed using SPSS, version 12.

7.3 Results

The mean TMN and CMN were significantly higher (more than twofold) among waterpipe smokers as compared to never smokers: mean TMN 10.9 ± 4.4 compared with 4.2 ± 1.9, $P < 0.001$; mean CMN 8.0 ± 3.2 compared with 3.7 ±1.6, $P < 0.001$ (Figure 7.1). In the never smokers, the range for TMN was 1–9 whereas for waterpipe smokers, TMN ranged from 2 to 27.

Waterpipe smoking was shown by multiple linear regression analysis to be a significant independent factor increasing the cytogenetic damage as measured by the TMN after controlling for the potential confounders (age and exposure to chemicals in the workplace). The model *P*-value was < 0.05 and the significance level of the waterpipe was < 0.05 (data not shown).

Table 7.1 shows the impact of smoking behaviour on the levels of TMN; the results for CMN were almost identical and therefore they are not show separately. There was no statistically significant dose related increase in TMN among those who smoked at least 5 *hagar* per day compared to less than 5 *hagar*, nor for weekly use of more than 25 *hagar* compared to fewer than 25 per week. No significant differences in TMN levels were found according to typical addiction indicators including the duration of smoking, minutes to the first use of waterpipe in the day, smoking even when ill, or inhaling the tobacco smoke into the chest.

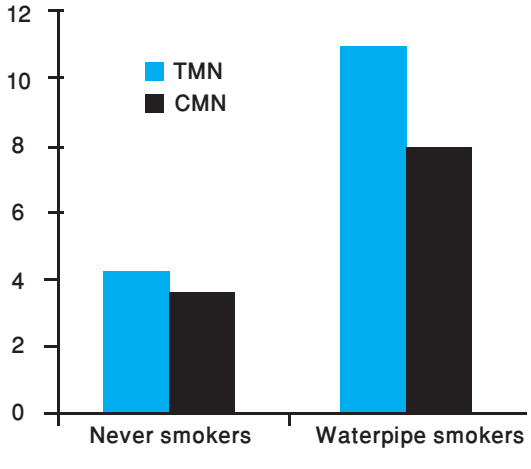

Figure 7.1 Mean TMN and CMN in never smokers and waterpipe smokers

Table 7.1 Mean TMN and smoking behaviour in waterpipe smokers (n = 118)

Variables	Categories	Number	Mean (SD)
Number of hagar/day	<5	57	10.6 (4.0)
	5+	61	11.2 (4.7)
	P	0.44	
Number of hagar/week	<25	50	10.3 (4.2)
	25+	66	11.3 (4.4)
	P	0.24	
Duration of smoking	≤20 years	62	11.4 (4.7)
	20 years+	56	10.1 (3.9)
	P	0.17	
Minutes to first waterpipe of the day	≤1 hour	58	11.3 (4.6)
	>1 hour	59	10.5 (4.1)
	P	0.33	
Smoking when ill	No	98	10.6 (4.3)
	Yes	20	12.3 (4.6)
	P	0.12	
Inhalation of smoke	No	92	10.8 (4.1)
	Yes	26	11.3 (5.3)
	P	0.61	

7.4 Discussion

Our study clearly demonstrated a more than double significant increase of MN frequency in waterpipe smokers compared to never smokers. These results were in agreement with other studies that have demonstrated increased frequency of micronuclei in cigarette smokers compared to nonsmokers. [14,26,27,28] Sarto et al. (1987) detected a twofold increase in the number of MN in smokers as compared with nonsmokers. [14] Burgaz et al. (1995) found a significant increase in micronucleated cells in smokers on examination of exfoliated buccal mucosa cells compared to nonsmokers. [27] The higher MN frequency in smokers was attributed to benzo(a)pyrene (B[a]P), as B[a]P is a component of tobacco smoke and consistently induced MN in a linear dose into an in vitro system. [29,30]

Also it is noteworthy that some researchers could not find any increase in the TMN frequency in lymphocytes in smokers. [21,31,32] A pooled reanalysis of 24 databases from the Human MicroNucleus project concluded that smokers do not experience an overall increase in MN frequency in their lymphocytes, although when the interaction with occupational exposure is taken into account, heavy smokers were the only group showing a significant increase in genotoxic damage as measured by MN assay in lymphocytes. [33] These studies evaluated the MN frequency in the lymphocytes, while in the present study MN frequency was evaluated in the oral epithelial tissues which are in immediate contact with tobacco smoke, and hence could be better surrogates than lymphocytes for assessing genotoxic damage.

Regarding occupational exposure to chemicals, we did not detect a significant interaction with waterpipe smoking on TMN in our study. Several studies have demonstrated an increase in

the MN frequency in exfoliated cells as a result of exposure to pesticides or other carcinogens, [14,15] radiotherapy, [16,17] and oil and petrol. [31] None of our waterpipe smokers workers have reported such exposures.

It was unexpected that, among waterpipe smokers, we did not detect associations of TMN or CMN with well known indicators of nicotine addiction, such as the lifetime duration of smoking, time to first waterpipe smoke of the day and number of *hagar* per day or per week. It should be noted that these variables are commonly used in studies of cigarette smokers, whereas waterpipe smoking may represent a completely different paradigm requiring the development of new variables and new tools to assess possible addiction. Similarly, whereas for cigarettes the dose is conveniently estimated from asking smokers about the number of cigarettes smoked per day, no such validated dose estimators exist for waterpipe smoking. It is not clear, for example, whether the number of *hagar* per day adequately captures dose information, nor is it clear how *hagar* and cigarettes can be directly compared for dose-response studies.

In summary, waterpipe smoking increased the frequency of MN due to possible genotoxic action of substances present in the waterpipe tobacco smoke. Extensive studies and standardization tests to quantify the tobacco exposure by waterpipe smoking are recommended to help in the evaluation and quantification of the biological damage at different levels of exposure to waterpipe smoking.

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