Title: Geographical Distribution and Time Trends of Water Pipe Use among Iranian Youth and Teenage Students: A Meta-Analysis and Systematic Review

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Abstract

Water pipe tobacco smoking is harmful to health; however, its prevalence estimates remain uncertain. Recent evidence showed that the prevalence of waterpipe smoking among students is higher than the general population. We systematically sought peer-reviewed literature databases; 76 articles were enterer to the study. Moreover, geographical distribution and time trends of water pipe consumption in Iran were considered. The results of our study show that Lifetime, Last year, Last month prevalence of waterpipe smoking among Iranian students were 28.78(25.07-32.49), 20.84(16.01-25.66) and 16.36(11.86-20.85) respectively. Our result showed a wide variation by the region and sex in Iran. This study has shown the importance of prevention and awareness programs in schools and universities.

Keywords: *student, water pipe smoking, prevalence, Iran*

Introduction

According to the last World Health Organization's (WHO) report, 20.2% of people aged 15 years and older were tobacco smokers in 2015 (1). There has been a decrease in the prevalence of tobacco use worldwide from 2000 through 2015, except in the Eastern Mediterranean Region (EMRO) and Africa Region (AFRO), where the prevalence remained constant (1). WHO has projected that the prevalence of smoking in men in the EMRO region will be increased more than 3% by 2025, while in other parts of the world, the tobacco prevalence will be declined.(1).

One type of tobacco smoking is called hookah or waterpipe smoking, which has been used extensively in the Middle East and has become popular in the USA and Europe in recent decades (2). ,

Water pipe have been reported to be much more harmful than cigarette because of the load of smoke inhaled and also the long duration of use- about 30 to 45 minutes (3). Hence, for more than a decade researchers have extensively investigated health impacts of water-pipe smoking. Until now, water-pipe smoking as a risk factor of many diseases/disorders including lung cancer, metabolic syndrome, hyperlipidemia, low birth weight, and more (4-8).

A systematic review showed that the prevalence of water pipe smoking among the Middle East and Middle Eastern descent students who moved to Western countries has been alarming(9). According to this study, the highest prevalence of water pipe in the last 30 days was for Lebanese school students (37.2% in 2008). The highest prevalence of lifetime water pipe smoking was reported in two Lebanese studies that both were 65.3% (10). Based on this study,

the prevalence rate of regular or occasional use was 16.3% among Iranian students in 2005 (10).

Adolescents are one of the high risk population of using tobacco. This period of life course is a transitional phase of characteristic development between childhood and adulthood. One of the characteristics is being accepted among peers by doing the same leisure interests like tobacco smoking. Therefore, many studies indicated that adolescent period could be the initial age of tobacco use including water-pipe smoking. Besides, some studies showed that water-pipe smoking could open the door to cigarette smoking and then drug abuse(11-14).

Several studies have reported the prevalence of water pipe smoking in various groups, especially youths in Iran. Also, water-pipe smoking went back to 1500s BC as an amusing tool which showed the warm hospitality in some regions of Iranians population. Since, water-pipe smoking is almost not a social stigma even for adolescents. Iran is a young country with around 60% of population below the age of 25 and around 50% below the age of 20(1, 15). Therefore, determining the prevalence of water-pipe smoking in this group is essential for designing interventional strategies. Based on previous studies the reported prevalence of hookah consumption, varied between 1% to 25% in general Iranian populations. The variation was dramatically worsen considering age groups, gender, and geographical region, acceptance at social level, cultural norms. previous studies showed the role of religious belief and parental support in the prevention of high risk behaviours like hookah consumption (161-22).

Systematic and meta-analysis are valuable as one of the study methods with valid policymaking and decision-making results.

Although, some national estimates of smoking prevalence have been reported(19) the exact numbers of hookah smokers among students remain debated also, they did not address the geographical and temporal variations of waterpipe use among young people, which prompted us to design this study. Also, our study examines the prevalence of waterpipe use among school

and university students separately. Despite the inconsistency of results across groups, the prevalence of waterpipe smoking among students is higher than the general population. However, there is no national survey among Iranian students. Thus, we aimed to conduct a systematic review and estimate the prevalence of water pipe use among Iranian students.

MATERIALS AND METHODS

In this study, we systematically sought peer-reviewed literature databases about the prevalence of water pipe use among Iranian students from 1990 until 2020. Our search was limited to papers in the databases that were published in English and Farsi until November 2020. These databases were: PubMed, Medline, Embase, ISI Web of Science, ProQuest, Scopus, Google scholar, also some Persian scientific databases including Iranmedex, SID, Magiran, and IranDoc.

Search strategy

The keywords used in the search were: (waterpipe* OR "water pipe*" OR shisha* OR sheesha* OR hooka* OR huqqa* OR guza* OR goza* OR narghil* OR nargil* OR argil* OR arghil* OR (hubbl* SAME bubbl* OR galyan OR ghalyan OR smoking pipe OR tobacco product OR smoking water pipes OR water pipe smoking OR tobacco)) AND Iran, Irani, Persian. Also, medical librarians reviewed and advised on the search strategies.

Inclusion and Exclusion Criteria:

After searching papers, the references of the included studies and reviews were checked. Regarding the aims of the study, cross-sectional studies and cohort studies were included. All schools and universitiesstudies, with the target group of high school, secondary school, and university students, were included. Also, regarding the outcome-prevalence of waterpipe use- we extracted the prevalence of waterpipe use by searching different terms, including Ever

hookah use (Last year hookah use, and Life time hookah use) , and current users (Last month hookah use).

Studies selection

Two teams of reviewers (MJ/RW and RB/RW) separately screened the titles and abstracts of the captured citations twice to distinguish potentially eligible studies.

The full text of eligible articles was reviewed, and the inter-rater reliability was calculated.-The score was 8-11 for papers, which indicated discordance. Disagreements were resolved by discussion, and when needed, ~~a~~ third reviewer (SA) was called to help.

Those studies which did not report the prevalence of waterpipe use and showed the association, systematic reviews, meta-analyses, randomized clinical trials, editorials, reports, in vitro articles, and duplicated articles were excluded.

Quality evaluation

A checklist was used to evaluate the quality of articles. This checklist, previously used in some studies (23, 24), included objectives of the study, study method, sample size, sampling method, data collection tools, variables evaluation status, the studied target group, and analysis status, using 12 questions (one score for each question). In this checklist, the maximum score was 12, and the minimum acceptable score was 8 (23). In this study, eight studies scored less than 8. These articles were not deleted because in some regions few studies were available ,.

Data abstraction

Five reviewers (SA, LN, MV, NK, and SM) conducted an exercise before abstracting data from each eligible study duplicated and independently using a standardized and pilot-tested data abstraction form. Excel 2016 software was used for the classification of data extraction. The

variables which were extracted included the corresponding author's name, year of publication, place, type of the study, target group, sample size, average age of the participants and gender, as well as the type of reported index (ever or lifetime water pipe use, last year or past 30 days).

Geographic regions of Iran

Iran is the 18th most populous and the 17th largest country globally and is the second-largest country in the Middle East.

Since water pipe smoking varies based on geographical regions, in this study, the country was divided into five regions of waterpipe use, namely: North, Northwest and West, South, East and south-east and Tehran and central regions (Figure 1) (25).

- In the northern region of Iran, which includes three provinces with 7.6 million inhabitants, no articles have been published in two groups, so it was excluded from the report.
- Northwest and west regions consist of 10 provinces, and it has about 18 million inhabitants.
- The southern region consists of six provinces, with 16.4 million inhabitants.
- The eastern and southeast region of Iran is more than 10.8 million and includes four provinces.
- There are eight provinces with about 27 million people in Tehran and the Central region of Iran.

Data analysis

There was no agreement in the studies on the definition of current smoking, so we inevitably considered two definitions for hookah consumption current, and ever smoking.

"current smoking":

- Current smoking that in many articles it was reported as last month soking by anyone who uses water pipe daily or, if less frequently, has smoked water pipe during the past 30 days (26).

For "ever water pipe use," we preferred the following definition:

- Smoking by anyone who has experienced water pipe smoking, even as little as one puff, during their life (26). The distribution of these definitions in several parts of Iran was depicted in Figure 6.

- Also we consider people who has had waterpipe use experience during last year(27). However, we classified these two option as two subcategories of ever water pipe use when the articles emphasized on this definition(27).

The analysis was performed by Comprehensive Meta-Analysis (CMA) software (version2) and Stata Statistical Software (version 11; Stata Corporation, College Station, TX, USA). The standard error of the prevalence of waterpipe use was calculated in each study. Finally, the heterogeneity index was determined by the Q test. A random model was used to estimate water pipe use prevalence regarding the heterogeneity results in a meta-analysis. The publication bias was not evaluated because the prevalence as a proportion was always a positive number, and if we observed asymmetry in the funnel design, it was not due to publication bias.

Results

Search results

In the initial search, 725 articles (including 687 articles in scientific databases and 38 articles by searching in other sources, including gray literature, etc.) were identified. Of these, 284 were duplicates. Thus, of 441 remaining papers, 360 articles were excluded at the screening stage including papers were *in vitro* or clinical trial and other target groups. After reading the full text, five articles were deleted because they did not measure the prevalence of tobacco

consumption or other types of studies), finally, data in 76 articles were extracted. Figure 2 shows the study flow and reasons for study exclusions. The descriptive summary of these papers is presented in Table 1. Since there are differences in the motivation and patterns of consumption among university and schools' students, the prevalence in these two groups is studied separately:

In the following, we will first address the School students 'group and then the University students' group based on ever, and current hookah smoking

Study characteristics

The 76 studies covered the regions of Iran include northwest and west, southern, East and South East, East and South East, Tehran and Central, and the whole country. The central region which Tehran as capital city located here returned 32% (25 studies), followed by south 23% (18 studies), and north west and west 22%, (17 studies). The whole country was covered in 9 studies (11%), while the East, and South east had the lowest coverage with seven studies (9%). Twenty-eight studies belong to school students while forty-eight studies were done on university students. Most of the articles reported the ever hookah consumption (life time). The meta-analyses showed that the total population covered from all selected studies was 16,106, with the mean age of samples ranging from 13.42, and 19.15 for school, and student's university. In total, the crude prevalence of the last month's, last year, life time prevalence of water pipe smoking among Iranian students, 16.36(11.86-20.85), 20.84 (16.01-25.66), 28.78 (25.07-32.49), respectively However, the heterogeneity of the articles was very high ($I = 99.39$, $p < 0.001$) for last month, ($I^2 = 99.68$, $p < 0.001$), and lifetime ($I^2 = 99.43$, $p < 0.001$) (Figure 3-5). Furthermore, the time line prevalence of (life time) ever water pipe smoking among Iranian school students showed the variation between this index among for several years,; it was depicted in Figure7.

University students group

Current smokers

The prevalence of last month tobacco smokers (current smokers) ranged from 3.6 recorded in Sahraian , in 2010 (28) to 36.9 in 2016 from south of Iran(29). The pooled crude prevalence of current smokers in Iranian university students was 14.26% (CI: 10.86, 17.66), with this significantly lower among women 7.79% (CI: 4.20, 11.38) compared to men 22.57% (CI: 16.91, 28.23). Across the geopolitical zones, the prevalence rate of current smokers was significantly higher in North West, and west 24.52% (CI: 12.94, 36.09), compared to the other geopolitical zones. The prevalence articles which were done on all provinces was 15.35 %(CI: 8.84, 21.87) while the south 12.39% (CI: 7.25, 17.52), and central 10.51 %(CI: 7.08, 13.95) parts of Iran have lowest prevalence respectively.

Ever smokers

The prevalence of last year, and life time hookah smoking was varied between 1.8% to 40.3 %, and 5.9% to 51.2% for university students (30-33). The pooled crude prevalence of ever hookah smokers (life time) was 30.00 (CI: 26.01, 33.99), while the (last year) was 22.23 (CI: 18.68, 25.77). In both last year, and life time of hookah smoking the prevalence of hookah consumption were roundly two times higher in male (Last year : 29.39% , Life time : 45.06% %) than female (Last year : 12.36 % , Life time : 28.48%). The pooled prevalence of ever smokers was highest in central part of Iran both for last year 25.63 (CI: 20.36, 30.90), and life time 32.81 (CI: 26.42, 39.20) hookah smoking. While in North West, and west (Last year: 12.31%, Life time: 17.48, %) and central (Last year: 25.63 %, Life time: 10.51, %) parts of Iraniian students have the lowest consumption of hookah.

School students group

Current smokers

The prevalence of current smokers ranged from 13.0% form North West, and west of Iran (34) to 31.1 % (35). The pooled crude prevalence of current smoker's in Iranian school students was 23.46(CI: 18.26, 28.), with significantly lower among female 19.47 (CI: 10.17, 28.78) than male26.12 (CI: 17.12, 35.12). The pooled prevalence of life time smoking 32.98 (CI: 28.83, 37.13) was significantly higher than last year 12.35 (CI: 6.47, 18.22 hookah smoking. Beside this, this trend was observed both for boys life time 38.52 (CI: 31.05, 45.98), and girls life time 26.60 (CI: 19.69, 33.50 hookah consumption compare to the boys15.42 (CI: 2.08, 28.75), and girls 8.70 (CI: -6.29, 23.69 last year hookah consumption. We cannot calculate the crude analysis across the region of the country due to low numbers of published articles.

Ever smokers

The prevalence of last year, and life time hookah smoking was varied between 8.5% to 26.3% , and 9.4% to 64.4% for university students(36). The pooled crude prevalence of ever hookah smokers (life time) was 32.98 (CI: 28.83, 37.13), while the (last year) was 12.35 (CI: 6.47, 18.22). In both last year, and life time of hookah smoking the prevalence of hookah consumption were roundly two times higher in male (Last year: 15.42 % , Life time : 38.52 %) than female (Last year : 8.70 % , Life time : 26.60 %). We cannot estimate the pooled ever consumption for school students based on geographical variation.

Discussion

This study integrated hookah smoking information from several parts of Iran to estimate the prevalence of hookah consumption in Iranian students, but we found a varied prevalence of hookah consumption in several parts of Iran ranging from 5% to 68%. Although the prevalence

of ever hookah user increased between 2008 to 2013, we observed a decreasing prevalence of hookah consumption during 2014 to 2018. However, an increasing trend was observed in recent years. Some factors like changing the socio-economic status, the pleasurableness of hookah, easy access, spending the leisure times with friends may cause this situation(37).

The prevalence of current hookah smoking was half of the ever hookah smoked. Mores students tend to drop the hookah, and they may use hookah as way for their leisure times but the 30 % of the student's experience hookah consumption in their life(37). The current prevalence of hookah consumption in school students higher than university students. However, the ever consumption of it have not any obvious different.

In another review on the prevalence of waterpipe use among the general population and specific groups of countries globally, the highest prevalence of waterpipe use was reported to be among students. According to this study, the prevalence of waterpipe smoking among Lebanese, Estonian, Persian Gulf countries, and Arab-Americans was 25%, 21%, 9 -16%, and 12-15%, respectively. In the college students subgroups, the current waterpipe smoking in Pakistan, Lebanon, Syria, United States, and England was 33%, 28%, 15%, 10%, and 8%, respectively (38).

Most of the time the consumption of hookah in male was higher than female. In Ansari-Moghaddam *et al.*'s study, ever water pipe smoking in girls was 66.5% (95%CI: 61.2%, 72.2%) which was much higher than boys 29.5% (95%CI: 28.0%, 31.2%) (25). In the present study, as in many studies in Iran (16, 17, 26, 39, 40) and other countries (38), ever water pipe use in men was higher than women in Iranian students. . However, the prevalence of waterpipe smoking in some Iran regions, including the south region in adult females, is higher than in males (41). Nevertheless, in almost all areas with high prevalence, the prevalence was higher in women (41). Also, the estimated prevalence of cigarette smoking was 19.8% (95% CI: 17.7, 21.9) in boys and 2.2% (95%CI: 1.4, 3.02)(24) in girls. This significant difference between sex

consumption was related to the discrimination of cigarette consumption in Iran than hookah usage.

According to the results of a systematic review, in the recent last month water pipe use and ever smoking, the highest prevalence was in the Lebanese youth and Lebanese academics respectively, but in the regular or sometimes use index, the highest rate was reported in Iranian students that were 16.3% (10). So, it seems that the prevalence of waterpipe use in different age groups significantly differs in most countries of the world. Also, in some countries, such as Iran, there is a significant difference in the prevalence index in different regions in the country. Therefore, it seems the presence of a country report without standardization, at least in terms of age and region, is incorrect. Also, while investigating the possible causes of the prevalence of waterpipe smoking in different regions of the country, a special intervention program should be designed to reduce this risk factor prevalence in each region.

In a study, Ansari Moghaddam *et al.* reviewed Iranian school student's studies from 2004 to 2014. They reported last month prevalence of all regions of Iran. In the water pipe section, it was 13.9% (95%CI: 12 .8%, 15.1%), 10.4% (95%CI: 9.0%, 12.0%), 27.5% (95%CI: 25.6%, 29.4%) and 28.7% (95%CI: 27.2%, 30.2%) in the North, West and Northwest, East and Southeast and Central regions and Tehran, respectively. There were no eligible articles from the Southern region (25). One possible reason for the different results of this article and the present study may be the number of articles reviewed. Also, there was no study from South and Southwest region in the above article , however in this regions the discrimination of hookah consumption is low , and many adults people use water pipe as a way for their Leisure time(42). The mean age of the participants were so young however previous studies showed that the majority of hookah smokers from both genders were aged 25 to 39 years old; therefore, they were young adults(43). also, the participants' age distribution were consistent with the results obtained in different foreign studies especially those in the eastern Mediterranean region

like Syria , Lebanon , and other Middle eastern countries that is revealed an alarming increase in hookah smoking among adults , and young adults(44).

In Taraghijah *et al.*'s study, the lowest ever hookah use was in Iran central provinces. The highest odds ratios were in the country western provinces (OR= 26.5), then the northeastern provinces, followed by the southeastern provinces. Thus, being resident in the Northwest and west region can be a strong predictor of waterpipe smoking (31). The prevalence of ever hookah consumption (life time) was 32.98% , and 30% for school and university students , but the variation of consumption especially in life time consumption of hookah was obviously observed in several studies . Nevertheless, according to the Iranian STEPS[1] study, the prevalence of waterpipe smoking in 15 to 24 years old was 2.7% and in 25 to 34 years old was 1.9%. These were 4.0% and 2.1% in men and 1.3% and 1.6% in women, respectively. In that study, the prevalence varied in different regions of the country. This difference between investigated articles, and STEPS survey may relate to the type, and methods of sample selection.

The most important reasons for waterpipe use in society are positive attitudes, misconceptions about low risk and being not addictive, social acceptance, ease of access, and the rules' weakness (45). According to a study in the United States, 29.1% of students were curious about trying out water pipe. This ratio was 45.9% for students who tested other tobacco types and 14.6% for students who did not test any type of tobacco (46). In a study in Russia, the prevalence of waterpipe smoking was associated with older students, anger coping, school problems, cigarette smoking, marijuana use, and alcohol drinking (44).

It should be noted, various studies have shown that predictive indicators of cigarettes smoking and water pipes are different in Iranian society. While being male, being married, aged 37-54

[1] The WHO Stepwise approach to Surveillance (STEPS)

years, having high stress and sedentary lifestyles are related to cigarette smoking, being unemployed or being housewives, and having manual jobs related to waterpipe use (47). Another study showed that although there is a correlation between self-esteem and cigarette smoking, there is no association between use of water pipe s and self-confidence by eliminating the confounding effect of demographic, economic, and behavioral variables (48). According to Taraghijah *et al.*, the most important predictors of water pipe smoking among Iranian public university students were: province of residence, being a boy, having water pipe friends, positive attitude toward waterpipe use, being native, low semester grade point average, and lack of emotional support from family (31). However, according to the study of Kabir *et al.*, residence in a dormitory or living alone is a contributing factor to water pipe smoking (49).

In some studies, friends' role in the onset of waterpipe smoking was more pronounced than that of the father using water pipe (50). Also, the causes of waterpipe smoking and its continuation have been varied in boys and girls. Excitement, recreation, and pleasure are more probable elements related to waterpipe smoking commencement in boys. However, cultural issues cause the spread of water pipe in girls (51).

Screening and psychometric testing of students at the beginning of each academic year can quickly identify people at risk. Running exciting educational and recreational programs in dorms, schools and universities can also help fill students leisure time. Also, providing proper sports equipment, art classes, and regular recreational camps help drain youth energy.

Most interventions to prevent water pipes use are educational, and using the Theory of Planned Behavior (TPB) increases the likelihood of educational programs impact. It incorporates individual and environmental characteristics that somehow influence behavior into health education interventions (52-54). Also, banning the advertising promotion and sponsorship of the tobacco industry eliminating all forms of illegal trade (55), and not selling to minors (56) can be used as control measures. However, these existing control measures have not

successfully prevented and controlled it (57). Some countries in the Eastern Mediterranean region-Afghanistan, Bahrain, Egypt, Lebanon, Pakistan, Saudi Arabia, and the United Arab Emirates-have raised taxes, banned tobacco advertising, banned water pipes in hotels and restaurants, and displayed warning signs for used water pipes in public places Implemented measures for water pipes (58, 59).

Water pipes are considered a major factor in the failure of tobacco control programs globally (60); it can undermine and ineffective the successes that have been made so far in reducing tobacco use, especially cigarettes (61). Turkey is the only country that has significantly mitigated water pipes consumption by implementing all international tobacco control treaties to control all tobacco products (59).

In this study, all studies that had been conducted at universities and schools in Iran between 1990 and 2020 were used. Also, we used transparent criteria to measure the quality of studies.

Lack of standard questionnaire and the vagueness of the definition of the type of waterpipe use are two major drawbacks of studies in Iran that reduces the possibility of meta-analysis. Given that the correct reporting of prevalence and trends are important tools for policymakers to design control interventions, according to WHO's proposal, at least three questions should be included in the smoking survey questionnaires: current tobacco smoking status, past daily smoking status, and past smoking status (62). In this studies we try to unify the definition therefore we used three categories however there is not consistency among these definitions between several studies.

Another issue was that the questionnaire validity and reliability were not reported in 24% of the studies. Also, in less than one-third of the studies, the sample size was estimated. In comparison, the sampling method in more than one-third of the studies was either unspecified or of an available type which can also affect the estimated prevalence. However, we used the

proper instrument for collecting, and evaluating the data, and try to select the high quality articles although we have some limitation which should hope future study solve them.

Another important issue is that in some universities, prevalence has been surveyed almost every year. While, in other major universities, no study has been published. We suggest conducting a national survey to study water pipe use among all students and consider all disciplines and provinces in Iran. It will provide more reasonable clues about the real prevalence of waterpipe smoking among students.

Conclusion

Iranian students ranked as one of the highest prevalent of hookah consumption in the world. Also, the consumption of hookah in Iranian female students obviously higher than cigarette smoking which may related to the positive attitude at the intrapersonal level, absence of law at the political level, low cost and easy access to hookah; moreover, in some regions of Iran cultural norms, and acceptance at social level may promote it. However, the risk of hookah consumption is higher than cigarette smoking; therefore, this is an alarming for health policy makers.

It seems that the best way to educate in different ways, along with strong laws to control and prevent water pipes use among young people, and follow-up an evidence-based intervention program to control water pipe use among students. However, it should be noted that the implementation of regulations on water pipes and related experiences, including successes and challenges, are less well documented. There is no proper evaluation of policies, their implementation, and evaluation of their impact; only limited assumptions about the effectiveness, efficiency, sustainability, and the short-term and long-term effects of these measures are allowed. The present study suggests that more studies should be conducted to precisely identify the determinants of hookah smoking.

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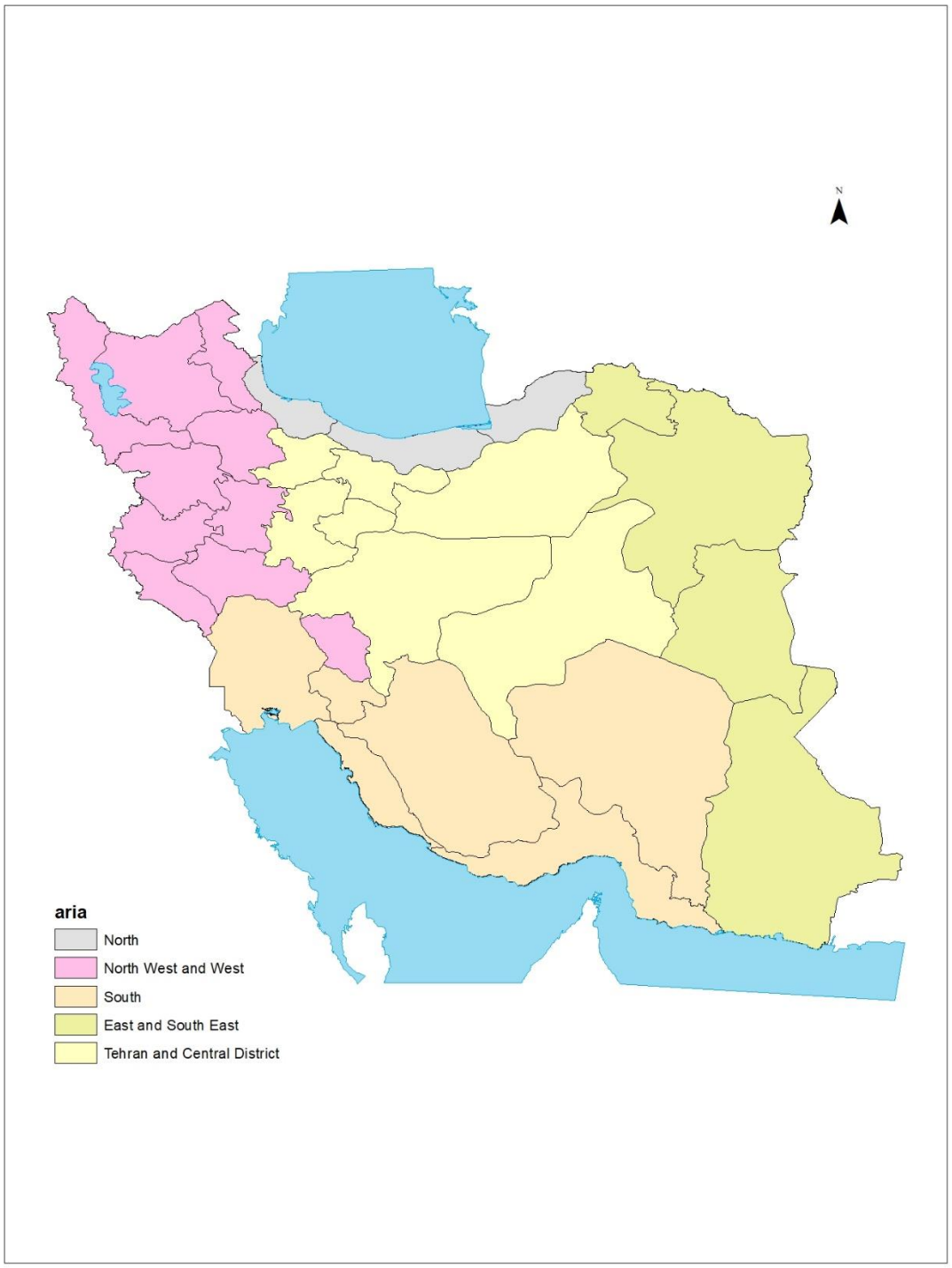

Figure 1- Geographic regions of Iran

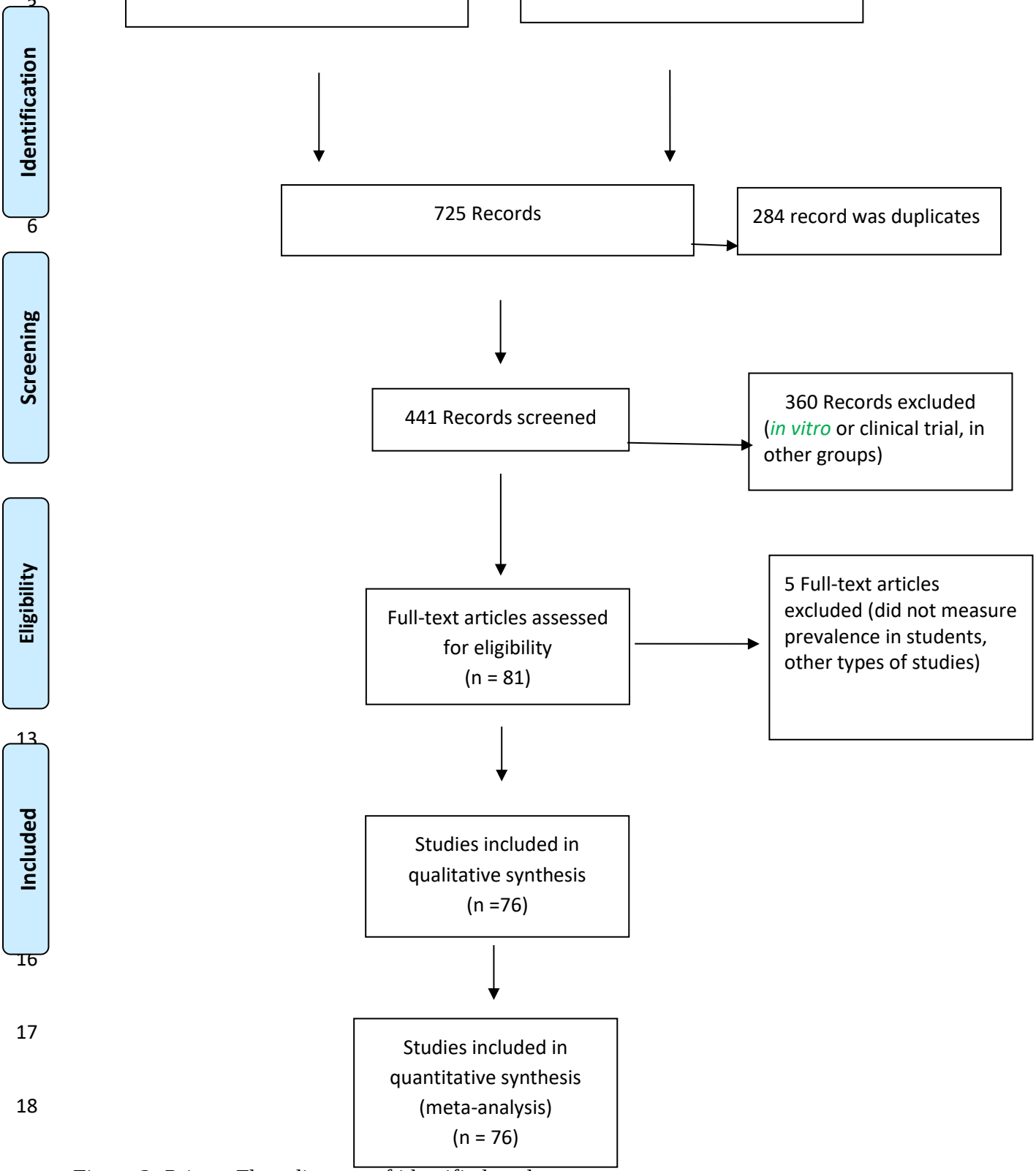

Figure 2- Prisma Flow diagram of identified study

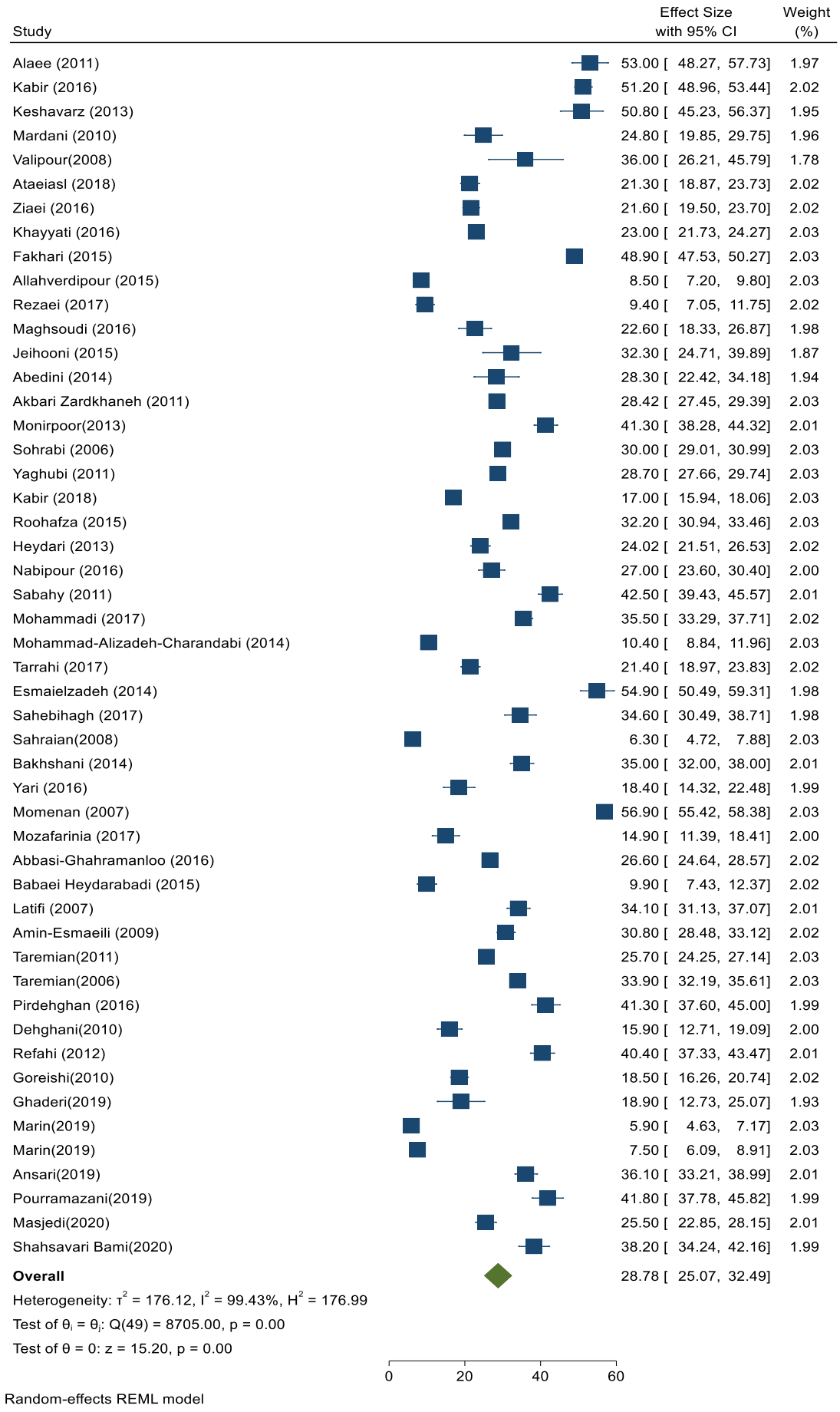

Figure 3- Lifetime prevalence of waterpipe smoking among Iranian students (both sexes)

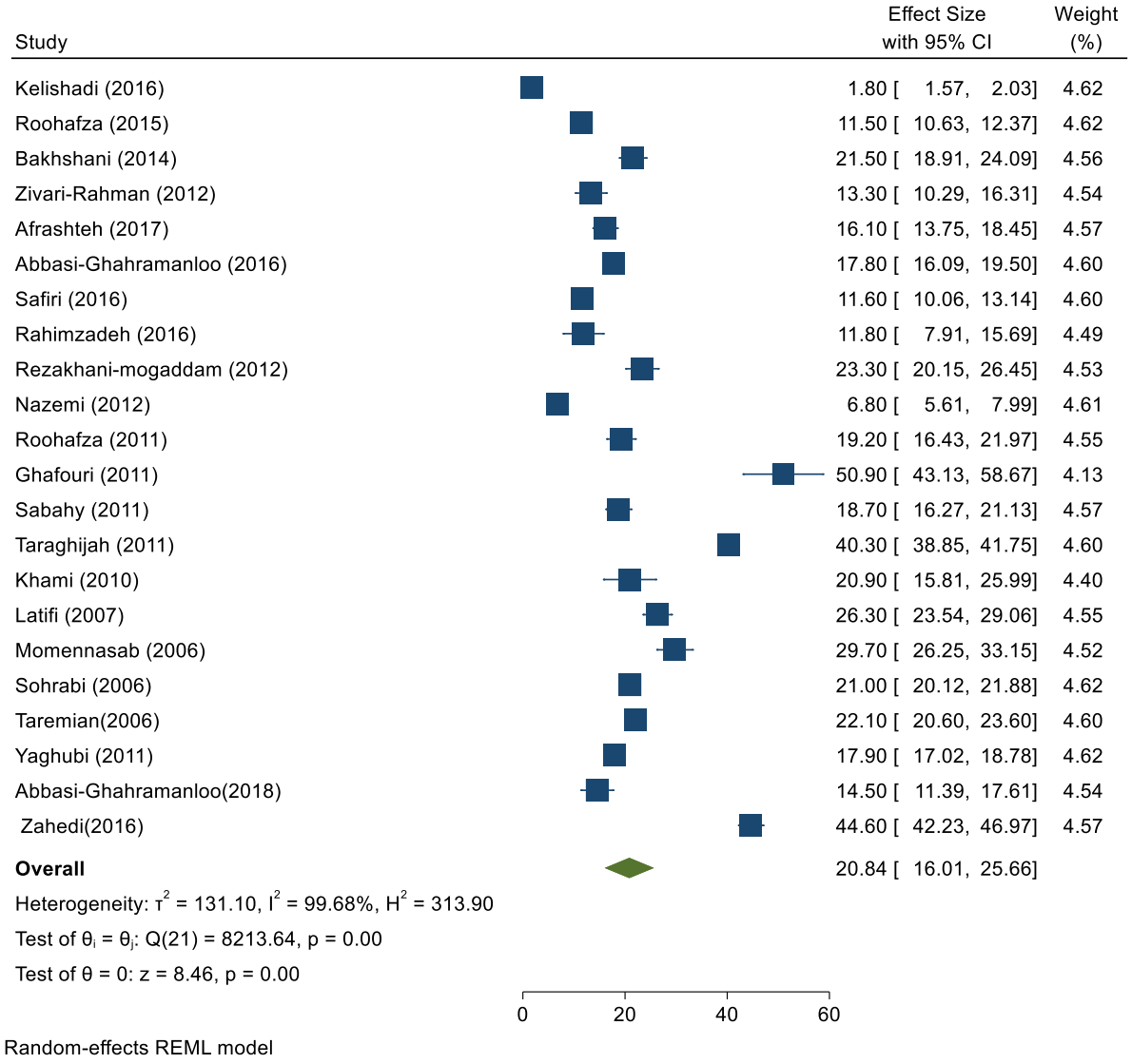

Figure 4- Last year prevalence of waterpipe smoking among Iranian students (both sexes)

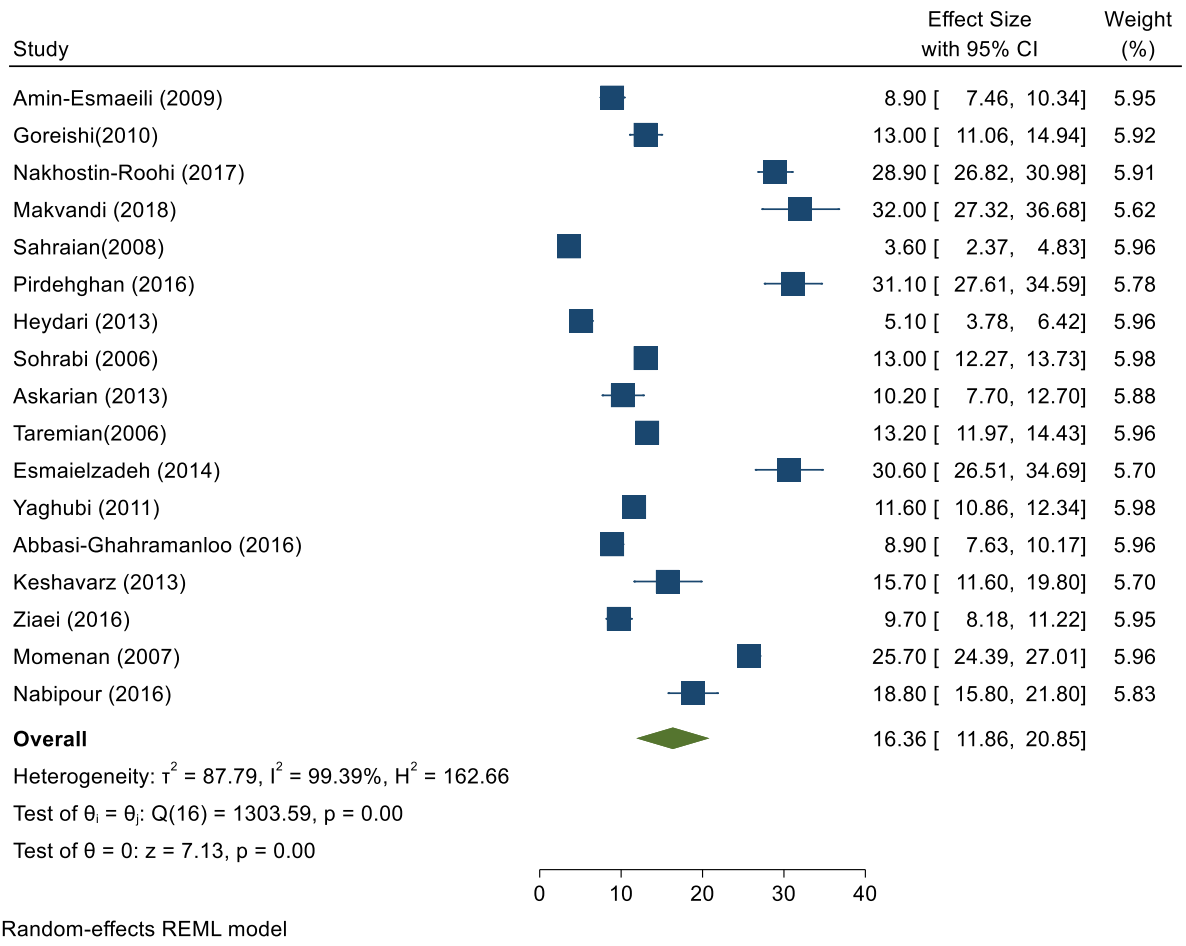

Figure 5- Last month prevalence of waterpipe smoking among Iranian students (both sexes)

Table 1: The characteristic of studies was included in the meta-analysis of Hookah Use among university students and school students in Iran

Author (Y)	Province	Region	School or university students	Sample size	Mean (±SD) age	Last year hookah use (Ever user)	Last year hookah use(Ever user)	Last month hookah use (Current user)
Ataeiasl (2018) (34)	East Azarbaijan	NW&W	School	1131	15.5±0.5	Both: 21.3 Boys: 28.5 Girls: 14.1		
Mohammadi (2017) (63)	Kordestan	NW&W	School	1837	15.1±0.8	Both: 35.5 Boys: 42.0 Girls: 29.0		
Ziaei (2016) (35)	East Azarbaijan	NW&W	School	1517	16.1 ± 0.8	Both: 21.6 Boys: 21.9 Girls: 21.3		Both: 9.7 Boys: 13.5 Girls: 6.2
Bashirian (2016) (64)	Kermanshah	NW&W	School	601	16.4 ± 0.8	Boys: 36.1		Boys: 17.1
Khayyati (2016) (65)	East Azarbaijan	NW&W	School	4304	15.8 ± 1.1	Both: 23.0 Boys: 28.4 Girls: 10.3		
Fakhari (2015) (66)	East Azarbaijan	NW&W	School	5192	15.7 ± 0.7	Both: 48.9 Boys: 62.6 Girls: 38.5		
(67)	Kurdestan	NW&W	School	1524	-	Both: 10.4 Boys: 13.7 Girls: 7.1		

Author (Y)	Province	Region	School or university students	Sample size	Mean (±SD) age	Last year hookah use (Ever user)	Last year hookah use(Ever user)	Last month hookah use (Current user)
Bashirian(2018)(68)	Hamadan	NW&W	School	730	16.41± 0.84	Both: 36.4		Both: 26.3
Makvandi (2018) (69)	Hamedan	NW&W	University	400	22.7 ± 3.3			Both: 32.0
Nakhostin-Roohi (2017) (70)	Ardabil	NW&W	University	1878	24.0 ± 5.6			Both: 28.9
Tarrahi (2017) (36)	Lorestan	NW&W	University	1131	19.6 ± 2.2	Both: 21.4 Boys: 28.3 Girls: 17.7		
Safiri (2016) (29)	East Azarbaijan	NW&W	University	1730			Both: 11.6 Boys: 21.3 Girls: 4.9	
Rahimzadeh (2016) (30)	Kordestan	NW&W	University	288			Both: 11.8 Boys: 17.2 Girls: 7.5	
Allahverdipour (2015) (71)	East Azarbaijan	NW&W	University	1837	22.1		Both: 8.5	
Marin(2019)(72)	Tabriz	NW&W	University	1406	19.48±2.68	Both (2015):5.9		

Author (Y)	Province	Region	School or university students	Sample size	Mean (±SD) age	Last year hookah use (Ever user)	Last year hookah use(Ever user)	Last month hookah use (Current user)
						Both(2017): 7.5		
Goreishi(2010)(73)	Zanjan	NW&W	University	1200	21.3±2.3	Both:18.5		Both: 13.0
Valipour(2008)(74)	Broujerd	NW&W	University	100	23	Both:36.0		
Yari (2016) (75)	South Khorasan	E & SE	School	369	17.0 ± 1.0	Both: 18.4 Boys: 22.8 Girls: 14.3		
Bakhshani (2014) (76)	Sistan & Balochestan	E & SE	School	1000	-	Both: 35.0 Boys: 40.2 Girls: 27.5	Both: 21.5 Boys: 25.1 Girls: 16.4	
Rajabalipour(2019)(77)	Kerman and Sistan and Baluchistan	E & SE	School	1218	15.93 ± 0.85	Boys: 43.8 Girls: 27.0		
Ansari(2019)(78)	Zahedan	E & SE	School	1094		Both: 36.1 Boys: 11.4 Girls: 4.1		

Author (Y)	Province	Region	School or university students	Sample size	Mean (±SD) age	Last year hookah use (Ever user)	Last year hookah use(Ever user)	Last month hookah use (Current user)
Joveini (2016) (79)	Razavi Khorasan	E & SE	University	306	22.4 ± 2.5		Boy: 46.7	
Ghaderi(2019)(80)	North Khorasan	E & SE	University	169	21.08 ± 2.03	Both: 18.9		
Refahi (2012)(81)	Zahedan	E & SE	University	1014		Both:40.4		
Rezaei (2017) (82)	Fars	S	School	630	15.7 ± 0.9	Both: 9.4 Boys: 11.4 Girls: 7.3		
Zivari-Rahman (2012) (83)	Kerman	S	School	520	-		Both: 13.3	
Abedini (2014) (84)	Hormozgan	S	School	240	-	Both: 28.3		
Ziaaddini (2010) (85)	Kerman	S	School	610	17.9 ± 0.6	Boys: 51.5		
Pourramazani(2019)(86)	Kerman	S	School	600	16.63 ± 1.06	Both: 41.8 Boys: 48.0 Girls: 34.3		
Ghahremani(2019)(87)	Shiraz	S	School	483		Girls: 39.6		
Shahsavari Bami(2020)(88)	Bam	S	School	600	16.78 ± 0.74	Both: 38.2 Boys: 45.3 Girls: 31.0		
Afrashteh (2017) (89)	Bushehr	S	University	977	21.1 ± 2.4		Both: 16.1 Boys: 22.5	

Author (Y)	Province	Region	School or university students	Sample size	Mean (±SD) age	Last year hookah use (Ever user)	Last year hookah use(Ever user)	Last month hookah use (Current user)
							Girls: 11.5	
Maghsoudi (2016) (90)	Fars	S	University	390	22.3 ± 2.4	Both: 22.6 Boys: 28.5 Girls: 15.7		
Nabipour (2016) (91)	Kerman	S	University	682	21.4 ± 2.5	Both: 27.0 Boys: 30.4 Girls: 33.8		Both: 18.8 Boys: 25.9 Girls: 12.6
Askarian (2013) (92)	Fars	S	University	600	21: in Azad &23:in public			Both: 10.2
Karimirad(2020)(93)	Hormozgan	S	University	524	23.0±4.2			Both: 11.1 Boys: 20.9 Girls: 4.3
Sahraian(2008)(28)	Shiraz	S	University	971		Both:6.3		Both:3.6
Abbasi-Ghahramanloo(2018)(32)	Hormozgan	S	University	524	23±4.2		Both:14.5	
Sabahy (2011) (94)	Kerman	S	University	1024	20.6 ±2.3	Both: 42.5 Boys: 56.8 Girls: 28.4	Both: 18.7 Boys: 28.0	

Author (Y)	Province	Region	School or university students	Sample size	Mean (±SD) age	Last year hookah use (Ever user)	Last year hookah use(Ever user)	Last month hookah use (Current user)
							Girls: 9.5	
Heydari (2013)(95)	Jahrom	S	University	1149	21.2±2.6	Both24.02		Both:5.1
Jeihooni (2015)(96)	Fasa	S	University	157	23.1±2.5	Both: 32.3		
Mardani (2010)(97)	Bandar Abbas	S	University	310	23	Both: 24.8		
Karimy (2013) (98)	Markazi	C	School	380	16.7 ±1.3	Boys: 30.5		Boys: 18.9
Pirdehghan (2016) (99)	Yazd	C	School	704	17.6 ± 0.6	Both: 41.3 Boys: 48.9 Girls: 28.1		Both: 31.1 Boys: 32.8 Girls: 28.1
Roohafza (2015) (100)	Isfahan	C	School	5336	14.4 ± 1.7	Both: 32.2	Both: 11.5	
Esmaielzadeh (2014) (101)	Qazvin	C	School	510	-	Both: 54.9 Boys: 59.0 Girls: 50.2		Both: 30.6 Boys: 36.9 Girls: 23.4
Alaee (2011) (102)	Alborz	C	School	447	16.5 ± 1.3	Both: 53.0 Boys: 64.4 Girls: 43.1		
Momenan (2007) (103)	Tehran	C	School	4361	15.6 ±1.8	Both: 56.9		Both: 25.7

Author (Y)	Province	Region	School or university students	Sample size	Mean (±SD) age	Last year hookah use (Ever user)	Last year hookah use(Ever user)	Last month hookah use (Current user)
						Boys: 60.6 Girls: 53.1		Boys: 30.7 Girls: 20.6
Masjedi(2020)(104)	Varamin	C	School	1,075		Both: 25.5		
Sahebihagh (2017) (105)	Qazvin	C	University	535	19.6 ± 2.4	Both: 34.6 Boys: 44.5 Girls: 31.4		
Mozafarinia (2017) (106)	Tehran	C	University	422	22.4	Both: 14.9		
Abbasi-Ghahramanloo (2016) (107)	Tehran	C	University	1992	21.2 ± 3.2	Both: 26.6 Boys: 42.8 Girls:19.4	Both: 17.8 Boys: 29.7 Girls: 12.5	Both: 8.9 Boys: 15.8 Girls: 5.9
Kabir (2016) (49)	Alborz	C	University	1959	22.5 ± 4.6	Both: 51.2 Boys: 63.0 Girls: 45.4		
Dehdari (2012) (108)	Tehran	C	University	162	22.3 ± 2.9		Boy: 29.0	
Rezakhani-mogaddam (2012) (109)	Tehran	C	University	720	22		Both: 23.3 Boys: 32.4	

Author (Y)	Province	Region	School or university students	Sample size	Mean (±SD) age	Last year hookah use (Ever user)	Last year hookah use(Ever user)	Last month hookah use (Current user)
							Girls: 14.7	
Nazemi (2012) (110)	Semnan	C	University	1800	28.5 ± 3.5		Both: 6.8	
Roohafza (2011) (51)	Isfahan	C	University	812			Both: 19.2 Boys: 28.7 Girls: 11.5	
Dehghani(2010) (111)	Yazd	C	University	534	22.0 ± 3.5	Both: 15.9		
Latifi (2007) (50)	Tehran	C	University	1012	21.4 ± 2.8	Both: 34.1 Boys: 42.9 Girls: 23.6	Both: 26.3	
Momennasab (2006) (112)	Tehran	C	University	700	21.3 ± 2.8		Both: 29.7 Boys: 40.2 Girls: 25.4	
Amin-Esmaeili (2009)(113)	Tehran	C	University	1568	20.2±1.8	Both:30.8		Both:8.9
Taremian(2011)(114)	Tehran	C	University	3582		Both:25.7		
Taremian(2006)(115)	Tehran	C	University	2997		Both:33.9	Both:22.1	Both:13.2
Zahedi(2016)(116)	Kerman	C	University	1730	20.5±1.5		Both:44.6	

Author (Y)	Province	Region	School or university students	Sample size	Mean (±SD) age	Last year hookah use (Ever user)	Last year hookah use(Ever user)	Last month hookah use (Current user)
Momeni(2019)(117)	Kerman	C	University	675	21.1 ±2.6	Both:30 Boys: 46.3 Girls: 19.4		
Ghafouri (2011) (118)	Tehran	C	University	169	22 ± 3	Both: 50.9		
Babaei Heydarabadi (2015) (119)	Tehran	C	University	604		Both: 9.9		
Kelishadi (2016) (120)	All provinces	WC	School	13486	12.5 ± 3.4		Both: 1.8 Boys: 2.5 Girls: 1.1	
Keshavarz (2013) (121)	All provinces	WC	University	325		Both: 50.8 Boys: 68.5 Girls: 41.6		Both: 15.7 Boys: 28.8 Girls: 8.9
Taraghijah (2011) (31)	All provinces	WC	University	4483			Both: 40.3	
Khami (2010) (122)	All provinces	WC	University	263			Both: 20.9 Boys: 29.0 Girls: 14.7	
Yaghubi (2011)(123)	Iran	WC	University	7330		Both:28.7	Both:17.9	Both:11.6
Kabir (2018)(33)	Iran	WC	University	4940	20.6±2.4	Both:17.0		
Akbari Zardkhaneh (2011)(124)	Iran	WC	University	8352	22	Both:2842		

Author (Y)	**Province**	**Region**	**School or university students**	**Sample size**	**Mean (±SD) age**	**Last year hookah use (Ever user)**	**Last year hookah use(Ever user)**	**Last month hookah use (Current user)**
Monirpoor(2013)(125)	Iran	WC	University	1053	22.5	Both: 41.3		
Sohrabi (2006)(126)	Iran	WC	University	8373	22	Both:30.0	Both:21.0	Both:13.0

a: NW&W= North West and West, S= South, E & SE= East and South East, C= Tehran and Central Region WC=Whole country

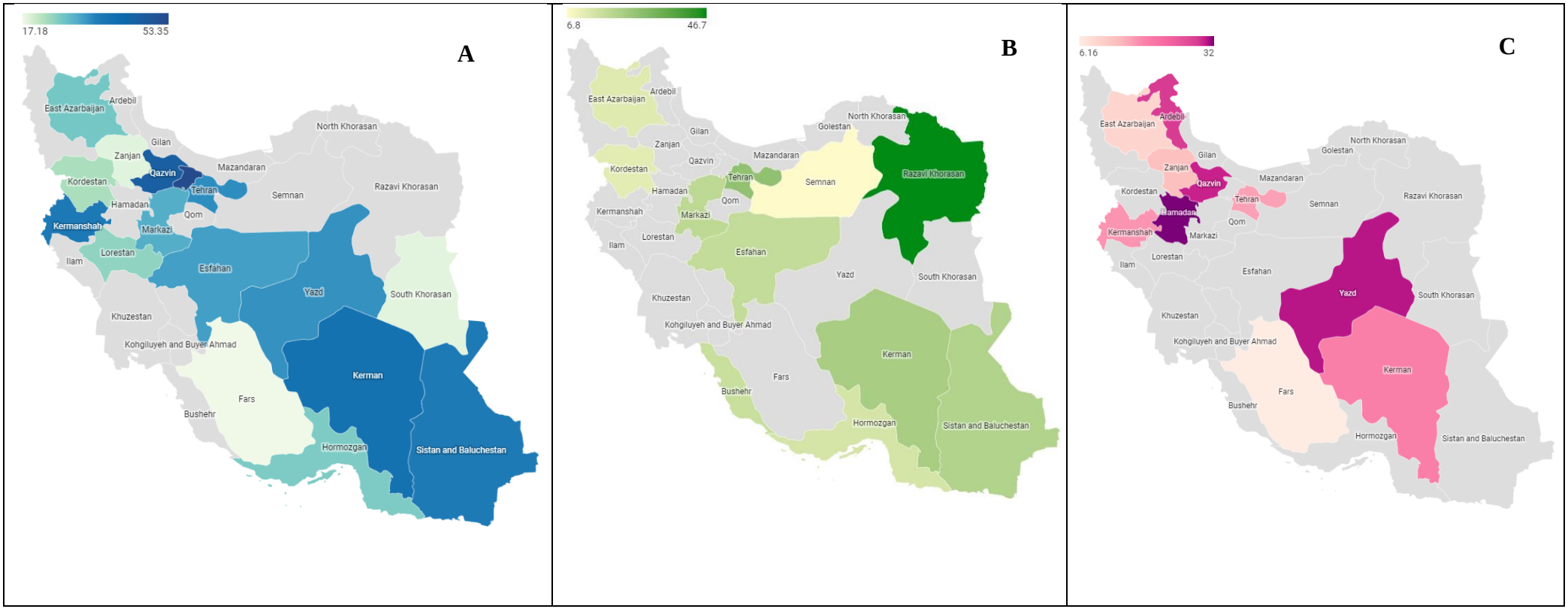

Figure 6: Geographical distribution of lifetime (A), last year (B), and last month(C) prevalence of water pipe smoking among Iranian school students (Colorless in the map is not reported)

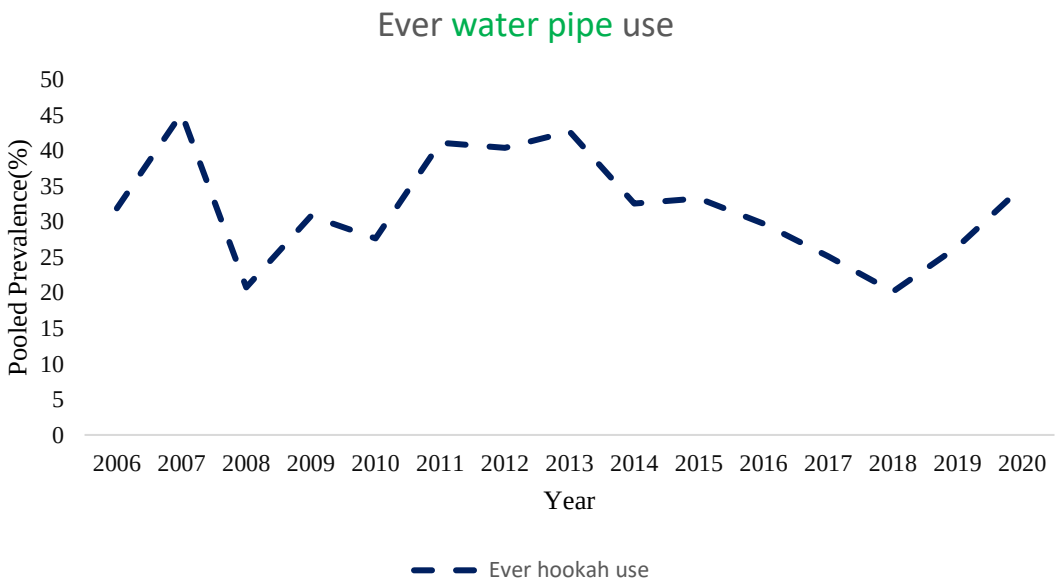

Figure 7: Timeline prevalence of ever water pipe smoking among Iranian school students