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# Water-Pipe (Narghile) Smoking: An Emerging Health Risk Behavior

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**ABSTRACT.** Narghile, or water-pipe smoking (WPS), has been practiced extensively for ~400 years. It is common in the Arabian Peninsula, Turkey, India, Pakistan, and other countries. In recent years, there has been a revival of WPS, notably among youth. Most US health professionals are unfamiliar with the practice and health consequences of WPS. Therefore, this trend presents a new challenge for adolescent health care providers. The composition of the tobacco used in WPS is variable and not well standardized. Studies that have examined narghile smokers and the aerosol of narghile smoke have reported high concentrations of carbon monoxide, nicotine, "tar," and heavy metals. These concentrations were as high or higher than those among cigarette smokers. The few scientific data regarding the adverse health consequences of WPS point to dangers that are similar to those associated with cigarette smoking: malignancy, impaired pulmonary function, low birth weight, and others. Additional dangers not encountered with cigarette smoking are infectious diseases resulting from pipe sharing and the frequent addition of alcohol or psychoactive drugs to the tobacco. Public health strategies for controlling the emerging epidemic of WPS include carrying out epidemiologic and toxicologic research; implementation of laws to limit acquisition and use; and health education, targeting adolescents in particular. *Pediatrics* 2005; 116:e113–e119. URL: [www.pediatrics.org/cgi/doi/10.1542/peds.2004-2173](http://www.pediatrics.org/cgi/doi/10.1542/peds.2004-2173); adolescents, cigarettes, health risk behaviors, narghile, nicotine, smoking, tobacco, water pipe.

ABBREVIATION. WPS, water-pipe smoking.

Narghile, or water-pipe smoking (WPS), has been practiced extensively for ~400 years. In recent years, there has been a revival of WPS, notably among youth. This trend, reflecting globalization's impact on developed nations, presents a new challenge for adolescent health care providers.

Narghile is known by a number of different names, including argileh, goza, hookah, hubble-bubble, and shisha. Its origin is often traced to India, although there are theories that it was first used in South Africa, Persia, Ethiopia, or other countries.<sup>1,2</sup> The narghile pipe is usually decorated with floral or other motifs and has served as an artistic medium for

craftsmen in many countries. Its use declined considerably during the past century and had principally become the habit of elderly and retired men who spent their time in bazaar cafes, particularly in poor areas.

There has been a resurgence of WPS in the past several years. This phenomenon has been attributed to the perception that WPS is less dangerous than cigarette smoking, its easy availability, its low cost, and a number of other factors. It is usually a social activity, engaged in by peer groups and families, and often practiced in special cafes.<sup>2,3</sup> The expanding influence of Eastern and Arab cultures in the United States and Europe places WPS as a potentially important public health issue for adolescents in these countries.

## EPIDEMIOLOGY

It has been claimed that >100 million people worldwide smoke water pipes daily.<sup>1,2</sup> It is a common practice in the Arabian Peninsula, Turkey, India, Pakistan, Bangladesh, and some regions of China. In some areas, WPS is more prevalent than cigarette smoking. Among Arab women in many countries, there is less of a stigma associated with narghile than with cigarette smoking and therefore less of a gender differential.<sup>3–6</sup>

Most of the epidemiologic studies of water pipe use have been conducted among adults; only a few reports have been published about university students and only 1 of middle and high school students.

In Lebanon, WPS rates of 14.6% among adults<sup>7</sup> and ~25% among pregnant women<sup>8</sup> have been reported. A survey of Lebanese university students found that 32% smoked narghile, with higher rates among men, and no differences according to socioeconomic status.<sup>4</sup>

A recent cross-sectional survey of 587 university students in Syria found that 62.6% of the men and 29.8% of the women had ever smoked narghile, and 25.5% of the men and 4.9% of the women were current smokers. Of these, only 7% of the men and none of the women were daily smokers. The mean age of initiation was 19.2 and 21.7 years, respectively. Smoking usually took place in dormitories, cafes, or restaurants and was almost always practiced in groups.<sup>9</sup> The recent trend of increased narghile use was illustrated in another Syrian study of 268 water-pipe smokers: most of them, regardless of age, had begun smoking in the 1990s.<sup>10</sup> A survey of 4000 Kuwaiti government employees found that 57% of men and 69% of women had ever used a narghile.<sup>11</sup>

In Israel, where there is a natural merging of Jew-

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ish and Arab cultures, WPS has recently become a common and growing phenomenon among Jewish youth. A national survey of ~6000 middle and high school students found that 37.7% had ever smoked narghile. The rates were higher among Jewish (39.5%) than among Arab (30.5%) students.<sup>12</sup> Another survey of 388 Jewish middle and high school students found that 41% smoked narghile, and 22% smoked at least every weekend. The rate of WPS was 3 times greater than that of cigarette smoking and increased from 15% in the seventh grade to 58% in the ninth grade. Fifteen percent reported that their parents smoked narghile, and approximately one quarter of the smokers reported smoking with their parents.<sup>13</sup>

In France and other European nations, there has been an upsurge of narghile use in the past several years. In the United States, national data are not currently available, and questions regarding its use are not included in national surveys of health risk behaviors, such as the Centers for Disease Control and Prevention's Youth Risk Behavior Surveillance System.<sup>14</sup> A recent review of WPS does not cite any published epidemiologic data from the United States.<sup>15</sup> One report of 28 Arab American adolescents who participated in a focus group in Michigan on smoking found that all of them had used narghile,<sup>16</sup> suggesting that this is a common practice among these youth. In addition, several dozen "hookah bars" have been opened in New York, Los Angeles, and other areas. Although most patrons are immigrants from Moslem countries, where WPS is common, Internet and lay press stories report that these bars are becoming increasingly popular among college students and young adults.<sup>17</sup> With globalization and immigration from these countries, the continued growth of this practice should be anticipated.

## THE WATER PIPE AND ITS USE

### Tobacco

The tobacco used in WPS typically weighs ~10 to 20 g and has 3 main forms. "Mu'essel" or "maasel" (literally, "honeyed") contains ~30% tobacco and 70% honey or molasses (treacle). "Tumbak" or "ajami" is a pure, dark paste of tobacco. "Jurak," mainly of Indian origin, is an intermediate form that often contains fruits or oils but that may also be treacled and unflavored.

"Muessel" is usually flavored with apple, mango, banana, strawberry, orange, grape, mint, cappuccino, or other additives. It is generally sold in cardboard boxes or plastic jars decorated with fruit illustrations. Drugs or alcohol is often added to the tobacco.<sup>1</sup>

### Apparatus

There are different types of water pipes, varying in size, shape, and composition. A typical, modern water pipe (Fig 1) is composed of a head, metal body, glass bottle, and a flexible connecting tube with a mouthpiece. The head, in which the tobacco is placed, consists of a bowl positioned into the body and is usually covered with a conical cap to protect the flame from extinction. The body is fixed to the



Fig 1. A modern water pipe.

neck of the bottle, which is partially filled with water and placed on the ground. The tube is attached to an aperture in the side of the pipe.

Tobacco combustion begins in the water-pipe head, where the moist tobacco is placed, with burning charcoals placed close to the tobacco. The smoke passes through the water in the body of the pipe, where it is diluted and cooled and where soluble compounds are dissolved. It then passes through the connecting tube and is inhaled by the smoker. Consecutive inhalations are required to inhale the smoke and to keep the tobacco burning.

### Smoking Practice

WPS is usually practiced in groups, with "rites" associated with preparation of the instrument and with the smoking itself. The water pipe is the center of a social activity of conversation and passing time. The hose is passed from person to person, and the same mouthpiece is usually used by all of the participants. Most smoking sessions last 45 to 60 minutes but may also continue for several hours.

## COMPOSITION OF NARGHILE AND ITS SMOKE AEROSOL

The composition of the tobacco used in WPS is variable and not well standardized. The nicotine content of water-pipe tobacco has been reported to be 2% to 4%, in comparison with 1% to 3% for cigarettes.<sup>18</sup>

Only a small number of studies have examined the composition of narghile smoke. A study of carbon monoxide in water-pipe and cigarette smoke found carbon monoxide concentrations of 0.34% to 1.40% for water-pipe smoke and 0.41% for cigarette smoke. The carbon monoxide concentration in water-pipe

smoke was significantly greater for smaller water-pipe size and for commercial as opposed to domestic charcoal.<sup>19</sup> Another study found elevated end-expiratory carbon monoxide levels in a group of 18 healthy Jordanian water-pipe smokers.<sup>20</sup>

In a separate report, the carboxyhemoglobin concentration was measured in 1832 healthy Saudi Arabian male volunteers after smoking for 10 to 40 minutes. The mean carboxyhemoglobin concentrations were higher among water-pipe smokers (10.1%) than among cigarette smokers (6.5%) or nonsmokers (1.6%), and a linear relationship was found between smoking intensity and carboxyhemoglobin concentration.<sup>21</sup>

A study of nicotine and cotinine in water-pipe smokers found high values of these substances after smoking. After a single 45-minute smoking session, the mean plasma concentration of nicotine rose from 1.11 to 60.31 ng/mL, and cotinine rose from 0.79 to 51.95 ng/mL. Saliva nicotine concentration rose from 1.05 to 624.74 ng/mL, and cotinine rose from 0.79 to 283.49 ng/mL. The mean amounts of nicotine and cotinine excreted in a 24-hour urine sample after smoking were 73.59  $\mu$ g and 249  $\mu$ g, respectively.<sup>22</sup> According to another report, urinary cotinine concentrations were similar for water-pipe smokers (median of 2 pipes per day) and for cigarette smokers (median of 30 cigarettes per day).<sup>23</sup>

An analysis of mainstream smoke aerosol found that narghile smoke contains significant amounts of nicotine, "tar," and heavy metals. Using a standard smoking protocol of 100 puffs of 3 seconds' duration in a single smoking session, 2.25 mg of nicotine and 242 mg of nicotine-free dry particulate matter were obtained. In addition, high levels of arsenic, chromium, and lead were found, in comparison with smoke from a single cigarette. Increasing the puff frequency increased the nicotine-free dry particulate matter, whereas removing water from the bowl increased the amount of nicotine.<sup>24</sup>

These studies provide limited data to suggest that water-pipe smoke is at least as toxic as cigarette smoke. Water-pipe smokers may absorb higher concentrations of these substances because of higher concentrations in the smoke itself or because of the mode of smoking, including frequency of puffing, depth of inhalation, and length of smoking session. Water-pipe smokers may smoke for several hours at a time and may breathe in more deeply because of the less irritating nature of the moisturized smoke. Carbon monoxide concentration, specifically, may also be elevated because of the charcoal used to burn the narghile tobacco. Contrary to popular opinion, the water in the pipe probably filters out only a small portion of the noxious substances. More research is needed to compare the toxic effects of the 2 types of smoking, taking into account the presmoking carbon monoxide levels, frequency and intensity of inhalation, and other factors.

#### HEALTH EFFECTS

Despite its widespread use, few studies to date have documented the adverse health consequences of WPS. This lack of data results from that WPS is

mostly a non-Western habit, the high prevalence of smoking is a relatively recent phenomenon, lack of standardization of narghile content, and the difficulty in studying the isolated effects of narghile because most of the smokers are also current or past cigarette smokers.

Existing studies suggest pathologic consequences for the most part similar to those induced by cigarettes and additional risks of infection related to smoking practice. These studies have examined either clinical or biological effects (Table 1).

#### Malignancy

A survey of 25 men with bronchogenic carcinoma in India found that 22 were narghile smokers.<sup>25</sup> A case-control study of 214 Chinese tin miners found a twofold risk for lung cancer among those who had ever used water pipes compared with nonsmokers and a dose-response relation with increasing pipe-usage.<sup>26</sup> WPS was associated with esophageal and gastric carcinoma in a preliminary survey from Yemen.<sup>27</sup> A case-control study of bladder cancer patients in Egypt showed no difference in rates between water-pipe smokers and nonsmokers.<sup>28</sup> Two cases of squamous cell carcinoma and 1 of keratoacanthoma of the lower lip have been reported among Egyptian narghile smokers.<sup>29</sup> These reports suggest that WPS has a carcinogenic role in a number of body systems.

#### Pulmonary (Nonmalignant)

WPS has been associated with noncarcinogenic morbidity and pathophysiologic effects in the respiratory system. In a study of 595 smokers in Saudi Arabia, the mean vital capacity, forced expiratory volume in 1 second, and the forced vital capacity were lower among water-pipe smokers than among nonsmokers, and these values declined with age. Water-pipe smokers were at greater risk than cigarette smokers for decreased pulmonary function.<sup>30</sup> A decrease in the peak expiratory flow rate was found among water-pipe smokers in 1 study of 203 Turkish men,<sup>31</sup> whereas no association was found between pulmonary function and WPS in another group of 54 Turkish men.<sup>32</sup> A third study of 397 Turkish men reported a detrimental effect on pulmonary function, specifically on the peak expiratory flow rate, although the decrease was smaller than with cigarette smoking.<sup>18</sup>

#### Infectious Diseases

In addition to its intrinsic pathogenic ability, WPS has the potential for spreading infectious diseases, given that smokers often share the same mouthpiece and pipe. The spread of infectious diseases could also result from the uncontrolled, manual preparation of narghile, in contrast to tobacco marketed by the cigarette industry.

In a group of Egyptian patients with *Helicobacter pylori*, water-pipe smokers who smoked in groups had increased rates of infection when compared with nonsmokers, similar to the rates among moderate to mild cigarette smokers.<sup>33</sup> Pulmonary aspergillosis has been reported in a leukemia patient as a

TABLE 1. Health Effects of WPS

Condition	Study Design	Study Population/Setting	Findings	Source
Malignancy Lung cancer	Retrospective	25 men with bronchogenic carcinoma	22 of 25 were water-pipe smokers	Nafae et al <sup>25</sup> (India, 1973)
	Case-control	107 male tin miners with lung cancer	Increased cancer rates (OR: 1.9, dose response)*	Qiao et al <sup>26</sup> (China, 1989)
Gastrointestinal cancer	Retrospective	183 patients with esophageal and gastric carcinoma	Increased cancer rates	Gunaid et al <sup>27</sup> (Yemen, 1995)
	Case-control Case reports	151 men with bladder cancer Oral surgery department	No difference in cancer rates (OR: 0.8) 2 cases of squamous cell carcinoma, 1 case of keratoacanthoma	Bedwani et al <sup>28</sup> (Egypt, 1997) El-Hakim and Uthman <sup>29</sup> (Egypt, 1999)
Pulmonary Pulmonary function	Controlled study	595 smokers	Decreased VC, FEV <sub>1</sub> , FVC; decline with age*	Al-Fayez et al <sup>30</sup> (Saudi Arabia, 1988)
	Controlled study	65 exclusive water-pipe smokers	Decreased PEFR*	Bayindir et al <sup>31</sup> (Turkey, 1993)
	Controlled study	19 exclusive water-pipe smokers 82 exclusive water-pipe smokers	No difference in PEFR Decreased PEFR*	Alinisik et al <sup>32</sup> (Turkey, 1995) Kiter et al <sup>33</sup> (Turkey, 2000)
Infectious diseases <i>Helicobacter pylori</i> Pulmonary aspergillosis Tuberculosis	Retrospective Case report Retrospective	128 men with <i>Helicobacter pylori</i> Adult leukemia patient 45 contacts of 5 men with pulmonary tuberculosis shared a marijuana pipe with the case	Increased infection rates (OR: 4.1) 1 case Increased risk for a positive tuberculin skin test (OR: 2.22)*	El-Barrawy et al <sup>33</sup> (Egypt, 1997) Szyper-Kravitz et al <sup>34</sup> (Israel, 2001) Munckhof et al <sup>35</sup> (Australia, 2003)
	Potential morbidity		Hepatitis C, HSV, HIV, EBV, respiratory viruses	
	Miscellaneous Reproductive	Case-control	100 infertile women	Increased infertility rates with WPS husbands (OR: 2.5)*
Retrospective		106 pregnant water-pipe smokers delivering in hospitals 18 healthy water-pipe smokers	Increased low birth weight rate (OR: 2.17)*; increased respiratory distress rate (OR: 3.65)* Elevated heart rates and blood pressures after smoking*	Nuwayhid et al <sup>37</sup> (Lebanon, 1998)
Cardiovascular	Clinical study	292 patients with coronary heart disease 100 water-pipe smokers	Increased rates among ever (OR: 2.2) but not among current (OR: 0.7) water-pipe smokers 3 times greater risk for dry socket	Shafagoj and Mohammed <sup>20</sup> (Jordan, 2002) Jabbour et al <sup>38</sup> (Lebanon, 2003)
	Dental: postextraction dry socket	Prospective		Al-Belasy <sup>39</sup> (Egypt, 2004)
Biological effects Hematologic	Laboratory	Water-pipe smokers	Increased superoxide anion and leukocyte counts*	Sharma et al <sup>40</sup> (India, 1997)
	Laboratory Laboratory	35 water-pipe smokers 7 subjects	Increased chromosomal abnormalities* Abnormal platelet function*	Yadav and Thakur <sup>41</sup> (India, 2000) Wolfgram <sup>2</sup> (Austria, 2003)

OR indicates odds ratio; VC, vital capacity; FEV<sub>1</sub>, forced expiratory volume in 1 second; FVC, forced expiratory flow rate; HSV, herpes simplex virus; EBV, Epstein-Barr virus.

\*Statistically significant.

result of smoking contaminated tobacco and marijuana in a water pipe.<sup>34</sup> Sharing a marijuana water pipe has been associated with the transmission of tuberculosis.<sup>35</sup> Other pathogens that could potentially be transmitted include hepatitis C, herpes simplex, Epstein-Barr virus, respiratory viruses, and HIV.

### Miscellaneous

A case-control study of 100 Egyptian infertile women found that WPS of the husband was associated with infertility of the couple.<sup>36</sup>

Low birth weight was reported to be approximately twice as common among the newborns of Lebanese women who smoked narghile (approximately the same as for cigarette smokers) and nearly 3 times as common among those who began smoking narghile in the first trimester than among nonsmokers. Their infants also had lower Apgar scores and higher rates of respiratory distress.<sup>37</sup>

Elevations in heart rate and systolic, diastolic, and mean arterial blood pressure were found after smoking in a group of 18 healthy Jordanian water-pipe smokers.<sup>20</sup> A case-control study of patients with recently diagnosed coronary heart disease found higher rates among those who had ever engaged in WPS.<sup>38</sup>

Egyptian patients who underwent oral surgery were more likely to develop postextraction dry socket when they were water-pipe or cigarette smokers.<sup>39</sup>

### Biological Effects

In a study of peripheral blood neutrophils, both cigarette and narghile smokers had higher production of superoxide anion and higher total leukocyte counts than nonsmokers, changes that may cause injury to lung tissue and have a role in the pathogenesis of chronic obstructive lung disease.<sup>40</sup> A study of the somatic chromosomes of male water-pipe smokers found genotoxic effects, including increases in the mitotic index, chromosomal aberrations, sister chromatid exchanges, and satellite associations, in comparison with nonsmokers.<sup>41</sup> Another study found that WPS resulted in impaired platelet function, including hemostatic changes and long-lasting oxidation injury.<sup>2</sup>

### Dependence

Given its nicotine content, narghile would be expected to have a great addictive potential. Indeed, tobacco dependence has recently been suggested in adult water-pipe smokers.<sup>42</sup> However, WPS among youth is typically not on a daily basis,<sup>9,13</sup> thus decreasing the potential for dependence at this age.

### ATTITUDES TOWARD WPS

WPS is perceived by many adolescents, the general public, and even health professionals as being less dangerous than cigarette smoking. Table 2 summarizes some common myths and misconceptions: (1) the nicotine content is lower than that of cigarettes; (2) water filters out all the noxious chemicals, including carbon monoxide, nicotine and tar; (3) WPS is less irritating and thus less harmful to the throat and

**TABLE 2.** Myths/Misconceptions

Myth: WPS is less dangerous than cigarette smoking because the nicotine content is lower.
Fact: Patterns of smoking may result in higher nicotine intake. The nicotine content is variable.
Myth: Tobacco toxins are filtered out by the water in the pipe.
Fact: Many toxins are not filtered out.
Myth: WPS is less irritating and therefore less toxic to the respiratory tract.
Fact: The lack of irritation as a result of the moisture in the pipe may give a false sense of security and reduce concerns about true health effects.
Myth: Fruit added to the tobacco makes WPS a healthy choice.
Fact: Fruit flavoring may mask the toxic substances in the tobacco.

respiratory tract than cigarette smoking; (4) narghile tobacco contains fruit, making it a healthy choice. These myths are reinforced by the media. For example, Internet sites praise the behavior, offer information about WPS, and provide sources for buying WPS products.

Only 1 study to date has reported on attitudes of adolescents regarding narghile use. Among the Israeli students in this survey, at least 50% believed that WPS is less harmful than cigarette smoking. Approximately half of the smokers did so without their parents' knowledge, but only 24% believed that their parents objected to their smoking, 38% reported that their parents even supported this behavior, and 53% reported that their parents preferred narghile to cigarette smoking. The reasons for smoking were "pleasurable experience" (77%), "adds to intimacy in a social gathering" (38%), "helps to deal with pressure" (11%), and "to be accepted by peers" (7%).<sup>13</sup>

Among the Syrian university students surveyed, reasons for periodic increases in WPS included weather and outdoor recreation (27% of men and 17% of women), stress relief (19% and 8%), meeting and socializing with friends (17% and 58%), and time availability and boredom (33% and 17%).<sup>9</sup> Common positive perceptions of narghile use related to its smell and taste, whereas negative perceptions related to the smoke produced, pollution, and perceived adverse health effects. Half of the students believed WPS to be more harmful than cigarette smoking.<sup>6</sup>

### WPS AS A HEALTH RISK BEHAVIOR

WPS may be viewed as a "traditional" health risk behavior that is undergoing a revival. In addition to its intrinsic health risks, WPS carries dangers in that adolescent smokers often mix the tobacco with marijuana or hashish, and many replace the water in the pipe with alcoholic beverages. In the Israeli sample, 6% of the respondents reported adding drugs or alcohol to the tobacco.<sup>13</sup> The combination undoubtedly has additive, acute health hazards. Some experts believe that WPS is a gateway substance to cigarette smoking or to the use of other psychoactive substances. Most Arab American adolescents who participated in a focus group had used narghile as their initial experience with smoking.<sup>16</sup>

WPS, like cigarette smoking, may be seen as meet-

ing certain developmental tasks of adolescence, such as attaining maturity and autonomy. Being a group activity, the initiation of narghile smoking is often a result of peer pressure and the desire to be accepted by others, thus providing the perceived benefits of belonging. WPS is also a relatively inexpensive activity, with a typical once-a-week smoker paying far less than a dollar per week. In Syria, daily cigarette smokers have reported spending 26% more than daily water-pipe smokers.<sup>9</sup> Because most narghile smokers are not daily smokers, the cost is considerably lower, which may make it more appealing to adolescents.

WPS also has characteristics that set it apart from other health risk behaviors. For example, tacit parental acceptance and the practice of parents' smoking with their teens place this behavior outside the realm of adolescent rebellion in many cases. The teen's perception that the practice is "less harmful" than smoking cigarettes even provides the feeling that the behavior is, at least in relative terms, a healthy choice. The frequently reported clustering of health risk behaviors may be less strong regarding narghile than for other practices. In the survey of Lebanese university students, cigarette smoking was associated with a range of other health risk behaviors, whereas WPS was associated only with drinking excessive amounts of alcohol.<sup>4</sup>

#### PUBLIC HEALTH IMPLICATIONS

WPS, as a health risk behavior enjoying an impressive revival, deserves the attention of public health policy makers and academic researchers. There is a paucity of epidemiologic data regarding water pipe use in general and among adolescents in particular. Investigation into the prevalence of narghile use in Western countries should be conducted, with ongoing surveillance.

Adolescent cigarette smoking is the leading preventable cause of future morbidity and mortality, and its health implications have been studied extensively. In contrast, little is known about the toxicology and long-term health effects of narghile. There is a need to study the content of narghile tobacco and its smoke aerosol in various countries, as well as the many potential health consequences that may result from its use.

A number of public health control measures should be considered in locations where WPS is commonly practiced. Narghile content should be regulated and monitored. Other measures that have been used in tobacco control, such as labeling packages with warnings about health effects (usually not done currently for narghile), prohibiting sale to minors, and increasing the cost through taxation, might be implemented. Personal risk reduction measures might include using disposable, plastic nozzles to avoid mouth-to-mouth contamination. Health education is important to dispel myths about narghile's alleged safety.

Primary care physicians who care for adolescents should be aware of the emerging phenomenon of WPS in Western countries and should know about its many potential health implications. They should be

prepared to counsel their patients on the individual level and to advocate for control measures that will minimize the health hazards on the community level of this "new" health risk behavior.

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