

REVIEW ARTICLE

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National, regional, and global prevalence of cigarette smoking among women/females in the general population: a systematic review and meta-analysis



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Abstract

Background: This systematic and meta-analysis review aimed to provide an updated estimate of the prevalence of ever and current cigarette smoking in women, in geographic areas worldwide, and demonstrate a trend of the prevalence of smoking over time by using a cumulative meta-analysis.

Methods: Following PRISMA guidelines, we conducted a systematic review and meta-analysis of studies published on the prevalence of ever and current cigarette smoking in women. We searched PubMed, Web of Science (ISI), Scopus, and Ovid from January 2010 to April 2020. The reference lists of the studies included in this review were also screened. Data were reviewed and extracted independently by two authors. A random effects model was used to estimate the pooled prevalence of ever and current cigarette smoking in women. Sources of heterogeneity among the studies were determined using subgroup analysis and meta-regression.

Results: The pooled prevalence of ever and current cigarette smoking in women was 28% and 17%, respectively. The pooled prevalence of ever cigarette smoking in adolescent girls/students of the school, adult women, pregnant women, and women with the disease was 23%, 27%, 32%, and 38%, respectively. The pooled prevalence of ever cigarette smoking in the continents of Oceania, Asia, Europe, America, and Africa was 36%, 14%, 38%, 31%, and 32%, respectively.

Conclusions: The prevalence of cigarette smoking among women is very high, which is significant in all subgroups of adolescents, adults, and pregnant women. Therefore, it is necessary to design and implement appropriate educational programs for them, especially in schools, to reduce the side effects and prevalence of smoking among women.

Keywords: Cigarette smoking, Prevalence, Women, Tobacco, Nicotine

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Introduction

The prevalence of cigarette smoking among women has increased worldwide in recent years and is considered a public health concern [1]. Smoking is one of the most preventable causes of death from non-communicable diseases [2]. Smoking in women carries the risk of diseases such as cervical cancer, osteoporosis, cardiovascular disease, atherosclerosis, and type 2 diabetes, lung cancer, premature menopause, premature birth, abnormal fetal growth, low birth weight, miscarriage, and increases fetal death [3, 4]. Women who smoke before and during pregnancy increase the risk of preterm birth, abnormal fetal growth, low birth weight, miscarriage, and fetal death [5, 6].

World Health Organization (WHO) reported that one in ten deaths worldwide is caused by tobacco use, and that tobacco use worldwide causes 7 million deaths each year. If the world's consumption patterns remain unchanged, by 2030, 8 million people will die from tobacco-related diseases every year [2, 7]. Cigarette smoking kills 480,000 people in the USA each year [8]. Every year, about 201,773 women around the world die from secondhand smoke [8].

Based on the results, 2000 adolescents under the age of 18 starts smoking every day for the first time in the world, and about 300 people start smoking daily [9]. The WHO reported that there are about 1.1 billion current cigarette smokers in the world [10]. The results of a meta-analysis study in China showed that the prevalence of smoking among women was 5.34% [11]. The results of a meta-analysis study in Iran showed that the prevalence of smoking among girls aged 12 to 17 years old was 6% [12]. A study conducted in Central and Eastern Europe showed that the prevalence of smoking among women was 64.7% [13].

One of the reasons for smoking in women has been the high number of tobacco companies promoting smoking by women in high and low-income countries over the past century. Advertising continues in low-income countries, where female smoking rates are still low. These companies have changed the cultural meaning of women's smoking in society, removed cultural barriers to reduce the social pressure related to smoking, and increase the smoking rate of women [14].

The results have shown that smoking by family members, having smoking friends, and accompanying the family in smoking are other reasons for the increase in the prevalence of smoking in men and women [15]. Factors such as peer pressure, smoking attraction, testing, belonging to a consumer group, curiosity, and lack of appropriate options to reduce stress are influencing the onset and continuation of smoking by women [16]. Therefore, this study conducted a systematic review and meta-analysis to (1) provide an updated estimate of the

prevalence of ever and current smoking in women worldwide, (2) explain the prevalence of smoking by geographical areas in the world, and (3) demonstrate a trend of the prevalence of smoking over time by using a collaborative meta-analysis.

Methods

Search strategy

We searched the international electronic bibliographic databases including PubMed, Web of Science (ISI), Scopus, and Ovid from January 2010 to April 2020. Moreover, a manual search of the reference lists of the related articles was also performed, as well as the references of previous systematic reviews in the world were reviewed [17, 18]. This review was performed in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement issued in 2009 [19] and the GATHER guideline [20] (Fig. 1).

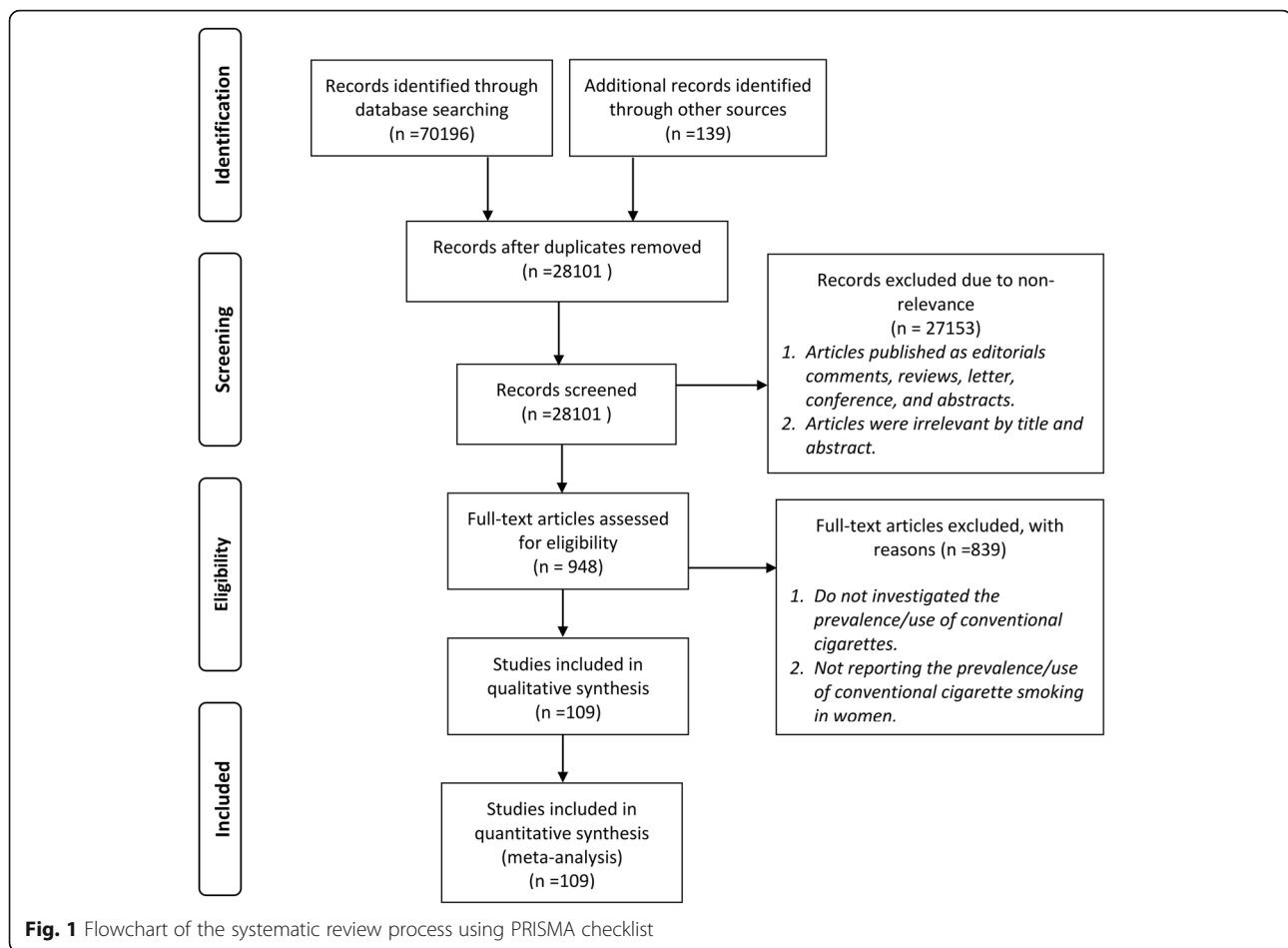
In this study, current smoking was defined as people who have smoked cigarettes at least once during the past 12 months, and ever smoking was defined as people who have smoked cigarettes during her/his lifetime. In our search strategy, we did apply limitations in the time of publication for January 2010 to April 2020 and English language. We reviewed the titles and abstracts to select potentially relevant papers. If there was doubt about the suitability of the paper in the abstract, the full-text was reviewed. We manually searched the references and relevant articles for inclusion. The search strategy is presented in Additional file 2. The protocol of this study was recorded in PROSPERO (record number: CRD42020183012).

Study selection

All the records identified by the search were imported into the Endnote library, where duplicated publications were identified and excluded (Fig. 1). Similar to our previous systematic reviews [21], the remaining unique reports underwent two stages of screening, performed by AJ and AR. First, the titles and abstracts were screened, and those deemed to be relevant or potentially relevant were further screened, and then the full text of papers were searched and evaluated according to our inclusion and exclusion criteria. Eligible reports were included in this study, while other non-eligible reports were excluded for the reasons shown in Fig. 1.

Inclusion and exclusion criteria

Studies were eligible for inclusion as follows: (1) studies published in the English language; (2) cross-sectional, cohort, and case-control studies reported data on smoking prevalence; (3) studies presented definitions of smoking; (4) if there were many studies based on the same sample, only the one that reported the most detailed



data was included. Studies were excluded for the following reasons: (1) editorials, reviews, qualitative studies, commentary, conference abstracts, or presentations; (2) insufficient characterization of the methods; (3) lack of information necessary for the computation of prevalence from the articles or the authors (such as the number of samples or the prevalence rate of tobacco use). To avoid multiple publication bias in our meta-analysis, duplicate publications were excluded from the analysis.

Quality assessment

The quality of the studies was evaluated by a validated quality assessment tool [22]. The tool included seven items that evaluated selection bias, measurement bias, and bias related to the analysis: (1) target population was defined clearly; (2) sampling is representative of potential respondents; (3) adequate response rate; (4) standardized data collection methods; (5) reliable survey instruments; (6) valid survey instruments; and (7) appropriate statistical methods. A total quality score was calculated based on the answers of “Yes” (scored 1) or “No” (scored 0) and varied between 0 and 7. All of the studies selected for this meta-analysis were assessed independently by two authors (AJ

and AR). The discrepancies of the assessment results were resolved through discussion with a third author.

Data extraction

The following data from all eligible studies were extracted: the first author, published year, year of study, study location, type of population, total sample size, the sample size in gender groups, smoking definition, and smoking prevalence. Data extraction was carried out by two authors (AJ and AR) independently. The discrepancies were resolved by discussion with another author.

Data analysis

The extracted data were entered into the Excel software. Then, Stata 16.0 was used for analysis. Pooled prevalence and 95% confidence intervals were calculated using Der-Simonian and Laird method, taking into account conceptual heterogeneity, and I^2 , τ^2 , and X^2 were applied to assess heterogeneity between studies. The “metaprop” command was used to calculate the pooled prevalence of cigarette smoking and the prevalence in different sub-groups, by available geographic regions, study settings, study population, and tools assessments of smoking. The

pooled prevalence of tobacco smoking was presented in a forest plot, and the heterogeneity of studies conducted in each subgroup was estimated. The Q test was applied to assess heterogeneity between subgroups.

To assess differences in the accumulation of evidence for tobacco smoking prevalence, cumulative meta-analyses were conducted. The cumulative meta-analysis provides cumulative pooled estimates and 95% CIs. As studies are successively added, the overall prevalence and 95% CIs are recalculated providing evidence of the evolution of tobacco smoking prevalence over time. To assess the sequential contributions of studies and evaluate changes in tobacco smoking prevalence over time, studies were added alphabetically by years of implementation to a random-effects model. The sequential contributions of studies were evaluated in subgroups for tobacco smoking prevalence over time by cumulative meta-analysis.

Results

In total, 70,335 articles were found by searching the databases. After deleting the duplicates articles (n = 42,

234), articles were screened based on the title and abstract, and 27,153 articles were excluded because of not meeting the study criteria. In the next step, the full text of articles was assessed, and 839 articles that did not meet the inclusion criteria were removed from the study based on the reasons given in the flowchart. Finally, 109 articles entered the meta-analysis stage [23–131].

The prevalence of smoking was assessed in 18,290,793 women. The smallest and largest study in the present study was 131 and 14,912,100 women, respectively. The study includes 36 studies from the Americas, 34 studies from Asia, 27 studies from Europe, 8 studies from Africa, and 4 studies from the Oceania region. Other features are shown in Table S1.

The pooled prevalence of ever and current smoking in women was 28% (with confidence intervals (CIs) of 95%: 24–32% and 17% (95% CIs: 14–19%), respectively (Fig. 2)). The prevalence of ever cigarette smoking in adolescent girls/students of the school, adult women, pregnant women, and women with the disease was 23% (95% CIs: 20–27%), 27% (95%: 19–35%), 32% (95% CIs: 22–42%), and 38% (95% CIs: 30–46%), respectively. The pooled

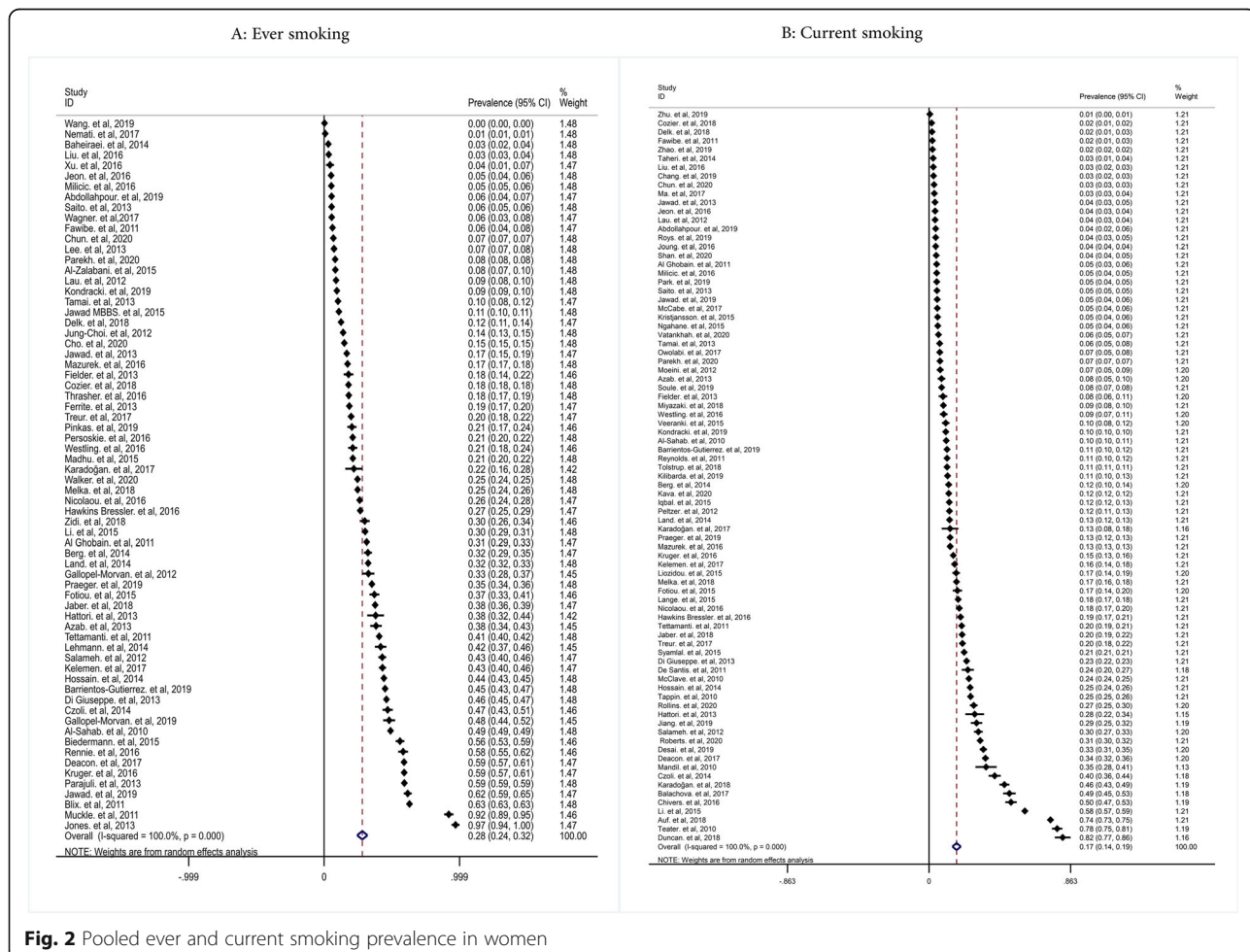


Fig. 2 Pooled ever and current smoking prevalence in women

prevalence of current cigarette smoking in adolescent girls/students of the school, adult women, pregnant women, and women with the disease was 15% (95% CIs: 13-17%), 13% (0.95% CIs: 7-18%), 21% (95% CIs: 17-26%), and 25% (95% CIs: 17-34%), respectively (Fig. 3).

The pooled prevalence of ever cigarette smoking according to the continents was as follows: Oceania 36% (95% CIs: 27-45%), Asia 14% (95% CIs: 11-18%), Europe 38% (95% CIs: 30-46%), America 31% (95% CIs: 25-37%), and Africa 32% (95% CIs: 5-68%). The pooled prevalence of current cigarette smoking according to the continents was for Oceania, Asia, Europe, America, and Africa 21% (95% CIs: 14-29%), 22% (95% CIs: 19-26%), 18% (95% CIs: 15-22%), 0.8% (95% CIs: 7-9%), and 12% (95% CIs: 6-18%), respectively (Fig. 4).

The pooled prevalence of ever cigarette smoking in cross-sectional studies, cohort studies, and case-control studies was 25% (95% CIs: 23-28%), 39% (95% CIs: 21-56%), and 34% (95% CIs: 21-47%), respectively. Also, the pooled prevalence of current cigarette smoking in cross-sectional studies, cohort studies, and case-control studies were 17% (95% CIs: 14-20%), 14%

(95% CIs: 10-19%), and 20% (95% CIs: 11-29%), respectively (Fig. S1).

According to the sampling method in the studies, the pooled prevalence of ever and current cigarette smoking in random sampling was 29% (95% CIs: 23-24%) and 14% (95% CIs: 11-18%), respectively (Fig. S2). According to the results of Fig. S3, by smoking assessment tools, the pooled prevalence of ever cigarette smoking in studies evaluated by the standard questionnaire and self-reporting was 35% (95% CIs: 24-46%), and 26% (95% CIs: 22-31%), respectively. In terms of smoking assessment tools, the prevalence of current smoking in studies evaluated by the standard questionnaire and self-reporting was 15% (95% CIs: 12-19%) and 17% (95% CIs: 14-20%), respectively (Fig. S3).

Cumulative meta-analysis test was conducted to examine the prevalence of ever smoking among women and increased the number of articles that have led to improved reading ability in recent years. The results showed that the prevalence of ever smoking has decreased from 2000 to 2010. So, in 2000, the prevalence of smoking was 57%, which in 2010 reached 30%. After

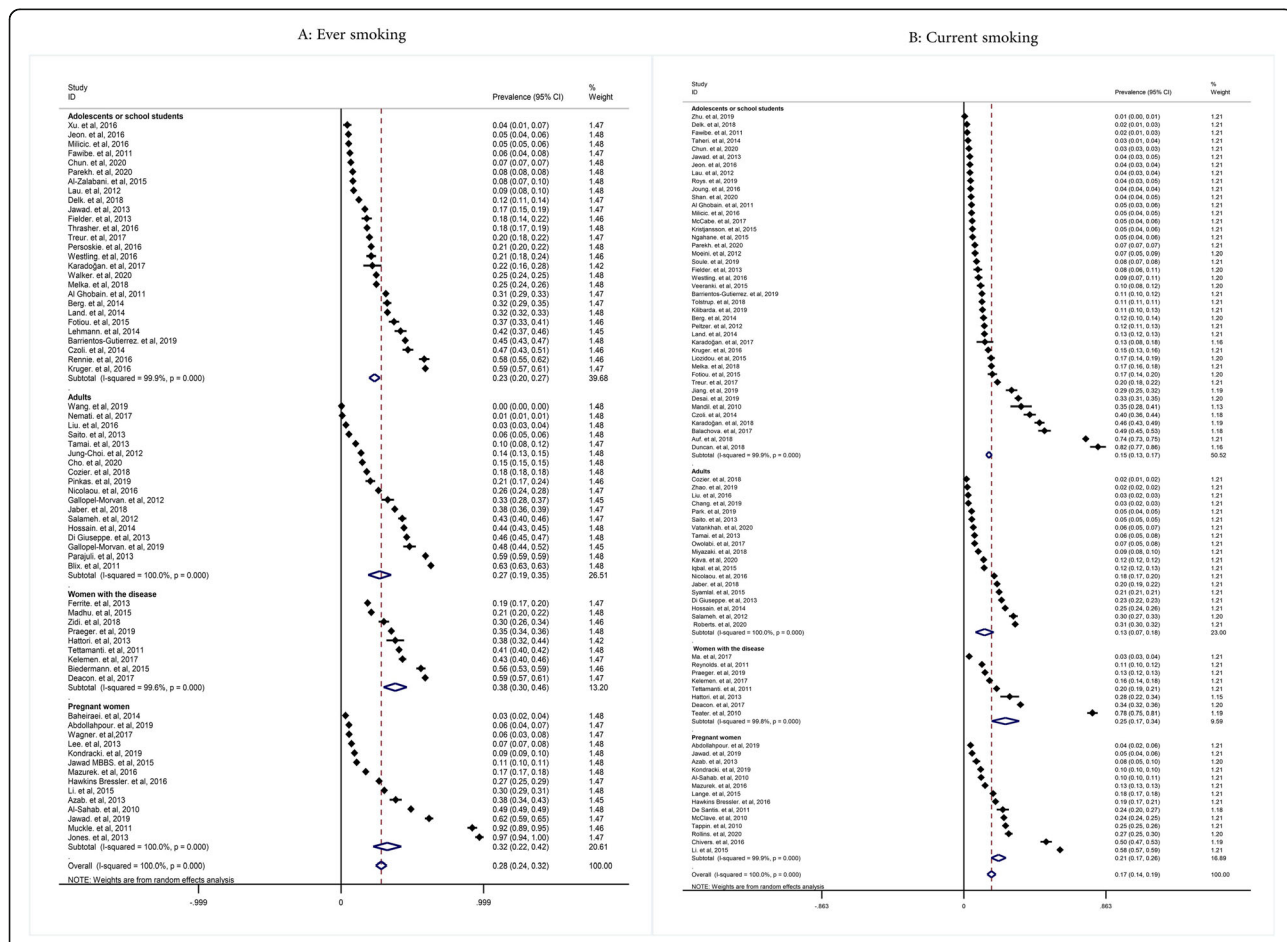


Fig. 3 Pooled ever and current smoking prevalence in women by study population

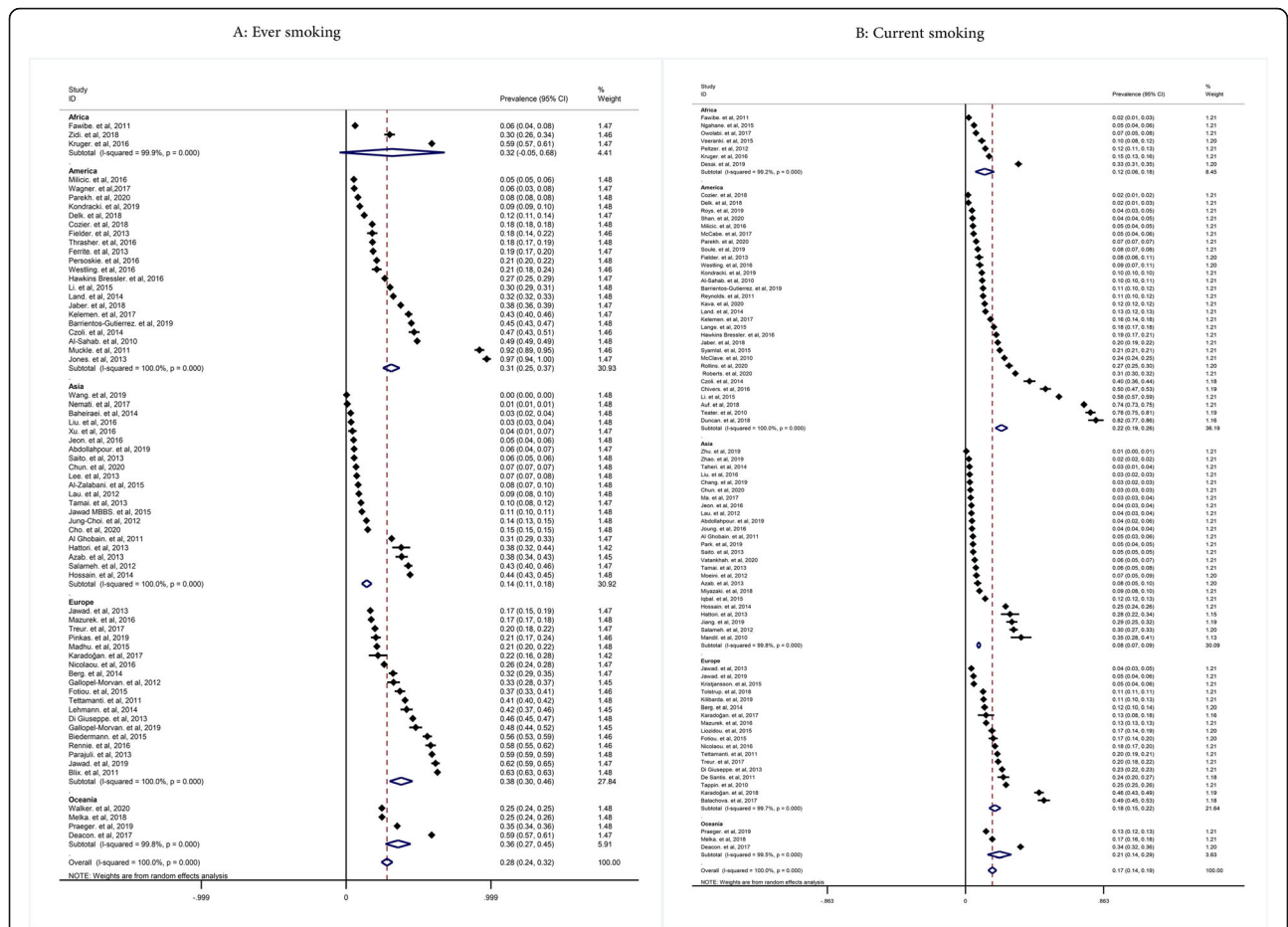


Fig. 4 Pooled ever and current smoking prevalence in women by continent

2010, the trend of the prevalence of smoking has been almost constant. The trends were presented in different subgroups (Fig. 5). However, cumulative meta-analysis for current smoking showed that with the addition of studies conducted between 2001 and 2009, the trend of smoking prevalence in the current solution of cigarettes is increasing, then this trend is not clear until 2013, but after 2013 with the addition of new studies by 2019, the trend is declining (Fig. 5). The results of the prevalence trend of smoking by subgroups are shown in Figs. S4 and S8.

Meta-regression analysis

The results of the univariate meta-regression analysis to investigating of sources of heterogeneity for the ever smoking showed that the years of the implementation study ($b = -0.016$, 95% CIs: $-0.026, -0.005$), continent Asia versus Africa ($b = -0.17$, 95% CIs: $-0.29, -0.05$) and study population women with disease versus adolescents or female students of the school ($b = 0.14$, 95% CIs: $0.01, 0.27$) had a significant effect on ever smoking prevalence. Also, for current smoking showed that the

years of the implementation study ($b = -0.007$, 95% CIs: $-0.01, -0.003$), continent America versus Africa ($b = 0.10$, 95% CIs: $0.03, 0.17$), study population women with disease versus adolescents or school students ($b = 0.09$, 95% CIs: $0.0007, 0.19$) had significant effect on current smoking prevalence.

Discussion

This systematic review and meta-analysis study aimed to determine the global prevalence of cigarette smoking in women. The results of this study showed that the prevalence of ever and current smoking among women was 28% and 17%, respectively, which indicated that the prevalence of cigarette smoking among them is high. Based on the present study results, smoking has been declining from 2000 to 2019 and has decreased from 92% in 2000 to 28% in 2019. The WHO report showed that tobacco use by women worldwide has decreased from 10.5% in 2000 to 5.2% in 2020, which is consistent with the results of this study [132]. The prevalence of smoking in the

the onset of cigarette smoking [141]. On the other hand, smoking by adolescent girls causes various health problems for them and their fetus during pregnancy, and appropriate interventions must be taken to prevent smoking, especially among girls of school age, to reduce the prevalence of female smoking.

The cigarette prevalence of adult women

Based on the results of this study, the prevalence of ever and current cigarette smoking in adult women was 27% (95% CI: 19-35), and 13% (95% CI: 7-18), respectively. This means that the prevalence of ever and current smoking for this age group first showed an upward trend, then a downward trend at some point, and then almost a steady trend.

The WHO reported that the prevalence of cigarette smoking among girls over 15 years old in 2018 was 4.8% [132]. In a systematic review study conducted by Ding on Chinese women in 2014, it was reported that the prevalence of ever smoking was between 6 and 17%, and the prevalence of current smoking was between 1.4 and 5% [142]. A cohort study conducted in the USA showed that 31% of women smoked [88].

One of the reasons for the tendency of women to smoke is the advertising of the tobacco industry, which has recently targeted women and is trying to make more women more likely to smoke by advertising more [143]. Results of a systematic review study showed that factors such as having a smoking partner, job stress, and exposure to smoking are the factors related to smoking among women [142]. Other reasons for the onset of smoking by women include reduced stress, lower education levels, and lower prices for cigarettes [144, 145]. Increasing the prevalence of smoking in adult women increases various health problems such as the increased risk of stroke, cardiovascular disease, asthma, decreased lung function, breast cancer, cervical cancer, and cervical cancer [146–152]. Therefore, it is necessary to adopt the political and social laws to reduce access and smoking.

The cigarette prevalence of pregnant women

Based on the results of this study, the prevalence of ever and current cigarette smoking among pregnant women was 32% (95% CI: 22-42), and 21% (95% CI: 17-26%), respectively. This means that trend of ever smoking has been declining, but the trend of current smoking in pregnant women is almost constant, and the prevalence rate is still high. The results of the Lange study in 2018 showed that the global prevalence of smoking during pregnancy is 1.7%, which is lower than the prevalence of this study [17]. A study conducted by Kondracki in the USA showed that 9.5% of pregnant women smoked, of which 7% smoked during pregnancy [109]. The results

of a 6-year study of women in Austria found that the prevalence of smoking was 18% [153].

One of the reasons for pregnant women's tendency to smoke is insufficient knowledge about the effect of smoking on congenital anomalies [154]. Other reasons include physiological changes during pregnancy, long-term smoking before pregnancy, having a smoker partner, low education, low socioeconomic status, not attending in pregnancy classes, experiencing stressful events before pregnancy or during pregnancy, being depressed, having smoking friends, being in smoking environments, being exposed to secondhand smoke, unplanned pregnancy, starting smoking at an early age, high smoking intensity, being in lower social class during childhood, or early adulthood are effective factors in smoking during pregnancy [23, 155–158].

The prevalence of smoking in pregnant women is more important than other groups and due to the effects of smoking on the health of the pregnant women, and their fetus such as reduced fetal size, stillbirth, increased perinatal death, death infant, miscarriage, placental abruption, premature birth, premature lung aging, and chronic disease of obstructive pulmonary [159–162], it is necessary to pay more attention to this issue. Endangering the health of mother and fetus can affect the quality of life of family and society, and will have devastating consequences for the psychology, socioeconomic, and social aspects. The effects of mother smoking on the fetus can be devastating effects and endanger future generations of any society.

The cigarette prevalence of the continents

The prevalence of ever smoking in the continents of Oceania, Asia, Europe, America, and Africa was 36% (95% CI: 27-45%), 14% (95% CI: 11-18%), 38% (95% CI: 30-46%), 31% (95% CI: 25-37%), and 32% (95% CI: 5-68%), respectively.

The WHO report in 2018 showed that the prevalence of cigarette smoking among women in the continents of Africa, America, Eastern Mediterranean, Europe, South-east Asia, and Western Pacific was 1.4%, 10.2%, 1.5%, 17.5%, 0.9, and 2.5%, respectively. The lowest prevalence is in the West Pacific and the Africa continent, while Europe has the highest prevalence [132]. Based on the WHO report, the cigarette smoking rate of women in European countries is higher than that of other countries in the world, which is consistent with the results of this study [163]. Based on the World Bank report, the prevalence of smoking among women in countries with high-income, upper middle-income, lower middle-income, and low-income was equal to 16.1%, 4.4%, 1.3%, and 2%, respectively, which indicating a high prevalence of consumption in high-income countries [132].

The results of a study have shown that the prevalence of smoking over the past 20 years has been gradually decreased in developed countries and steadily increasing in developing countries [164]. Results of a study showed that the price of cigarettes is declining in the middle- and low-income countries, and rising in the middle- and upper-income countries, and a 10% increase in cigarette prices has led to a 2% decrease in cigarette consumption [165]. The different prevalence rates in different continents and countries may be due to income levels, tax increases in certain countries, the implementation of various regional laws, and the implementation of education and prevention programs.

The cigarette smoking prevalence by study design, sampling, and assessment tools

In the present study, most of the studies included were cross sectional. This study indicated that the prevalence of cigarette smoking in the cohort and cross-sectional studies were similar. The quality of cross-sectional and baseline cohort studies is usually more reliable and valid for estimating the prevalence [166], which was the same in the present study.

In estimating prevalence, the most appropriate sampling method is the random sampling method [167]. In the present study, the results are presented based on the subgroups and are valid and acceptable based on the random sampling method. Cigarette smoking usually is assessed by standard tools (such as questionnaires) or self-report. Usually, the data that is collected with standard tools is more reliable and valid [168]. In the present study, the subgroup analysis (standard tools and self-reporting tools) showed that the estimated prevalence in standard tools is somewhat different from self-reporting tools. The strengths of the present study were the determinant of the prevalence of ever and current cigarette smoking worldwide, in subgroups of adolescents, adults, pregnant women, and based on the continents.

Limitations

Like other studies, this study had limitations. The first limitation was that in some studies data were collected using self-report tools which may cause biases. The second limitation was that in some studies the percentage or number of women smokers was not reported. The third limitation of this study was that the number of studies from the African continent was limited. The last limitation was that in some studies the prevalence of ever smoking or current smoking was not reported by women.

Conclusion

Based on the results of the present study, the prevalence of cigarette smoking among women is very high, which is significant in all subgroups of adolescents, adults, and pregnant women. Given the role of women in the family, the growth and upbringing of children, it is essential to

pay more attention to smoking in women. Therefore, it is necessary to design and implement appropriate educational programs for them, especially in schools, to reduce the side effects of smoking and reduce the prevalence of smoking among women.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12199-020-00924-y>.

Additional file 1: Table S1. Population characteristics of the studies reported the prevalence of current and ever cigarette smoking among women.

Additional file 2:. Search Strategy.

Additional file 3:. PRISMA 2009 Checklist.

Additional file 4: Fig S1. Pooled ever and current smoking prevalence in women by study design.

Additional file 5: Fig S2. Pooled ever and current smoking prevalence in women by sampling method.

Additional file 6: Fig S3. Pooled ever and current smoking prevalence in women by tools assessment smoking.

Additional file 7: Fig S4. Cumulative meta-analysis of ever and current smoking prevalence among women by study population.

Additional file 8: Fig S5. Cumulative meta-analysis of ever and current smoking prevalence among women by continent.

Additional file 9: Fig S6. Cumulative meta-analysis of ever and current smoking prevalence among women by study design.

Additional file 10: Fig S7. Cumulative meta-analysis of ever and current smoking prevalence among women by sampling method.

Additional file 11: Fig S8. Cumulative meta-analysis of ever and current smoking prevalence among women tools assessment smoking.

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Authors' contributions

AJ and HT conceptualized the study and led the project and writing. All authors contributed to the development of the coding scheme. AJ and AR conducted the coding and analyses and drafted the methods. AR, AJ, and HT reviewed the codes and results. All authors contributed to the writing and revision and approved the final version of the manuscript.

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Availability of data and materials

The data generated or analyzed during this study are available from the corresponding author on a reasonable request.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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