ADVISORY NOTE

Waterpipe tobacco smoking: health effects, research needs and recommended actions for regulators

2nd edition

WHO Study Group on Tobacco Product Regulation (TobReg)

World Health Organization

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Contents

Members of the WHO Study Group on Tobacco Product Regulation and contributors 6

1. Preface 8

2. Acknowledgements 10

3. Purpose 12

4. Background and history 13
   4.1 History 15
   4.2 Recent emergence 15

5. Factors that contribute to the increase in prevalence and spread of use 17
   5.1 Introduction of flavoured tobacco (*maassel*) 17
   5.2 Social acceptability due to the café and restaurant culture 18
   5.3 Developments in mass communication and social media 19
   5.4 Lack of waterpipe-specific policy and regulations 21

6. Regional and global patterns of waterpipe smoking 23
   6.1 African Region 23
   6.2 Region of the Americas 24
   6.3 Eastern Mediterranean Region 25
   6.4 European Region 26
   6.5 South-East Asia Region 26
   6.6 Western Pacific Region 27

7. Health effects of the toxicant content of waterpipe smoke 29
7.1 Toxicant uptake by waterpipe users 31
7.2 Acute physiological and health effects of waterpipe use 31
7.3 Second-hand waterpipe smoke 32
7.4 Long-term health effects 32
7.5 Addiction to waterpipes 34
7.6 Waterpipes as a bridge to cigarette smoking 38

8. Research needs 41

9. Scientific basis and conclusions 44

10. Policy 45

11. Suggested actions for regulators 48

12. References 52

WHO Study Group on Tobacco Product Regulation

Members

Dr D.L. Ashley, Director, Office of Science, Center for Tobacco Products, Food and Drug Administration, Rockville, Maryland, United States of America

Professor O.A. Ayo-Yusuf, Dean, School of Oral Health Sciences, Sefako Makgatho Health Sciences University, Pretoria, South Africa

Professor A.R. Boobis, Centre for Pharmacology and Therapeutics, Department of Medicine, Imperial College, London; Director, Public Health England Toxicology Unit, Imperial College London, United Kingdom

Dr Vera Luiza da Costa e Silva, Independent Consultant, Senior Public Health Specialist, Rio de Janeiro, Brazil

Dr M.V. Djordjevic, Program Director/Project Officer, Tobacco Control Research Branch, Behavioral Research Program, Division of Cancer Control and Population Sciences, National Cancer Institute, Bethesda, Maryland, United States of America

Dr N. Gray, Honorary Senior Associate, Cancer Council Victoria, Melbourne, Australia†

Dr P. Gupta, Director, Healis Sekhsaria Institute for Public Health, Mumbai, India

Dr S.K. Hammond, Professor of Environmental Health Sciences, School of Public Health, University of California, Berkeley, California, United States of America

Dr D. Hatsukami, Professor of Psychiatry, University of Minnesota, Minneapolis, Minnesota, United States of America

Dr A. Opperhuizen, Director, Office for Risk Assessment and Research, Utrecht, The Netherlands

Dr G. Zaatari (Chair), Professor and Chairman, Department of Pathology and Laboratory Medicine, American University of Beirut, Beirut, Lebanon

Contributors

Dr E. Akl, Associate Professor of Medicine, Department of Internal Medicine, American University of Beirut, Lebanon

Dr T. Eissenberg, Professor of Psychology and Co-Director, Center for the Study of Tobacco Products, Virginia Commonwealth University, Richmond, Virginia, United States of America

Dr W. Maziak, Professor and Chair, Department of Epidemiology, Florida International University; Director, Syrian Center for Tobacco Studies, Miami, Florida, United States of America

Dr P. Mehrotra, Senior Programme Officer, Population Council, New Delhi, India

Mr J. Morton, Senior Survey Methodologist, Global Tobacco Control Branch, Office on Smoking and Health, Centers for Disease Control and Prevention, Atlanta, Georgia, United States of America

Dr A. Shihadeh, Professor of Mechanical Engineering, Faculty of Engineering and Architecture, American University of Beirut, Beirut, Lebanon

WHO Secretariat
(Tobacco Free Initiative, Prevention of Noncommunicable Diseases, Geneva, Switzerland)

Ms M. Aryee-Quansah, Administrative Assistant

Dr A. Peruga, Programme Manager

Ms G. Vestal, Technical Officer (Legal)

1. Preface

Tobacco product regulation, which involves regulating the contents and emissions of tobacco products by testing, mandating the disclosure of the test results and regulating the packaging and labelling of tobacco products, is one of the pillars of any comprehensive tobacco control programme. The WHO Framework Convention on Tobacco Control (WHO FCTC), a binding international treaty, acknowledges the importance of tobacco product regulation in Articles 9, 10 and 11, and Parties to the Convention are bound by the provisions of those articles.

A WHO scientific advisory group on tobacco product regulation was established in 2000 to fill the gaps in knowledge that existed at the time. The scientific information provided by that group served as a basis for the negotiations and the subsequent consensus reached on the language of those three articles of the Convention.

In November 2003, in recognition of the critical importance of regulating tobacco products, the WHO Director-General formalized the ad hoc Scientific Advisory Committee on Tobacco Product Regulation by changing its status to that of a study group, which became the WHO Study Group on Tobacco Product Regulation (TobReg). The Group is composed of national and international scientific experts on product regulation, treatment of tobacco dependence and the laboratory analysis of tobacco ingredients and emissions. Its work is based on scientific evidence from the latest research on tobacco product issues. It makes recommendations and proposes testing for filling regulatory gaps in tobacco control. As a formalized entity of WHO, TobReg reports to the WHO Executive Board through the Director-General to draw Member States' attention to the Organization's efforts in tobacco product regulation.

TobReg prepared the first edition of the advisory note *Waterpipe tobacco smoking: health effects, research needs and recommended actions by regulators* (*1*) in response to requests from Member States in which the population is particularly exposed to this form of tobacco use and in accordance with the priorities of the WHO Tobacco Free Initiative and the provisions of the WHO FCTC concerning tobacco product regulation. TobReg approved and adopted the advisory note at its second meeting, held in Rio de Janeiro, Brazil, in 2005. Since then, new information has become available, and scientific research has addressed some of the gaps identified at the time of the first edition. Moreover, the First International Conference on Waterpipe Tobacco Smoking, held in Abu Dhabi in October 2013, addressed the state of knowledge on this subject; this was followed by a second conference, on the theme "Waterpipe smoking research: a collision of two epidemics of waterpipe and cigarettes", held in Doha, Qatar, in October 2014. The participants at both conferences called on WHO to update the 2005 advisory note and to consider other actions to support Member States and Parties to the WHO FCTC in preventing and controlling waterpipe use and other forms of exposure to tobacco. In addition, in March 2014, several TobReg members and regional and international waterpipe experts attended a workshop held at the WHO Regional Office for the Eastern Mediterranean in Cairo, Egypt, where they discussed the scientific evidence, challenges, gaps and regulatory policy issues and agreed to write this second edition of the advisory note.

WHO commissioned the six contributors listed in the acknowledgements to draft the sections that form the backbone of this report. Further, WHO was requested by the Conference of the Parties to the WHO FCTC at its sixth session, in October 2014 in Moscow, Russian Federation, to prepare a report on the toxic contents and emissions of waterpipe tobacco products and also a report on policy options and best practices in the control of use of waterpipe tobacco products, to be submitted to the seventh session of the Conference of the Parties to the WHO FCTC. WHO therefore invited TobReg to issue a second edition of the advisory note on the health effects, research needs and recommended actions for regulators with regard to waterpipe tobacco smoking. Section 7 addresses the health effects of the toxic contents and emissions of waterpipes, section 10 recommends policy, and section 11 gives recommendations for regulators. TobReg is pleased to present this second edition of the advisory note on waterpipe smoking.

TobReg members serve without remuneration in their personal capacities rather than as representatives of governments or other bodies; their views do not necessarily reflect the decisions or stated policies of WHO. The members' names are provided in this report.

2. Acknowledgements

WHO has many people to thank for the production of this advisory note of the WHO Study Group on Tobacco Product Regulation (TobReg). Ms Gemma Vestal coordinated the production, with the supervision and support of Dr Armando Peruga and Dr Douglas Bettcher.

Special appreciation goes to the contributors, who worked with us for a full year so that this advisory note could be launched during the Waterpipe Tri-Plenary at the 16th World Conference on Tobacco or Health, on 17–21 March 2015, in Abu Dhabi, United Arab Emirates. The contributors, Dr Elie Akl, Dr Thomas Eissenberg, Dr Wasim Maziak, Dr Purnima Mehrotra, Mr Jeremy Morton and Dr Alan Shihadeh, all worked tirelessly through many drafts and revisions.

Our infinite gratitude to all the members of TobReg for their full, whole-hearted dedication, time and unfailing commitment to fulfilling their mandate to advise WHO on tobacco product regulation, a highly complex area of tobacco control. We thank them for the numerous hours they spent reviewing the manuscript and for their insightful advice and guidance. As independent experts, members of TobReg serve WHO without remuneration.

Administrative support throughout the months of production was provided by WHO colleagues Ms Miriamjoy Aryee-Quansah, Mr Gareth Burns, Ms Elaine Alexandre Caruana, Mr Luis Madge, Ms Elizabeth Tecson, Ms Rosane Serrao and Ms Moira Sy.

Special thanks are due to Dr Ala Alwan, Regional Director of the WHO Eastern Mediterranean Region, and to his colleagues Dr Samer Jabbour, Director of the department for Noncommunicable Diseases and Mental Health, and Dr Fatimah

El Awa, Regional Advisor for the Tobacco Free Initiative, for their vision and leadership in convening and hosting the workshop for preparation of this second edition at the Regional Office, on 30 and 31 March 2014 in Cairo, Egypt. At that meeting, the initial outline of the second edition and the terms of reference for each of the section contributors were decided. With the cooperation and flexibility of the contributors and TobReg members, the contents were subsequently reframed to address the requests made by the Conference of the Parties to the WHO FCTC at its sixth session, in October 2014 in Moscow, Russian Federation.

In addition, we would like to convey our appreciation to the WHO editor, copy-editor and proofreader and to the layout and typesetter company in Portugal for their eye for detail and their patience with the tight deadlines under which they worked. We also express our gratitude to Mr Jon Barnhart of Health Partners, LLC for creating the front cover image and Mr Christophe Oliver for the illustrations of the waterpipe from the Middle East and the "bong" waterpipe.

Last but not least, WHO expresses its profound gratitude to former interns at the Tobacco Free Initiative who contributed large amounts of their internship time to the fruition of this document: Ms Aurelie Abrial, Ms Hannah Patzke and Ms Angeli Vigo. It is our hope that they continue to work passionately in some aspect of tobacco control, whatever bright career they follow in the future.

Undoubtedly, many people to whom we are indebted are not mentioned here, because so many people were involved in production of this report. We apologize for any omission. We therefore thank both those who are named and those who are not named. Without your assistance and support, none of this would have been possible. Thank you very much.

3. Purpose

This advisory note from TobReg addresses growing concern about the increasing prevalence and potential health effects of tobacco smoking with waterpipes. The first edition of this advisory note was published almost a decade ago, in 2005 (*1*). During the intervening period, much research has been conducted on both the health hazards and the increasing prevalence of waterpipe smoking in many countries and populations. Despite the increase in knowledge, there is still a prevailing public misconception that waterpipe tobacco smoking is somehow protective or "safer" than cigarette smoking. In some countries, the prevalence of waterpipe tobacco smoking has increased in certain subgroups to exceed that of cigarette smoking.

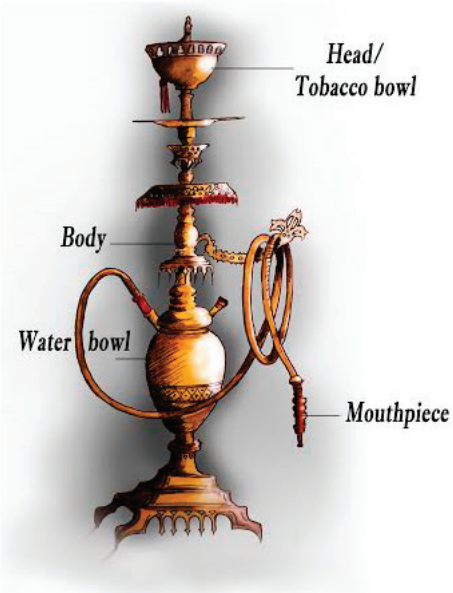
Given these trends, more effort is needed to bring policy on waterpipe tobacco smoking into line with the WHO FCTC. The purposes of this advisory note are to provide guidance to WHO and its Member States, to inform regulatory agencies in implementing the provisions of the WHO FCTC concerning education and communications, to suggest policy and to inform consumers about the risks of waterpipe smoking. It also provides a more thorough understanding of the health effects of waterpipe tobacco smoking to researchers, research agencies and funding bodies. In addition, the advisory note addresses those engaged in tobacco smoking prevention and cessation programmes, to ensure that such programmes accommodate the unique aspects of waterpipe use.

4. Background and history

While there are numerous kinds of waterpipe around the world, the kind addressed in this note is popularly referred to as "*narghileh*", "*shisha*" or "*hookah*", the type globalized in the 1990s. It includes a head or tobacco bowl (in which tobacco is placed), a body, a water bowl, a hose and a mouthpiece (Figure 1). Holes in the bottom of the head allow smoke to pass into the body's central conduit, which is submerged in water (or alcohol or soft drinks), half-filling the water bowl. The leather or plastic hose exits from the top of the water bowl and terminates with a mouthpiece, from which the smoker inhales. Charcoal or a briquette[1] is placed on top of the tobacco-filled head, often separated from the tobacco by a perforated aluminium foil sheet. After the head or tobacco bowl is loaded and the charcoal lit, the smoker inhales through the hose, drawing air into and around the charcoal. The resulting heated air, which also contains charcoal combustion products, then passes through the tobacco, which, as it is heated, produces the mainstream smoke aerosol. The smoke passes through the waterpipe body, bubbles through the water in the bowl and is carried though the hose to the smoker. During a smoking session, smokers typically replenish and adjust the charcoal to maintain the desired taste and smoke concentration. A pile of lit charcoal may be kept in a nearby firebox for this purpose, which may present an additional inhalation hazard. Smokers may opt for more convenient, easy-lighting briquettes, which can be lit directly with a portable lighter. Because of the communal nature of waterpipe smoking, with sharing of a mouthpiece, there is potential transmission of infectious diseases.

[1] Briquettes are sometimes used instead of charcoal; hereafter, all references to charcoal include briquettes.

Figure 1.
A Middle-East waterpipe



There are regional and cultural differences in waterpipe design features, such as the size of the head or water bowl and the number of mouthpieces, but all waterpipes contain water through which smoke passes before reaching the smoker.

Waterpipes should be differentiated from the electronic devices known as "e-hookahs", "e-shisha" or "hookah pens". These devices are types of electronic nicotine delivery systems, which can be flavoured so that the taste is similar to that of the flavoured waterpipe tobacco called *maassel*. The electronic devices do not involve charcoal combustion; rather, a sweetened liquid is electrically heated to create an aerosol that is then inhaled. Research is currently being done on these devices.

Although cigarette smoking is the dominant form of tobacco use in most parts of the world, waterpipe use accounts for a significant and growing share of tobacco use globally. It is most prevalent in Asia, Africa and the Middle East, but it is a rapidly emerging problem on other continents. In the WHO Eastern Mediterranean Region, waterpipe use has surpassed cigarette use in some countries, with growing use by both men and women and, most seriously, among young people and children (*2*).

4.1 History

Waterpipes have been used to smoke tobacco and other substances, such as flowers, spices, fruits, coffee, marijuana or hashish, by the indigenous people of Africa and Asia for at least four centuries, and perhaps earlier (*3*). Their origin is somewhat nebulous, but it is known that trade routes through India and China helped disseminate the practice throughout parts of Asia, the Middle East and Africa (*4*). A form of waterpipe used in India in the sixteenth century was made from a coconut shell as the water reservoir, with a bamboo reed inserted through the top (*4*). This type of coconut-shell hookah was used by commoners, while smokers in affluent families used brass hookahs with ornate designs (*5*). According to one historical account (*6*), the waterpipe was invented in India by a physician during the reign of Emperor Akbar (who ruled from 1556 to 1605) as a purportedly less harmful method of tobacco use. The physician, Hakim Abul Fath, suggested that tobacco "smoke should be first passed through a small receptacle of water so that it would be rendered harmless." (*5*, *6*) Thus, the widespread but unsubstantiated belief held by many waterpipe users today—that the practice is relatively safe—may be as old as the waterpipe itself (*7*).

4.2 Recent emergence

Waterpipes can be purchased from dedicated supply shops (including Internet vendors) that also sell charcoal, tobacco and accessories. Waterpipes are sometimes marketed as portable, with accessories such as carrying straps or cases. Some accessories are sold that are claimed to reduce the harmfulness of the smoke, such as mouthpieces containing activated charcoal or cotton, chemical additives to the water bowl and plastic mesh fittings to create smaller bubbles. None of these accessories has been tested empirically to verify whether they reduce smokers' exposure to toxicants or diminish their risks for tobacco-caused disease and death.

Misconceptions about the less harmful nature of waterpipes may be reinforced by marketing tools for the pipes and the tobacco. For example, the label of a popular waterpipe tobacco brand sold in several regions of the world states that it contains "0.5% nicotine and 0% tar". Others claim their product to be "natural" or "free of chemicals". Popular advertising shows waterpipes made from coconuts or pineapples. One advertisement states that not a single tree was cut down to make the product. Unlike cigarette packaging, which usually carries mandated health warnings, waterpipe tobacco products are commonly sold with no health warning.

Although waterpipe tobacco smoking had reportedly become associated with elderly men in the Middle East, in the 1990s, it quickly surged to become an epidemic among young people. This trend started in the Middle East and spread to universities and schools in many countries and continents. The increasing prevalence of waterpipe use outside regions in which it is traditionally known is reflected in the growth of the international waterpipe industry. The International Hookah Fair[2] is a trade fair showcasing the latest developments in waterpipes, hookah tobacco and similar products, with participants from over 60 countries. The evolution of these fairs reflects the demand for waterpipe products, with a continuous increase in both fair visitors and exhibitors since its establishment in 2013.

[2] http://hookahfair.com/index.php/en/

5. Factors that contribute to the increase in prevalence and spread of use

It is hard to identify all the factors responsible for the global spread of an addictive behaviour such as waterpipe smoking. An addictive behaviour tends to spread gradually unless it is countered by effective policies and regulations. The focus of this advisory note is on the unique features of waterpipes and the combination of factors, within or outside the context of the waterpipe, that have contributed to its fast spread globally. These are: the introduction of flavoured tobacco, social acceptability due to the café and restaurant culture, developments in mass communication and social media and lack of waterpipe-specific policy and regulations.

5.1 Introduction of flavoured tobacco (*maassel*)

The definite date of the first production of sweetened flavoured waterpipe tobacco, commonly called *maassel*, is unknown, but it was already in use in the Middle East in the early 1990s (*8*). Circumstantial evidence suggests a temporal link between the production of *maassel* at the beginning of the 1990s and the surge in the number of waterpipe smokers in the Middle East (*8*). *Maassel* is typically manufactured by fermentation of tobacco with molasses, glycerine and fruit essence, producing a moist, pliable mixture. Before the introduction of *maassel*, most waterpipe smokers used some form of raw tobacco that they manipulated (e.g. crushed, mixed with water, squeezed and moulded) before use. This method usually produces strong, harsh smoke, unlike the smooth aromatic smoke produced from *maassel* (*9*). In retrospect, the introduction of *maassel* for waterpipes was the equivalent of the Bonsack machine, which enabled mass production and marketing of cigarettes. Industrialization and commercialization of *maassel* and its increased availability and variety made it appealing to young people, paving the way for mass marketing through the Internet, and simplified waterpipe preparation (*9*).

Data from all over the world show that *maassel* is the preferred tobacco for use in waterpipes by most smokers, especially young ones (*8–11*). For example, in a survey conducted in 2010 among 3447 students in eight universities in North Carolina (USA), 90% of students who had ever used a waterpipe smoked *maassel* (*11*). Many waterpipe smokers are drawn to this method because of the aromatic, smooth smoke and the variety of flavours of *maassel* (*12*).

5.2 Social acceptability due to the café and restaurant culture

The strong social dimension of waterpipe smoking has been well characterized (*9–14*). Many waterpipe smokers practise the habit in the company of friends and family, and it is a central component of social and family gatherings (*9*, *10*, *15*, *16*). Sharing the same waterpipe is also a well-recognized, widespread practice, especially among young people (*9*, *10*, *17*). Lasting for an hour or more, at a relatively slow puffing rate, waterpipes are conducive to social interactions, especially in café settings. These features coincided with a boom in the café culture among young people in the Middle East and globally (*12*). One of the milestones in this regard was the introduction of "Ramadan tents" in the 1990s, which were a special form of café that provided a social venue during the Muslim holy month of Ramadan. Especially young people gathered in the evening after breaking their fast, and waterpipes became the centrepieces of such settings (*18*). They provided the nicotine for smokers (smoking is not allowed during fasting), an especially active social experience during Ramadan and lengthy sensory indulgence after the strict deprivation of fasting.

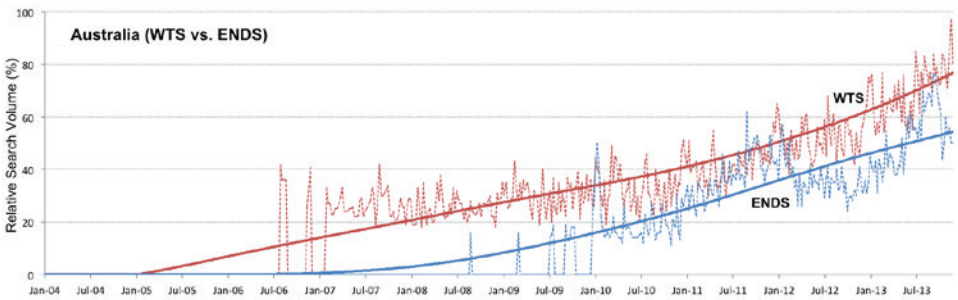
As waterpipes gained appeal among tourists and young people outside the Eastern Mediterranean region, expatriates from the region opened waterpipe cafés and restaurants around the world. The enterprise took on a life of its own, and waterpipe cafés began to open in most urban centres of the world, benefiting largely from the weak or absent regulatory framework for this tobacco use. In the USA for example, the number of hookah cafés has increased dramatically in the past decade, and they are often situated around university campuses (*17*). In a study of 3770 students in eight US universities, current waterpipe smoking was associated with the presence of a waterpipe café or restaurant within a 10-mile (16-km) radius of the university campus (*19*).

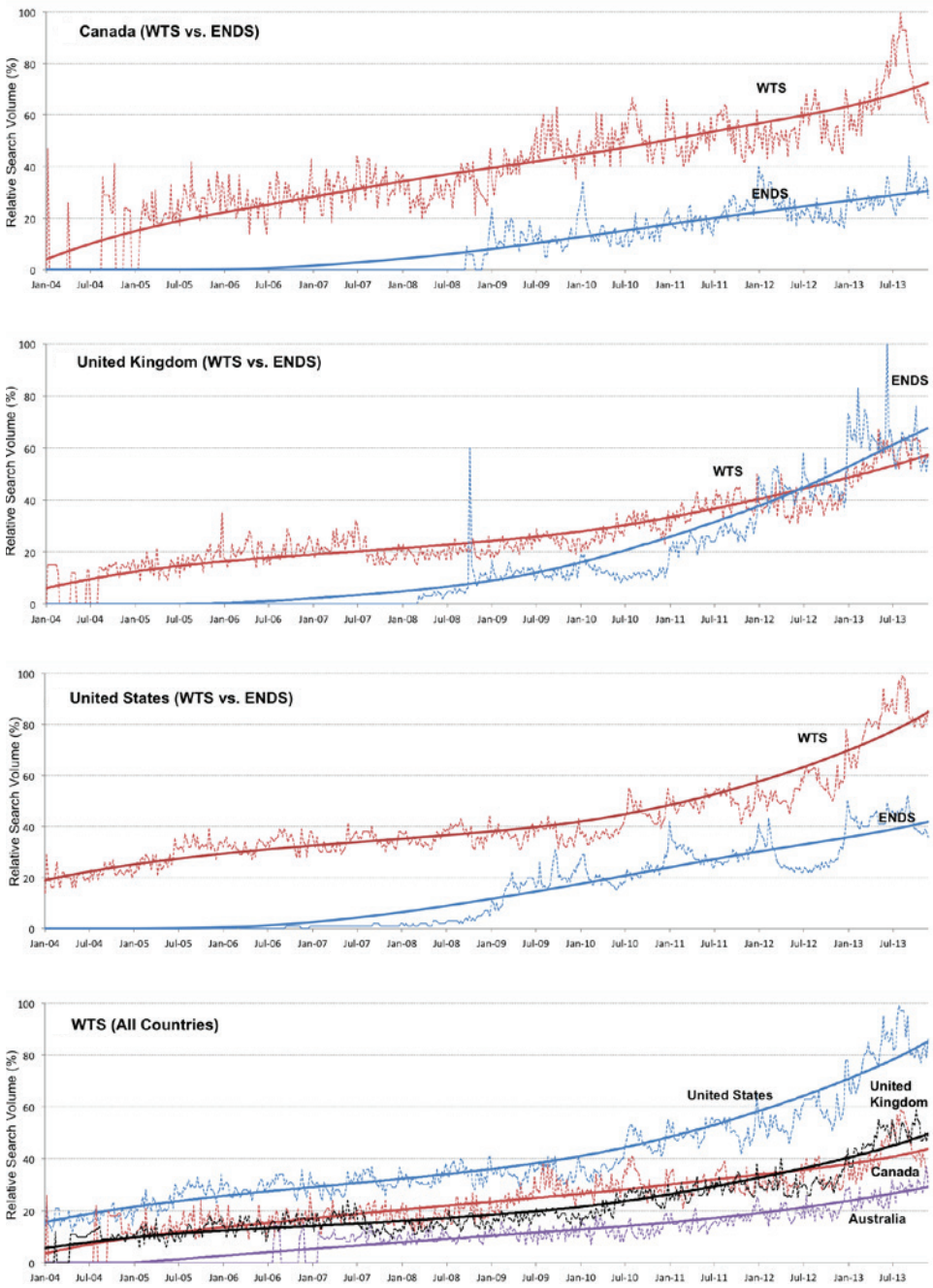
5.3 Developments in mass communication and social media

A local trend, such as waterpipe smoking in Middle Eastern societies, will either remain local or spread slowly in the absence of global communication and networking systems. The waterpipe epidemic has benefited from two technological developments. The first occurred in the 1990s, with the introduction of unregulated, inexpensive, widely accessible satellite television media throughout the Middle East. As a result, satellite television quickly became the entertainment of choice for the masses, and new satellite channels were launched constantly, with increasing air time to be filled. Social activities involving waterpipes, such as Ramadan tents, quickly found air time and were transmitted throughout the region (*18*).

The second technological innovation that probably contributed to the increasing popularity of waterpipe smoking among the young and educated was the Internet. This was particularly relevant to the spread of waterpipe use from the Middle East to regions with little or no knowledge of this form of tobacco use. In a recent study, trends in search engine queries about waterpipes were compared with trends in queries about electronic cigarettes between 2004 and 2013 in Australia, Canada, the United Kingdom and the USA. The study showed that Internet-based searches for waterpipes increased steadily in all four countries during the period and were more frequent for waterpipes than for e-cigarettes in Australia, Canada and the USA, the highest volume being documented in the USA (Figure 2) (*20*).

Figure 2.
Internet search patterns for waterpipe and e-cigarettes in Australia, Canada, the United Kingdom and the USA





Source: reference *20*

WTS, waterpipe tobacco smoking; ENDS, electronic nicotine delivery system

The online searches were primarily for waterpipe products for home use, followed by searches for waterpipe cafés and lounges. The largely unregulated Internet allows waterpipe promoters to circumvent most of the advertisement bans and reach their preferred customer pool of the young and educated. In an analysis of 144 websites of waterpipe venues in the USA, only 4% posted tobacco-related health warnings (*21*). A similar analysis of cigarette- and waterpipe-related YouTube videos showed that user-generated videos of waterpipe use were less likely to acknowledge the negative health consequences of smoking than cigarette videos. In fact, 92% of waterpipe-related videos and only 24% of cigarette-related videos portrayed smoking in a positive light (*22*). Much of the promotion on the Internet and in social media is portrayed as a front for interest groups but in fact disguises waterpipe sellers and marketers (e.g. www.hookahblogger.tumblr.com/ and www.hookah-shisha.com/hookahlove/) (*21–23*).

5.4 Lack of waterpipe-specific policy and regulations

Despite the remarkable success of public health policies in reducing cigarette smoking in many countries, waterpipe smoking has thrived in the wake of strict tobacco control policies and regulations that are mostly cigarette-oriented. For example, waterpipe venues and products in many developed countries are exempt from tobacco control policies, and lack of enforcement of relevant tobacco control policies is the main problem in developing countries. This has contributed to the proliferation of waterpipe venues all over the world (*14*, *24*).

While cigarette pack size and packaging are fairly uniform worldwide, this is not the case for waterpipes. Waterpipes vary in shape and size, are less portable, comprise multiple parts, are often shared and involve diverse commercial stakeholders. Therefore, many policy-related elements must be waterpipe-specific (*25*). For example, a typical waterpipe smoker in a public venue does not see the tobacco package or the warning labels about the health risks associated with the use of tobacco, charcoal combustion or spread of infection (*9*, *26*, *27*). To address this limitation, Turkey has extended warning labelling to the bottles or bowls of waterpipes, requiring that warnings be placed on both sides of waterpipe bottles to cover 65% of the surface (*2*).

Whereas most price-based policies have been effective in curtailing the demand for cigarettes (*28*, *29*), raising the price of *maassel* might not have the same effect,

particularly with regard to waterpipe smoking in a café or restaurant, where tobacco constitutes only a small component of the profit margin (*14*). As anyone can prepare homemade *maassel* from relatively cheap ingredients,[3] waterpipe smokers may be less sensitive to price than cigarette smokers. Additionally, flavouring is considered a major factor in the appeal to young people, yet bans on the use of flavours in tobacco often do not cover waterpipe tobacco products.

This synopsis of the factors that contribute to widespread waterpipe smoking globally is based on an analysis of converging lines of evidence from different sources. While it is obviously limited, its aim is to increase understanding of the dynamics of the global waterpipe epidemic in order to control the spread (*12*).

[3] http://www.thehookahlounge.org/how-to-make-your-own-shisha/, accessed 5 July 2014.

6. Regional and global patterns of waterpipe smoking

Waterpipe smoking has traditionally been associated with the Eastern Mediterranean region, Southeast Asia and northern Africa (*30–32*). Waterpipe use is, however, increasing globally (*1*, *31*, *33–37*), particularly among schoolchildren (*31*, *38–46*) and university students (*33*, *47*, *48*). In many countries, waterpipe smoking is not monitored specifically; however, a systematic review of studies of the prevalence of waterpipe smoking in various populations and subpopulations showed alarmingly high numbers, especially among high-school and university students of Middle Eastern descent (*31*).

Several epidemiological studies have indicated the growing use of waterpipes in all WHO regions and among young people and adults of both genders. According to the Global Youth Tobacco Survey of tobacco use among 13–15-year-old children, use of tobacco products other than cigarettes increased in 34 of 100 sites surveyed, which was largely attributed to rising waterpipe use. The prevalence was 6–34% in the countries that reported data (*38*). Although nationally representative data on waterpipe use by adults are not widely available, the Global Adult Tobacco Survey showed that waterpipe smoking may be emerging in countries in which this tobacco product was not used previously (*34*). In this section, we present the epidemiology of waterpipe use in the six WHO regions.

6.1 African Region

Research on waterpipe use in Africa is limited. Three empirical studies in South Africa were conducted among students. In the first study, 60% of high-school students in a poor urban community in Johannesburg reported ever having used

a waterpipe, while 20% reported daily use (*49)*. The second study, among medical students in Pretoria, found that 19% of the participants had ever used a waterpipe (*50*). In the third study, conducted among university students in Western Cape, 40% of the participants reported current use of waterpipes, and, of these, 70% reported daily use (*51*). Almost half the users (48%) thought that the harmful effects of waterpipe smoking were greatly exaggerated. Waterpipe use fit the global pattern of the young embracing waterpipe smoking as a social experience.

In the Global Adult Tobacco Survey in Nigeria in 2012 (*52*), a very low prevalence was found of current use of tobacco products other than cigarette smoking (0.8% overall, 1.6% males, 0.1% females) in the entire population aged ≥ 15 years. Although empirical evidence is lacking for other countries in this Region[4], anecdotal evidence for Algeria, Ethiopia, Kenya, Nigeria, Sudan, Uganda and the United Republic of Tanzania (*53*) indicates a proliferation of fashionable hookah bars in the larger urban centres in all these countries, which are frequented mainly by the young and business people.

6.2 Region of the Americas

Some research has been done and published on waterpipe tobacco smoking in Canada and the USA, but much less in the Latin American countries. A study in Canada showed that the prevalence of current and any use of waterpipes increased by 2.6% among young people between 2006 and 2010 (*54*). This trend was especially noticeable, as cigarette smoking among young people had significantly decreased in recent years. In the USA, the latest data on adults (aged ≥ 18 years) indicate prevalence rates of 0.5% for use every day and on some days and 3.9% for use every day, on some days and rarely, while use every day, on some days and rarely among 18–24-year-olds was 18.2% (*55*).

In a national study in the USA (*56*), of the 104 434 university students for whom complete information was available on cigarette, waterpipe and cigar use, 8733 (8.4%) were current waterpipe users. In this group, 4492 (51.4%) reported no current use of cigarettes, and 3609 (41.3%) reported no current use of other forms of tobacco. Of the 104 434 respondents, 31 749 (30.4%) had used a waterpipe at some time; of these, 9423 (29.7%) reported never using cigarettes,

[4] The results of Global Adult Tobacco Surveys of waterpipe smoking in Cameroon, Senegal and Uganda were not available at the time of this publication.

and 6198 (19.5%) reported never using tobacco of any kind. Thus, after cigarette smoking, waterpipe smoking was the most frequent form of tobacco use. Among adolescents, the rate of waterpipe smoking in the past month was 2.6% and that of any use was 7.3%. The authors concluded that "nearly one in five adolescents will try hookah before high-school graduation". A nationally representative study of high-school seniors showed an 18% rate of waterpipe use in the past year; those of a higher socioeconomic status were at particular risk for waterpipe smoking (*57*).

Significant waterpipe tobacco smoking does not appear to be common in Latin America, although the published literature is limited. The Global Adult Tobacco Survey showed very low rates in Brazil in 2008, Mexico in 2009, Uruguay in 2010 and Argentina in 2012, with an overall prevalence of < 0.2% in all four countries (*34*, *58*). The rates for young adults were similarly low.

6.3 Eastern Mediterranean Region

The Eastern Mediterranean Region (which includes Middle Eastern and North African countries) has the highest prevalence of waterpipe use in the world (*59*), especially among young people (*30–32*, *60*). In a longitudinal study of smoking among young people in the Region in 2008–2010, the prevalence of waterpipe smoking increased by 40% within 2 years of follow-up (from 13.3% to 18.9%; $p < 0.01$) (*61*). In a representative study of 13–15-year-old schoolchildren in various countries in the Region, the prevalence of waterpipe smoking ranged from 9% to 15% (*62*). In these studies, the prevalence of waterpipe smoking was actually higher than that of cigarette smoking. A Global Youth Tobacco Survey showed that use of other tobacco products (mainly waterpipes) was more frequent than cigarette smoking among children aged 13–15 in all 17 countries of the Region (*38*).

Data on adults are available from the Global Adult Tobacco Surveys for Egypt (2009) (*63*) and Qatar (2013) (*64*). In the population aged ≥ 15 years, the prevalence of waterpipe use was 6.2% for males and 0.3% for females in Egypt and 4.9% for males and 1.6% for females in Qatar. In Egypt, the men who smoked waterpipes tended to be older (40–54 years), live in rural areas and be less educated, consistent with previous results, reflecting the old tradition of waterpipe smoking in Egypt (*34*).

6.4 European Region

According to the Global Adult Tobacco Survey, the overall current and daily prevalence of waterpipe smoking in the population aged ≥ 15 years were lower than those of cigarette smoking. The prevalence among men was highest in the Russian Federation in 2009 (4.4%), followed by Turkey in 2008 (4.0%), Ukraine in 2010 (3.2%) and Romania in 2011 (0.3%) (*34*, *65*). In these countries, users were young (18–24 years), lived in urban areas, were better educated and tended to be occasional rather than daily users (*34*).

According to a Eurobarometer report in 2012 on the prevalence of and attitudes to tobacco in the 28 countries of the European Union among people aged ≥ 15 years (*35*), 16% reported that they had tried a waterpipe at least once, an increase over the prevalence found in the previous survey in 2009. Use of waterpipes was most widespread in Latvia (42%), Estonia (37%) and Lithuania (36%) and least prevalent in Ireland (5%), Portugal (5%), Malta (8%) and Spain (8%). The greatest percentage increases in waterpipe use were reported in Austria, the Czech Republic and Luxembourg, while the largest decrease was reported in Sweden. In general, young male respondents and students reported more waterpipe use.

Smaller-scale studies also showed increasing use of waterpipes in Europe. In the United Kingdom, the prevalence among university students was 8–11%, and that among secondary school students was 8% (*47*, *66*, *67*). In a study of 920 high-school students in France (mean age, 18 years), 40% reported experimenting with tobacco products other than cigarettes, including waterpipes (*68*). In a national study of 13 826 students in Estonia (aged 11–15 years), waterpipe use was reported by 25% of boys and 16% of girls (*69*). In a study of schoolchildren in Israel, 22% reported weekly use of waterpipes (*70*). Other studies in Israel also showed a high prevalence of waterpipe use among schoolchildren (< 18 years) (*71*, *72*), up to 40% (*73*).

6.5 South-East Asia Region

Global Adult Tobacco Survey data collected between 2008 and 2011 on waterpipe use was available for Bangladesh and Thailand in 2009, India in 2010 and Indonesia in 2011 (*34*, *74*). The prevalence among men was highest in Bangladesh (1.3%), followed by India (1.1%), Indonesia (0.3%) and Thailand (0.03%); the prevalence among women was highest in India (0.6%), followed by Bangladesh

(0.2%), Thailand (0.01%) and Indonesia (0.0%). In India, the prevalence of waterpipe smoking was significantly higher in people aged > 50 years than in those aged < 30 years (2.0% vs 0.3%), in those living in rural rather than urban areas (1.1% vs 0.0%), in those with lower rather than higher educational attainment (1.4% vs 0.0%) and among current cigarette smokers than among non-cigarette smokers (5.6% vs 0.6%) (*75*).

No empirical evidence was available on the prevalence of waterpipe smoking in the other countries in the Region; however, anecdotal evidence from newspapers and online resources shows that hookah bars and restaurants are becoming increasingly common and are most often frequented by young people.

6.6 Western Pacific Region

There is a long history of smoking tobacco through "bong" waterpipes[5] (Figure 3) in Asia, which are different from traditional Arabic waterpipes (34) and are not usually included in research on waterpipe tobacco smoking. Bong waterpipes can be made of bamboo, metal or glass and are used in countries such as China, the Lao People's Democratic Republic, Myanmar and Viet Nam. They may be misconceived as less harmful than the Eastern Mediterranean hookah waterpipe (*76*).

Figure 3.
A Chinese bong waterpipe

[5] Bongs are slightly different from waterpipes used in the Middle East: the bong is not necessarily used with charcoal, perhaps resulting in less exposure to carbon monoxide.

In a comparison of 13 countries worldwide, the highest rate of waterpipe tobacco smoking among males (aged ≥ 15 years) was found in Viet Nam in 2010 (13.0%), the rate being higher than that in Egypt in 2009 (6.2%) and in Turkey in 2008 (4.0%) (*34*). The highest prevalence of waterpipe smoking in Viet Nam was in older age groups (40–54 years), those living in rural areas and less educated people. The prevalence in Vietnamese women was very low (0.2%).

A Global Adult Tobacco Survey in China in 2010 showed a prevalence in the population aged ≥ 15 years of only 0.65% for males and 0.08% for females. In a Global Adult Tobacco Survey in Malaysia in 2011, the prevalence in people aged ≥ 15 years was 1.0% for males and 0.1% for females (*77*).

The traditional bong waterpipes thus appear to be used by older, rural, less educated men. There is anecdotal evidence, however, that many traditional Middle Eastern hookah cafés are opening in cities in the Region, and the prevalence of waterpipe tobacco smoking should be monitored as these cafés become more common. In the surveys cited above, no distinction was made between traditional Eastern Mediterranean waterpipes and bong waterpipes.

7. Health effects of the toxicant content of waterpipe smoke

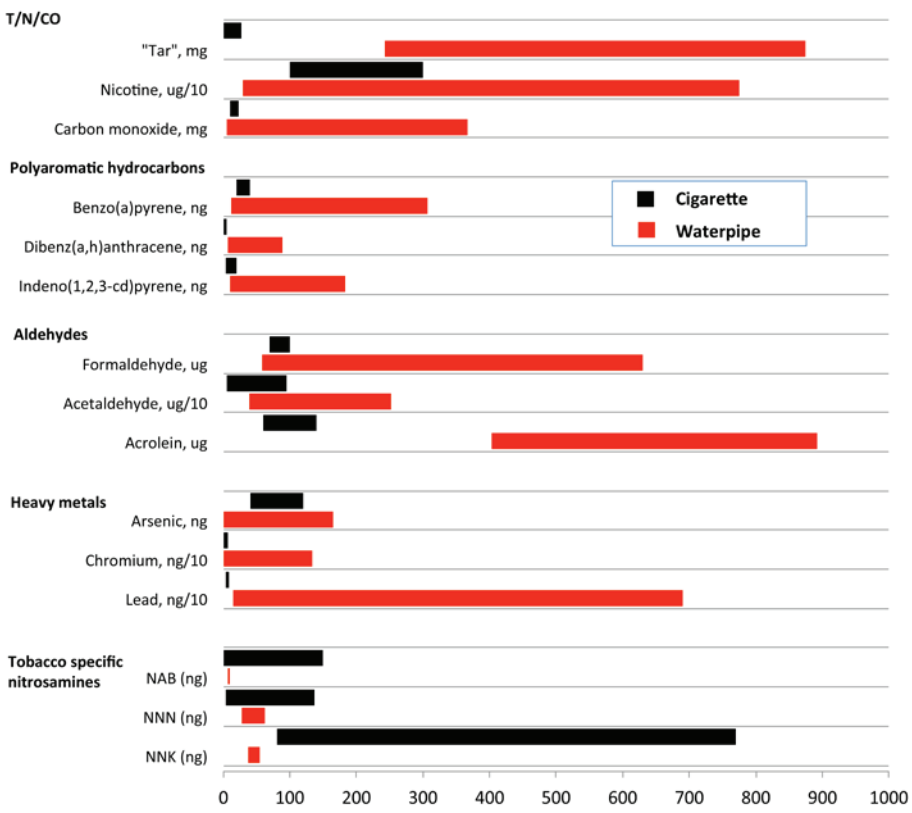
As burning charcoal is usually used as the heat source in waterpipes, the smoke contains toxicants emitted from both the charcoal and the tobacco product, including flavourings. Thus, the composition of both the charcoal and the tobacco can influence the toxicant content of the smoke.

Laboratory studies during the past decade with the use of modern analytical methods and reliable machine smoke generation and sampling protocols have begun to elucidate the toxicant content of waterpipe smoke. Numerous carcinogens and toxicants have been identified, such as tobacco-specific nitrosamines, polycyclic aromatic hydrocarbons (PAH) (e.g. benzo[*a*]pyrene, anthracene), volatile aldehydes (e.g. formaldehyde, acetaldehyde, acrolein), benzene, nitric oxide and heavy metals (arsenic, chromium, lead). The charcoal contributes to high levels of carbon monoxide (CO) and the generation of carcinogenic PAH (*2*). Some of these chemicals are classified by the International Agency for Research on Cancer (IARC) as human carcinogens (*78*). In 2014, it was reported that people exposed to waterpipe smoke are at risk for leukaemia due to benzene uptake (*79*).

Additional factors that influence the toxicant content of the waterpipe smoke aerosol are puff topography (i.e. the number of puffs drawn, the puff volume, duration of puffs and the interval between consecutive puffs) and waterpipe design and construction. Waterpipes are not standardized, although some attempt has been made to standardize them, and they therefore vary in numerous ways, including the volume of the head space above the water and the porosity of the hose through which the user draws smoke. Differences in hose porosity can greatly influence the toxicant content, by varying dilution and combustion conditions (*80*).

Published reports on the toxicant content of waterpipe smoke thus refer to a particular combination of charcoal and tobacco and specific waterpipe features and puffing parameters. In the same way as for cigarette smoke, reports on the toxicant content of waterpipe smoke vary widely. Nevertheless, all the studies to date indicate that, during a typical waterpipe use session, the user will draw large doses of toxicants (ranging from less than one to tens of cigarette equivalents) (Figure 4). These toxicants have been linked to addiction, heart and lung diseases, and cancer in cigarette smokers and can result in similar outcomes in waterpipe users if these toxicants are absorbed in the body in appreciable amounts.

Figure 4.
Reported ranges of toxicants produced during a single 1-h session of waterpipe use (in red) and from a single cigarette (in black)



NAB, *N*-nitrosoanabasine; NNN, *N*-nitrosonornicotine; NNK, (4-methylnitrosamino)-1-(3-pyridyl)-1-butanone
Data on cigarettes from Apsley et al. (*81*) and Jenkins et al. (*82*) and data on waterpipes from Monzer et al. (*83*), Schubert et al. (*84*) and Shihadeh (*85*)

The nicotine in waterpipe products is responsible for their dependence potential (addictiveness). For a single smoking session of 10 g of *maassel* tobacco with 1.5 quick-lighting charcoal discs applied to the waterpipe head, 2.94 mg nicotine, 802 mg "tar" and 145 mg CO were measured in the mainstream smoke (*2*).

7.1 Toxicant uptake by waterpipe users

While analyses of waterpipe smoke show clearly that it contains large doses of toxicants, they do not reveal whether the toxicants are absorbed by the smoker in appreciable amounts. Thus, another line of inquiry for assessing the potential hazard of waterpipe use is to study biomarkers of exposure to toxicants in the blood and urine of users. Such studies have been conducted to investigate acute, "multi-day" and long-term exposure to CO, nicotine, PAH or tobacco-specific nitrosamines (*86–91*). Waterpipe smoking results in significant exposure to all these compounds, and waterpipe smokers have much greater exposure to CO, significantly greater exposure to PAH, similar exposure to nicotine and significantly lower exposure to tobacco-specific nitrosamines than cigarette smokers (*87*, *91*). These findings are consistent across studies and mirror the pattern of differences found in analyses of the toxicant content of waterpipe and cigarette smoke. Even when the results are normalized for nicotine, waterpipe smoke contains much more CO, more PAH and less tobacco-specific nitrosamines than cigarette smoke. Comparison of exposure biomarkers in the blood and urine of waterpipe and cigarette smokers reflects this pattern.

7.2 Acute physiological and health effects of waterpipe use

Waterpipe use has deleterious effects on the respiratory system, cardiovascular system, oral cavity and teeth, and long-term waterpipe smokers have higher incidences of chronic obstructive pulmonary disease and periodontal disease (*2*, *92*).

The emission of high levels of CO leads to syncope among some users due to CO intoxication secondary to the formation of carboxyhaemoglobin in blood, which compromises the transport of sufficient oxygen to body parts, including the brain (*2*). Acute CO poisoning of waterpipe users has also been reported (*93, 94)*, and acute effects have been reported in several controlled clinical studies. Some of the effects, such as elevated heart rate and blood pressure, are consistent with well-

known effects of nicotine (*95–97*). Other deleterious acute cardiovascular effects, such as impaired baroreflex control (*98*) and cardiac autonomic dysfunction (*87*, *88*), have also been documented and found to be independent of nicotine content. Waterpipe smoking also appears to impair lung function and exercise capacity (*99*) and to elicit changes in inflammation biomarkers (*96*). These effects are consistent with the notion that waterpipe smoke delivers physiologically active doses of not only nicotine but also other toxicants and suggest that chronic waterpipe use may lead to disease in the long term.

7.3 Second-hand waterpipe smoke

Second-hand smoke emitted directly from waterpipes into the surrounding atmosphere also contains toxicants, as shown in controlled laboratory test chambers (*100*, *101*) and by measurement of airborne particulate matter in settings where waterpipes are used (*102–104*). Collectively, these studies show that waterpipe smoking results in significant emissions of CO, aldehydes, PAH, ultrafine particles and respirable particulate matter. Establishments in which waterpipes are smoked exclusively tend to have higher concentrations of respirable particulate matter than those in which cigarettes are smoked exclusively (*102*, *103*). On a smoker–hour basis, waterpipe smoking results in higher emissions of CO, PAH and volatile aldehydes than cigarette smoking (*105*). In addition, the direct emissions of toxicants from waterpipes smoked with a tobacco-free preparation were equal to or greater than those from waterpipes smoked with tobacco-based preparations. Thus, except for nicotine, smoke from tobacco-free waterpipe products has the same toxicant content and biological activity as that from tobacco-based products (*103*). These studies indicate that waterpipe smoking should be included in all regulations designed to minimize exposure to second-hand smoke.

7.4 Long-term health effects

A systematic review of the health effects of waterpipe tobacco smoking showed significant associations between waterpipe tobacco smoking and lung cancer, periodontal disease and low birth weight (*106*). The evidence available at that time (2010) was not sufficient to rule out or confirm associations with other outcomes, including other types of cancer. Since that review, more than 20 new, relevant studies have been published, which have contributed to the evidence base and to better understanding of the effects of waterpipe tobacco smoking on health, as detailed below.

Evidence available as of June 2014 suggested that waterpipe tobacco smoking is probably associated with the following types of cancer: oral cancer, with an odds ratio of about 4, based on two cross-sectional studies conducted in India and Yemen (*107*, *108*); oesophageal cancer, with an odds ratio of 2.65, based on three case–control studies in the Islamic Republic of Iran and Kashmir (India) (*109–111*) and lung cancer, with an odds ratio of 2.12, based on six studies conducted in China,[6] India and Tunisia (*112–117*).

Waterpipe tobacco smoking may also be associated with gastric carcinoma, as suggested by a case–control study and a prospective cohort study, both conducted in the Islamic Republic of Iran (*118*, *119*), and with urinary bladder cancer, as suggested by two case–control studies conducted in Egypt (*120*, *121*). During the past 5 years, significant evidence has become available for an association between waterpipe tobacco smoking and respiratory disease, mainly chronic bronchitis. A meta-analysis of data from five studies conducted in the Middle East and North Africa gave a pooled odds ratio of about 2 (*122–126*). In addition, cigarette smoking and waterpipe smoking have a synergistic effect on chronic obstructive pulmonary disease (*127*). A study of Chinese waterpipe smoking showed a significant increase in the risk for chronic obstructive pulmonary disease among waterpipe smokers and also among women exposed to second-hand waterpipe smoke (odds ratio, > 10) (*76*). It is important to recall that this disease is often associated with lung cancer (*128*).

In terms of cardiovascular disease, in a study of 1210 patients in four hospitals in Lebanon, those who had smoked waterpipes for > 40 years had a three times higher odds ratio for severe stenosis (> 70%) than non-smokers (odds ratio, 2.95; 95% confidence interval, 1.04–8.33) after adjustment for demographic characteristics and risk factors for coronary artery disease: cigarette smoking, alcohol consumption, insufficient physical activity, diabetes, hypertension, hyperlipidaemia and a family history of coronary artery disease (*129*). Another large prospective study, in Bangladesh, suggested that waterpipe tobacco smoking was associated with a 20% increase in mortality from ischaemic heart disease and stroke in men (*130*). A cross-sectional study in the Islamic Republic of Iran provided less conclusive evidence on the association between waterpipe tobacco smoking and self-reported heart disease but showed a dose–effect relation (i.e. a higher risk with higher exposure), making the association more likely (*131*). A few studies have addressed surrogate outcomes, such as the severity of findings on cardiac angiography, with results consistent with those described above (*129*, *132*).

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[6] Although Chinese waterpipes are different from that shown in Figure 1. See Figure 3.

Three cross-sectional studies conducted in Egypt did not show an association between waterpipe use and hepatitis C infection (*133–135*). While there have been case reports of an association with tuberculosis (*27*, *136*, *137*), no formal study of the association has been published so far.

The association between waterpipe tobacco smoking and quality of life was assessed in two studies. A national cross-sectional study in Lebanon did not provide conclusive evidence of an association with "respiratory quality of life"[7] (*138*), while a similar study in the Islamic Republic of Iran found that people who smoked waterpipes reported poorer health-related quality of life (*139*).

Waterpipe tobacco smoking has been associated with a variety of other outcomes. Two retrospective cohort studies conducted in Lebanon and one case–control study in the Islamic Republic of Iran found an association between waterpipe tobacco smoking and low birth weight, with an odds ratio of about 2 (*140–142*). One cohort study in Egypt and four cross-sectional studies in Saudi Arabia consistently showed statistically significant associations with periodontal disease (*143–147*).

There have been isolated reports of associations between waterpipe use and other health effects. One cross-sectional study in Lebanon found an association between waterpipe smoking and perennial rhinitis (*148*); a study in Egypt suggested an association with male infertility (*49*); a large cross-sectional study in the Islamic Republic of Iran suggested an association with gastro-oesophageal reflux disease (*149*); and a national survey of university students in the USA found a moderate, statistically significant association between waterpipe smoking and poorer mental health (*150*).

7.5 Addiction to waterpipes

One of the main features of waterpipe smoking is the distinctive use pattern (*7*). Among young people in particular, waterpipe smoking is frequently practised as a group pastime, in the company of friends and family. A waterpipe smoking session takes an average of 1 h, and its limited accessibility or mobility contributes to the predominant pattern being intermittent use (*7*). Furthermore, there is a

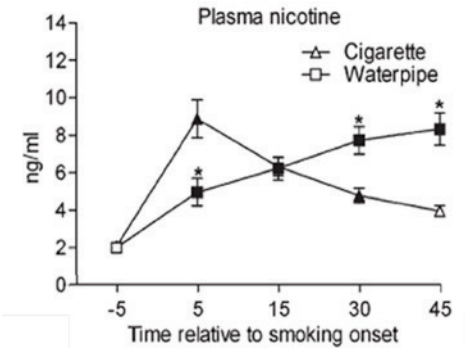
[7] Significant predictors of respiratory quality of life, in decreasing order of importance, are: cumulative number of cigarettes smoked, older age, having at least one smoker in the family, shorter education, female gender, living in a house heated with fuel oil, cumulative dose of smoke from waterpipe tobacco, living in a house heated with hot air and working with at least one smoker.

common misperception that the water has a filtering effect. These features indicate why many waterpipe smokers claim that it is not as addictive as cigarettes (*151*). Whether waterpipe smoking is as addictive as cigarettes at equal levels of use is not known, but evidence of the addictive nature of waterpipe smoking is accumulating and becoming unequivocal.

In 1997, Macaron and colleagues first showed the exposure of waterpipe smokers to nicotine, by measuring cotinine in their urine (*152*); this finding has been replicated repeatedly since. For example, in a recent laboratory study at the Syrian Centre for Tobacco Studies, waterpipe smokers who had been abstinent for 24 h were invited to the clinical laboratory for one session of waterpipe smoking while their venous blood was sampled for later analysis of nicotine. Waterpipe smoking led to about a fivefold increase in plasma nicotine levels (from 3.07 ± 3.05 ng/mL before smoking to 15.7 ± 8.7 ng/mL after smoking; $p < 0.001$) (*153*). In another study, the exposure of waterpipe and cigarette smokers to nicotine was compared in a two-condition cross-over design (i.e. if the first session was with a waterpipe, the second was with a cigarette and vice versa). While peak plasma nicotine levels did not differ in the two conditions, the dynamics of exposure and cumulative dose of nicotine were different, with a slower rise and more protracted, larger cumulative exposure for the waterpipe smokers than for the cigarette smokers (Figure 5) (*154*).

Figure 5.

Mean (± 1 standard error of the mean) plasma nicotine concentration in 31 participants who smoked tobacco using a waterpipe (triangles) or a cigarette (squares) in a laboratory session



While both waterpipe and cigarette smoking were allowed ad libitum, the waterpipe was available for 45 min, and the cigarette was smoked in approximately 5 min. Filled symbols indicate a significant difference from baseline (time 0), and asterisks (*) indicate a significant difference between conditions at that time ($p < 0.001$).

Other than the neuropharmacological aspect of addiction mediated by nicotine, behavioural studies indicate dependence among waterpipe smokers, such as failed quit attempts, self-perception of being "hooked" on the waterpipe, use escalation over time, behavioural adaptation to ensure access and abstinence-induced withdrawal that is suppressed by subsequent use (*33*). For example, in a random sample of 268 waterpipe users in Aleppo, Syria, 28% wanted to quit and 59% had made an unsuccessful attempt to quit in the past year. Belief in the ability to quit was inversely related to perceived dependence (*155*). This experience was confirmed in a standardized laboratory environment, in which waterpipe smokers who had been abstinent for 24 h were invited to the clinical laboratory of the Syrian Centre for Tobacco Studies to smoke a waterpipe *ad libitum*, and their subjective withdrawal and craving were measured before and after smoking. The results showed that the urge to smoke, restlessness, craving and other symptoms of abstinence were intense before smoking and were significantly reduced after smoking, while feeling dizzy or lightheaded and other direct effects of nicotine showed the opposite trend (*156*).

Personal interviews with waterpipe tobacco smokers reveal much about the addictiveness of this form of smoking. For example, a qualitative study brought out several interesting statements from waterpipe smokers: "I started smoking [waterpipe] when I was young and I know its side effects and I know what it does to my lungs. I go up the stairs, I start panting. But I cannot [stop it] because I am addicted to it, I would not mind stopping it but I cannot"; "I like to dominate everything, but the narghile [waterpipe] has completely dominated me. That bothers me. My happiness is related to the narghile. It is essential for having a good time…"; "I usually smoke narghile once daily, but sometimes I smoke more. Because even when I have already smoked it, seeing or smelling narghile makes me feel that I need to smoke again, and I usually do smoke" (*157*). These findings are consistent with the notion that waterpipe smoking is associated with features of tobacco and nicotine dependence similar to those associated with cigarette smoking.

While many of the indicators of waterpipe dependence are seen with cigarette smoking, there are strong reasons to believe that the unique features of waterpipes influence the development and manifestations of tobacco dependence in users. Waterpipe sharing, its social dimension and its limited accessibility are not usually covered in conventional models of tobacco dependence (*7*). Moreover, because a waterpipe is usually used repeatedly, even the act of purchasing one might be a more significant milestone than buying a pack of cigarettes. Nevertheless, studies of waterpipe dependence have relied so far on models and measures derived from the

literature on cigarettes, which can lead to insufficient and erroneous judgements about the addictive potential of waterpipe smoking. For example, doubt was cast on the addictive nature of waterpipe smoking in a recent publication on the basis of the lack of evidence of a desire to smoke a waterpipe within the first 30 min of waking, which is a strong predictive measure of tobacco dependence in cigarette smokers (*158*). Such a critique is pointless in view of the known pattern of waterpipe smoking, with long smoking sessions in a relaxed atmosphere and social context. Almost a decade ago, waterpipe experts warned about the use of cigarette-specific scales or items (such as smoking within the first 30 min of waking) for assessing waterpipe dependence because of its incompatibility with known patterns of waterpipe use (*159*).

Evidence of the addictive potential of waterpipe smoking has spurred efforts to develop specific measures of tobacco dependence. One of the pioneer efforts was the Lebanon Waterpipe Dependence Scale (*160*). While this scale was not based on data for waterpipe smokers but was derived from the criteria of the Fagerström test for nicotine dependence and the *Diagnostic statistical manual of mental disorders* (4th revised edition), it has been used in several studies to measure dependence in waterpipe smokers (*161–163*). With this caveat, tobacco dependence in waterpipe smokers has unique features that continue to be unrecognized in models and instruments derived from the literature on cigarettes. Some of these features probably influence all stages of the development of dependence in waterpipe smokers. Thus, while the specific waterpipe cues of smell and sound may attract new users and reinforce use by established smokers, behavioural adaptation to ensure access may signify more advanced dependence. Daily smokers who perceive themselves to be addicted to waterpipes can engage in more intensive behavioural adaptations to ensure access, such as carrying their own waterpipe and selecting cafés on the basis of waterpipe availability (*37*).

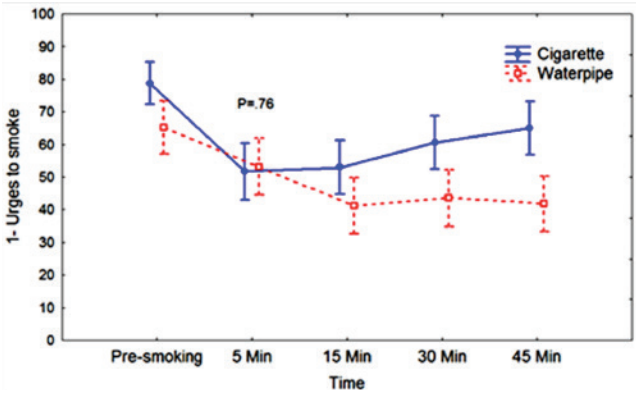
The role of waterpipe-specific cues in attracting new smokers and supporting use has been demonstrated in several studies (*162*). For example, a recent qualitative study conducted in Lebanon supports the contribution of features like smell, sound and taste to young people's connection to the waterpipe (*18*). Specifically, the taste and smell of waterpipe tobacco (*maassel*) were listed as the main reasons for trying a waterpipe and eventually becoming addicted by some people: "my parents used to sit and smoke the waterpipe .... Then, from its nice smell we got hooked". The smell of the waterpipe, even in public places, motivated initiation of waterpipe smoking for some: "When you arrive at a café, you smell the waterpipe from the outside, you say that's it, you want to smoke it". Furthermore, studies on

the attitudes and behaviour of waterpipe smokers in the Eastern Mediterranean Region and elsewhere repeatedly identified the influence of features such as the aromatic smell, the smooth taste of the smoke and the bubbling sound of water in shaping the waterpipe experience (*10*, *12*, *33*, *152*, *162*, *164*). These unique features of waterpipe use and its associative cues to smokers require a novel approach to prevention and cessation of waterpipe use based on evidence from research on the development and character of the dependence of waterpipe smokers and the factors that influence it.

7.6 Waterpipes as a bridge to cigarette smoking

Another worrisome aspect of the spread of waterpipe smoking is its potential to thwart cessation attempts by adult cigarette smokers and to serve as a gateway to cigarette smoking among young people. Several lines of evidence support this potential. First, studies of smoking cessation in the Eastern Mediterranean Region have shown that some people who have quit cigarettes switch to waterpipes, perhaps to sate their craving and avoid withdrawal (*165*). The potential of waterpipes to replace cigarettes for abstinent cigarette smokers was investigated further in a clinical laboratory study in which dual waterpipe and cigarette smokers who had been abstinent for 12 h attended two randomly ordered sessions (waterpipe or cigarette) separated by 48 h. For both methods of tobacco use, the scores for withdrawal and craving were high at the beginning of the session (before smoking) and were significantly and comparably reduced during smoking either a cigarette or a waterpipe (Figure 6) (*166*).

Figure 6.
Mean scores for the item "Urge to smoke" in abstinent dual cigarette–waterpipe smokers

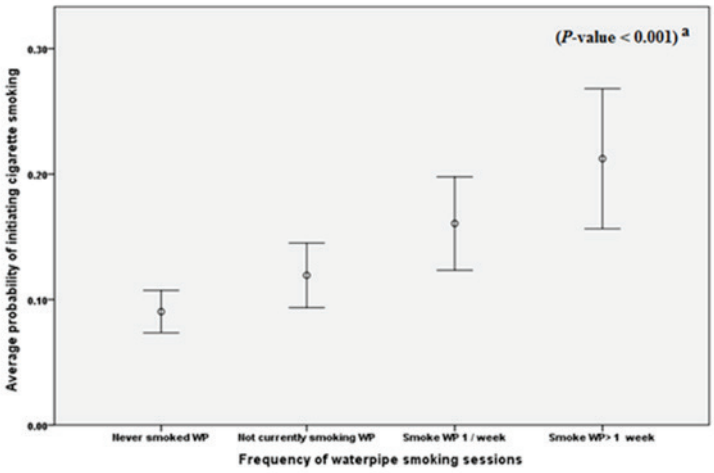


p = 0.8 for a comparison at 5 min in repeat-model analysis of variance

Qualitative studies of adult smokers extend this observation, showing that waterpipe use among cigarette quitters not only helps deal with abstinence symptoms but can increase the probability of failure of quit attempts. For example, in the qualitative study of adult waterpipe and cigarette smokers, one smoker stated "I quit smoking [cigarettes] for more than 6 months. Then, I was invited to smoke narghile [waterpipe]. After the second puff I asked for a cigarette and I started again" (*157*).

While such observations are indicative of the potential of waterpipes to replace and act as a bridge to cigarette smoking, the gateway hypothesis that waterpipe smoking leads to cigarette smoking is still being investigated. Generally, because of their size and the time-consuming preparation process, waterpipes are less accessible to smokers than cigarettes. These features are limiting for an addictive behaviour that requires frequent dosing, which led to the suggestion that young people who start their tobacco use with a waterpipe may turn to the more readily accessible cigarettes to deal with their dependence needs more rapidly (*33*). In other words, the balance between dependence and access may determine which waterpipe users are likely to initiate cigarette smoking. This hypothesis was tested in a longitudinal study of adolescents (aged 13 at baseline) who were not waterpipe or cigarette smokers at baseline and who were compared with people who had never smoked in terms of risk for future cigarette smoking. The 12-month risk of waterpipe smokers for initiating cigarette smoking was twice that of people who had never smoked, and the risk was dose-dependent (Figure 7) (*167*).

Figure 7.
12-month average predicted probabilities of initiating cigarette smoking as a function of previous year's frequency of waterpipe smoking in a school-based sample of 1454 adolescents in Irbid, Jordan, 2008–2011



WP, waterpipe

These results strongly support the possibility that waterpipe smoking serves as a gateway to cigarette smoking and suggest the plausibility of the concept that more frequent (dependent) smokers are more likely to turn to cigarettes (*168*).

In summary, in order to deal effectively with waterpipe dependence, a waterpipe-specific model and measures are needed to capture the full spectrum of experiences of waterpipe users at different stages of their smoking trajectory. Clear understanding is also needed of the role of environmental factors (e.g. policy, family, culture) and cigarette smoking in propagating waterpipe use. Such knowledge could guide waterpipe-specific prevention and intervention strategies to curb its global spread.

8. Research needs

The widespread use of waterpipe tobacco smoking across the globe and the many toxicants to which users are demonstrably (*86*, *90*) or probably (*169*) exposed provide ample justification for vigorous research on the health risks associated with this form of tobacco use and on methods for preventing and treating it. There has been remarkable progress in some research areas, and this document shows that we have come closer to understanding national and global trends in waterpipe tobacco smoking; methods for evaluating toxicant yields; smokers' exposure to and absorption of toxicants; individual patterns of smoking; the relations among yield, exposure and absorption; and the pharmacology and toxicology of waterpipe smoke. During the past 10 years, research on waterpipe use has increased dramatically, especially in Germany, Jordan, Lebanon, the United Kingdom and the USA, but more is needed (*170*, *171*). Progress is, however, slow, because individual research groups tend to work in relative isolation.

The global response to repeated calls for more research on all aspects of waterpipe tobacco smoking (*164*, *172*) has been positive, but more must be done. A coordinated approach is required to address the critical research needs listed below.

- the types and patterns of waterpipe smoking in all regions and cultures (*1*);
- the extent to which the chemical and physical properties of the smoke depend on the waterpipe set-up and smoking conditions (*1*);
- the epidemiology of waterpipe-associated acute health effects and disease risk, including addiction, transmission of non-tobacco-related communicable diseases (*1*), respiratory cancer and cardiovascular and other tobacco-related diseases, with an emphasis on understanding how patterns of use (for example, frequency, ingredients or material placed in the head and/or the bowl of the

waterpipe, group versus individual sessions and whether the mouthpiece is shared) influence disease risk, taking into account specific groups, such as pregnant women and women of reproductive age;

- development of standardized biomarkers of exposure and effect, such as DNA adducts, in order to obtain complementary evidence of the biological effects of waterpipe smoke on cells and in experimental animals to determine whether waterpipe smoke induces inflammatory and oxidative stress responses;
- the influence of cultural and social practices on initiation and maintenance (*1*);
- the relation between smoking waterpipes and other forms of tobacco, including substitution and smoking multiple products (*1*), and the extent to which initiation of waterpipe tobacco smoking is a factor in subsequent use of other forms of tobacco;
- the relation between waterpipe tobacco smoking and use of other drugs, including marijuana (*1*);
- development of culturally relevant prevention and cessation strategies (*1*);
- development of measures of nicotine and tobacco dependence that are validated for waterpipe tobacco smoking, also taking into account differences in culture and language;
- the extent to which flavoured tobacco, waterpipe cafés and other marketing tools, economic factors and the absence of waterpipe-specific tobacco regulation influence the global spread of waterpipe tobacco smoking;
- the effect on non-smokers of exposure to waterpipe tobacco smoke and smoking, including health effects, and "renormalization" of tobacco smoking;
- experimental research on the effects of clinical and public health interventions on preventing and cessation of waterpipe tobacco smoking;
- whether use of waterpipes without tobacco or with very low-nicotine tobacco leads to dependence;
- epigenomic effects of waterpipe tobacco smoking, such as in the human respiratory epithelia;
- the role of flavours in increased initiation, dual use and continuation of use of other tobacco products, as well as long-term effects of flavours; and,

– for the WHO Tobacco Laboratory Network (TobLabNet),[8] assessment within 2 years of whether the standard operating procedures for measuring nicotine (*173*), tobacco-specific nitrosamines (*174*) and benzo[*a*]pyrene (*175*) in cigarette contents and emissions are applicable or adaptable as appropriate to waterpipe smoke, pursuant to the request to WHO at the sixth session of the Conference of the Parties to the WHO FCTC (*176*).

[8] http://www.who.int/tobacco/industry/product_regulation/toblabnet/en/

9. Scientific basis and conclusions

While the evidence base for the health effects of waterpipe tobacco smoking remains sparse, it is nonetheless sufficient to justify strong control measures to limit the spread of this practice. As outlined above, every study to date has found that waterpipe tobacco smoke contains ample quantities of the toxicants known to cause diseases in cigarette smokers, including cancer, and that at least some of those toxicants are effectively absorbed by waterpipe users and are therefore present in their breath, blood and urine (*177*). A complementary line of evidence is derived from studies of the biological effects of waterpipe smoke on cells and experimental animals, which have shown that it induces inflammatory and oxidative stress responses (*178*) and plausible mechanisms for the development of vascular disease and chronic obstructive pulmonary disease in regular waterpipe users. The findings of epidemiological studies are congruent with those of toxicological research. The accumulating body of evidence shows that waterpipe tobacco smoking is probably associated with oral, oesophageal and lung cancers and possibly with gastric and bladder cancers. There is also evidence of associations with respiratory disease, cardiovascular disease, periodontal disease, low birth weight, perennial rhinitis, male infertility, gastro-oesophageal reflux disease and impairment of mental health (*91*). Uncertainty remains about an association with tuberculosis.

In summary, all the evidence, from studies of molecules to studies of human populations, converges towards the conclusion that waterpipe tobacco smoking causes diseases that are commonly associated with cigarette smoking, including addiction. While there are fewer studies of waterpipe tobacco smoke constituents and their biological activity and health effects than of cigarette smoke, the consistency of the evidence within and across scientific approaches suggests strongly that this basic conclusion will not change as more evidence becomes available. In light of the widespread, growing use of waterpipes worldwide, firm action is necessary and justified to protect public health.

10. Policy

At the sixth Conference of the Parties to the WHO FCTC, held in Moscow, Russian Federation, on 13–18 October 2014, WHO was invited to prepare a report on policy options and best practices in controlling use of waterpipe tobacco products in light of the WHO FCTC, to be submitted to the seventh session of the Conference of the Parties in November 2016 (*179*). TobReg hereby makes the following policy recommendations.

WHO FCTC article	Specific policy recommendations for waterpipes
Article 5	**General obligations.** Even in countries with well-established tobacco control programmes, waterpipe tobacco smoking may be underrepresented or exempted because of its novelty in some countries and its long-standing traditional presence in others. Legislation and regulations on tobacco should specify all tobacco, not just in cigarettes, and should ensure that waterpipe-specific stipulations[9] are included in legislation in countries with a high or increasing prevalence.
Article 5.3	**Protection from vested commercial interests.** International exhibitions have been held recently to promote waterpipe tobacco products and accessories (*1*). Transparency should be required from waterpipe tobacco and accessory companies that are advocating for and against legislation and regulation, both directly and through third parties. No matter what role the tobacco industry plays in the production, distribution and sale of waterpipes and waterpipe products, this industry, its allies and front groups can never be considered a legitimate public health partner or stakeholder while it continues to profit from tobacco and its products or to represent its interests.

[9] Waterpipes with or without tobacco in the "head"

Article 6	**Price and tax measures to reduce the demand for tobacco.** Because tax measures have been shown to reduce tobacco consumption, especially by young people, Parties should implement both tax and price measures on waterpipe tobacco and waterpipe products.
Article 8	**Protection from exposure to tobacco smoke**. Because all second-hand tobacco smoke has the potential to cause death, disability and disease, waterpipes should be included with cigarettes in clean indoor air policies. Waterpipe cafés or lounges should not be exempt from clean indoor air legislation.
Articles 9 and 10	**Regulation of the contents of tobacco products and tobacco product disclosures.** Policy should be implemented to ensure that waterpipe tobacco is included in legislation requiring the testing and regulation of tobacco contents and emissions, as well as the reporting thereof.
Article 11 **a**	**Health claims.** Waterpipe tobacco packaging and all waterpipe parts and accessories must not promote any misleading understanding about tobacco or give an erroneous view of the dangers inherent in its use.
b	**Health warnings.** Waterpipe tobacco, product packaging and waterpipes themselves should be labelled with health warnings in accordance with Article 11 of the WHO FCTC.
Article 12	**Education, awareness and training.** Given the prevalence of misinformation surrounding the health dangers of waterpipe tobacco smoking, specific education and training must be included in wider tobacco education and public awareness programmes implemented by Parties.
Article 13	**Advertising, promotion and sponsorship**. A comprehensive ban on advertising, promotion and sponsorship of waterpipes should be included under Article 13 of the WHO FCTC. Parties not in a position to undertake a comprehensive ban should strongly restrict such advertising, promotion and sponsorship.
Article 14	**Demand reduction measures concerning tobacco dependence and cessation.** In accordance with the measures listed in Article 14 of the WHO FCTC and the guideline, Parties should include waterpipe tobacco smoking in cessation and treatment programmes for tobacco dependence.
Article 15	**Illicit trade in tobacco products.** Legislation and measures prohibiting illicit trade in tobacco should follow the guidelines set forth in Article 15 of the WHO FCTC and should ensure that waterpipe tobacco is included with cigarettes and all other forms of tobacco.

Article 16	**Sales to and by minors.** Sales of all tobacco, including waterpipe tobacco, should be prohibited to minors under Article 16 of the WHO FCTC. Waterpipe venues should not be an exception to this legislation.
Additionally	**Product design and information**. Waterpipes and waterpipe products should be regulated to: – minimize the content and emissions of toxicants; – ensure that any nicotine used is of pharmacological quality; – minimize acute nicotine toxicity; – minimize CO toxicity from heated charcoal; – impede product alteration to include other drugs; – ban waterpipe tobacco with alcohol and sweet-like flavours that may appeal to children and young people; – require manufacturers and importers to disclose to government authorities information about the contents and emissions of waterpipe tobacco smoking; and – require registration of manufacturers and importers with government authorities.
	Surveillance and monitoring. It is recommended that governments use or strengthen existing tobacco surveillance and monitoring systems to assess the current prevalence and the evolution of waterpipe use in various demographic groups, including by gender and age.
	Assessment of fire risk. The use of charcoal poses a regulatory challenge regarding its contribution to fires, which should also be assessed, and Parties should consider establishing monitoring systems for that purpose (*1*).

11. Suggested actions for regulators

TobReg also recommends specific actions for regulators (*179*):

WHO FCTC Article	Suggested actions for regulators
Article 6 **a**	In order to conform to Article 6 of the WHO FCTC, Parties should both implement tax measures on tobacco products and restrict or prohibit importation and sale of duty-free tobacco and waterpipe products.
b	The goal of tobacco taxation is to decrease demand by discouraging purchasers by cost. Therefore, the tax should actually be prohibitive. If waterpipe tobacco is taxed only in bulk (e.g. by kg), it is still relatively inexpensive for individual users. Parties should consider taxing waterpipe tobacco per individual serving or at higher bulk prices.
c	Waterpipes themselves, as well as parts and accessories, should also be taxed.
d	Waterpipes, waterpipe tobacco, parts and accessories should be prohibited or restricted from being sold tax- or duty-free.
Article 8	Waterpipe cafés or lounges must not be exempted from clean indoor air laws, as they are in some countries where waterpipes are traditionally smoked. Indoor waterpipe smoking in public areas should be prohibited and smoking allowed only outside. Waterpipe venues should not be allowed within large shopping areas, such as indoor malls.
Articles 9 and 10	Waterpipe tobacco and waterpipe smoke should be tested by the same stringent standards that are applied to cigarette tobacco. Legislation should ensure that waterpipe tobacco is not exempt from testing and regulation of contents and emissions. The results of the testing of contents and emissions should be reported to the appropriate government body. Effective measures should be in place to disseminate information to the public about the toxicity and emissions of waterpipe tobacco smoking.

Article 11.1 **a**	**Health claims on packaging and labelling**. In accordance with Article 11 of the WHO FCTC, Parties should prohibit manufacturers and third parties from making health claims for waterpipe tobacco smoking and should prohibit deceptive descriptors that infer claims of health or safety (e.g. "contains 0% tar or 0.05% nicotine"). This must also apply to accessories, including claims made for charcoal ("odourless", "free of chemicals", "100% natural"). Even "tobacco free" or "herbal" waterpipe alternatives contain large doses of toxicants, and the packaging should not be allowed to carry health or safety claims.
b	**Health warnings on packaging and labelling.** Health warnings should indicate the various harmful effects of tobacco use and should: – be approved by a competent regulatory body; – be rotated at set intervals (e.g. every 12 months); – be large, clear, legible and visible; – cover no less than 30% of the principal display area (i.e. not hidden on the bottom or side where it might not be seen); and – be in the form of or including pictures or pictograms. Warning labels must be placed on waterpipe tobacco packaging and also on all accessories and on waterpipes themselves. Labelling waterpipe tobacco is not sufficient, as smokers may not see the packaging (if they smoke in a bar or café). As waterpipe parts, charcoal, filters and mouthpieces can be sold separately, warning labels should be affixed to all individual packaging. Regulation should go beyond the placement of warning labels on waterpipes. Waterpipes are considered aesthetically pleasing as well as functional, and manufacturers and smokers may resist or remove labelling that is considered to mar the beauty of the waterpipe. This should not be allowed. Because waterpipes present a novel challenge in terms of the placement of warning labels (on the waterpipe itself as well as accessories), pre-market testing of warning label placement would be useful, as would monitoring of placement options found to be successful in trials.

Article 12 **a**	Comprehensive education and public awareness programmes on the dangers of waterpipe smoking should be implemented. Programmes should specifically address the fallacy that waterpipe smoking is safer or healthier than smoking cigarettes.
b	Education and programmes for and about the benefits of cessation should be widely available.
c	Training on and awareness of the dangers of waterpipe smoking should be provided for health workers, community workers, social workers, media professionals, educators, decision-makers, administrators and all those who are pivotal in tobacco control and health care.
Article 13 **a**	Any form of waterpipe advertising, promotion and sponsorship must be regulated by an appropriate government body. This can be done most easily by making certain that waterpipes are included in all legislation and regulations governing cigarette advertising, promotion and sponsorship, without exception.
b	The regulations must be adapted to the unique feature of waterpipe vending, namely, that most advertising, promotion and sales are through the Internet.
c	At a minimum, Parties' regulations on advertising, promotion and sponsorship of waterpipes must: – not make them appealing to or target, either explicitly or implicitly, – non-smokers or non-nicotine users; – not make them appealing to or target, either explicitly or implicitly, minors, including through the selection of media, the location or the context in which they appear or through imagery that promotes sexual or sporting prowess; – encourage quitting smoking, and provide a quitline number if one exists; – not contain health, safety or medicinal claims; – not undermine any tobacco control measure, including not promoting exemption of waterpipe cafés from clean indoor air policies; – include factual information about the product's ingredients in a way that does not distort evidence of risks; – not link these products with gambling, alcohol, illicit drugs or activities or locations in which using them would be unsafe or unwise; – clearly state the addictive nature of nicotine and that these products are intended to deliver nicotine; and prohibit suggestions that waterpipes have positive qualities.

d	All authorized forms of waterpipe advertising, promotion and sponsorship must be cleared by the appropriate authority prior to publication or transmission in order proactively to prevent inappropriate marketing and then monitored to assess compliance with approval.
Article 14	Cessation programmes for tobacco dependence should include waterpipe tobacco smoking dependence. The interventions should target the unique features that make waterpipe smoking appealing and thus difficult to quit: – the appeal of the aroma, – the pleasant bubbling sound and – the social atmosphere or bonding and sharing over a waterpipe.

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After 10 years of accumulating evidence for the increasing prevalence and untoward health effects of waterpipe tobacco smoking, the WHO Tobacco Free Initiative announces publication of the second edition of the WHO Study Group on Tobacco Product Regulation scientific advisory note on waterpipe tobacco smoking. This advisory note addresses growing concern about the increasing prevalence and potential health effects of tobacco smoking with waterpipes, a practice that dates back at least four centuries in Africa and Asia. The note will provide a more thorough understanding of the health effects of waterpipe smoking for WHO Member States and research agencies. The note is issued in response to the request made to WHO by the Conference of the Parties to the WHO Framework Convention on Tobacco Control at its sixth session, in Moscow, Russian Federation, in October 2014.

9 789241 508469

World Health Organization
Tobacco Free Initiative
Avenue Appia 20,
1211 Geneva 27, Switzerland
Tel: +41 22 791 21 26
Fax: +41 22 791 48 32
tfi@who.int
http://tobacco.who.int