Addictive Behaviors 128 (2022) 107234

Contents lists available at ScienceDirect

Addictive Behaviors

journal homepage: www.elsevier.com/locate/addictbeh

The first day of smoking abstinence is more challenging for women than men: A meta-analysis and meta-regression across 12 low- and middle-income countries

João M. Castaldelli-Maia [a,b,c,*], Elizabeth D. Nesoff [d], Danielle R. Lima [a], Zila M. Sanchez [e], Silvia S. Martins [c]

[a] Department of Psychiatry, Medical School, University of São Paulo, Brazil
[b] Department of Neuroscience, Medical School, ABC Health University Center, Brazil
[c] Department of Epidemiology, Mailman School of Public Health, Columbia University, US
[d] Department of Biostatistics, Epidemiology & Informatics, University of Pennsylvania Perelman School of Medicine, Philadelphia, PA, USA
[e] Department of Preventive Medicine, Medical School, Universidade Federal de São Paulo, Brazil

ARTICLE INFO

Keywords:
Sex differences
Smoking
Cessation
Early abstinence
Cross-national
Meta-analysis

ABSTRACT

Background: Maintained abstinence during the first 24 h of a quit attempt is a critical predictor of long-term smoking cessation. Little is known about sex differences in the very early abstinence period, particularly in the context of low- and middle-income countries (LMICs) with varying anti-smoking policies and female smoking prevalences. We examined female sex effects on one-day relapse in a cross-national sample from 12 LMICs.

Methods: Data from the Global Adult Tobacco Survey (2008–2012) included nationally representative samples from 12 LMICs restricted to smokers with ≥ 1 quit attempt in the past 12 months (n = 16,576). We ran adjusted logistic regression models for female sex effects on one-day relapse, adjusting for nine individual-level demographics (e.g., age, education, age at smoking initiation) and smoking cessation variables (e.g., exposure to health warnings, receipt of counseling). We then conducted a meta-analysis adjusted for national-level and policy measures through meta-regression (e.g., cigarette consumption per capita, percent of cigarette box covered with warning labels).

Results: One-day relapse prevalence varied across countries (2.7–13.6%). The odds of one-day relapse were significantly higher for women than for men in six countries (adjusted for nine individual-level sociodemographic variables), and there were no significant sex differences in the remaining six countries. Result remained significant after meta-regressions for national-level tobacco consumption and policy measures. Sensitivity analyses showed that the odds of one-day relapse for women remained significant when excluding countries with both higher and lower relative rates of female smoking. Larger warning labels on cigarette packs were associated with reduced odds of one-day relapse among women.

Conclusion: The first day of a quit attempt is more challenging for women than men in LMICs. Tailored interventions incorporating national policies, in addition to counseling and pharmacotherapy, could play an essential role in supporting women during the initial abstinence phase of smoking cessation in LMICs.

1. Introduction

In 2017, smoking was considered the second biggest risk factor for years of life lost globally—the first for men and the tenth for women (GBD, 2017). Smoking cessation has significant acute and long-term health benefits, including reductions in smoking-related disease (U.S. Department of Health and Human Services, 1990). While global smoking prevalence remains higher among men than women, the greatest decreases in smoking prevalence during the last two decades were achieved among men, with several countries showing increases in smoking among women (Reitsma et al., 2017). Moreover, the drivers for smoking initiation and cessation differ between men and women (Al-

* Corresponding author at: Department of Epidemiology, Mailman School Of Public Health, Columbia University, 722 West 168th street, Rm. 515, New York, NY 10032, USA.
E-mail address: jmcmaia2@gmail.com (J.M. Castaldelli-Maia).

https://doi.org/10.1016/j.addbeh.2021.107234
Received 14 July 2021; Received in revised form 24 November 2021; Accepted 29 December 2021
Available online 3 January 2022

Nimr et al., 2020). For example, women are more likely to name weight control as a reason to start smoking, and women are more likely to be motived by health concerns, particularly pregnancy, to quit smoking compared to men (Al-Nimr et al., 2020; Smith et al., 2016; Sieminska & Jassem, 2014). Women are less likely to attempt to quit smoking than men (Piper et al., 2010), and women have more difficulty maintaining long-term abstinence than men (Smith et al., 2016). Female smokers are also more likely to develop and die from some smoking-related diseases such as lung cancer and coronary heart disease compared to their male counterparts (Freedman et al, 2008; Bain et al., 2004; Huxley & Woodward, 2011). Thus, understanding sex differences in smoking initiation and cessation is essential for effective global tobacco control policies.

Early smoking abstinence is an important predictor of sustained smoking cessation (Yeh et al., 2012; Bujarski et al., 2015). Achieving abstinence for a full 24 h on the targeted quit date is associated with a 10-fold increase in the odds of sustained abstinence at 6 months (Westman et al., 1997). Most smokers have significant withdrawal symptoms in the first day of abstinence, with one-third of daily smokers reporting severe negative affect, extreme hunger, or acute craving responses (Piper et al., 2017). However, little is known about sex differences in the very early abstinence period. A variety of biological, psychological, and social factors influence women's long-term smoking cessation. These factors include sex-dependent responses to nicotine replacement therapy; psychiatric comorbidities, particularly depression and anxiety; post-cessation weight management concerns; withdrawal and craving symptoms; and social support (Reynoso, Susabda & Cepeda-Benito, 2005; Greaves, 2015, Evans-Polce et al., 2015; McKee et al, 2016; Smith et al, 2015). For example, a recent meta-analysis found that women who attempted to quit smoking had worse mood symptoms than men who attempted to quit, and that these symptoms arose within the first three hours of abstinence (Weinberger et al., 2016). Whether these factors or other considerations influence women's early abstinence success is unknown.

Furthermore, sex differences in early abstinence in the context of countries with varying anti-smoking policies and female smoking prevalences have not been examined. Globally, tobacco control policies do not appear to influence female smoking as effectively as male smoking (Reitsma et al., 2017). Over the last two decades, female smoking prevalence has been stable and even increasing in some countries (Shkolnikov et al., 2020), while most countries with a large number of people who smoke reported substantial decreases in male smoking (Aldakhil et al., 2018). For instance, Germany, India, and the Philippines reported no significant decreases in female smoking, and female daily smoking significantly increased in Russia and Indonesia (Reitsma et al., 2017; Shkolnikov et al., 2020). Sex differences in early abstinence may be particularly salient in low- and middle-income countries (LMICs) as these countries have implemented varying degrees of evidence-based anti-smoking policies. Effective, evidence-based anti-smoking policies include increasing tobacco prices and taxes; implementing comprehensive smoke-free policies; conducting mass media anti-tobacco use campaigns; and subsidizing and promoting accessible smoking cessation assistance and nicotine replacement therapy (Nguyen et al., 2016). While studies (Campbell et al., 2019; Mead et al., 2019) conducted in the U.S. show sex differences in responses to evidence-based policy interventions such as graphic warning labels—such as greater efficacy among women compared to men; fetal risk warning labels eliciting stronger reactions—few studies have explored sex differences in LMICs (González Jiménez et al., 2019).

To our knowledge, there are no studies investigating sex differences in the first day of a quit attempt. This study aimed to fill this gap by investigating female sex effects on one-day relapse in daily tobacco smokers. We hypothesized that higher odds of relapse will be observed for women, relative to men, on the first day of a quit attempt. We used meta-analytic techniques to generate global measures of association using nationally-representative samples of LMICs. We also used meta-regression, which is an extension to standard meta-analysis, to investigate statistical heterogeneity across countries related to national-level tobacco control policies.

2. Methods

2.1. Sample

We used data from the Global Adult Tobacco Survey (GATS) collected from 2008 to 2012—part of the Global Tobacco Surveillance System (GTSS) (GTSS Collaborating Group, 2005), a collaborative initiative from World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), and Canadian Public Health Association (CPHA)—to create nationally-representative household surveys from participating countries (Warren et al., 2009). GATS has been implemented in 29 LMICs with high tobacco use burden, allowing cross-national comparison on tobacco control (Brown et al., 2017). GATS reports data on adult tobacco use (non-institutionalized, 15 years of age or older) and tobacco control measures in each country, enabling countries to formulate, track, and implement effective tobacco control policies. In addition, it is possible to make cross-national and cross-regional comparisons. All GATS countries use country-specific stratified multi-stage cluster sampling designs to produce country-representative samples (Ahluwalia et al., 2019). Data are collected through in-person interviews using electronic handheld devices, and all members of the target population are sampled from the household that is their primary place of residence. GATS uses a standardized questionnaire translated into multiple languages with many questions adapted from Tobacco Questions for Surveys (GTSS Collaborating Group, 2005). Datasets are available for public use.

The present study aimed to investigate data on nationally representative samples of 14 low- and middle-income countries that include 2/3 of the world's smokers (Brown et al., 2017), classified as the priority countries for tobacco control by several key anti-tobacco advocacy organizations (e.g., Bloomberg Philanthropies, The Union, Campaign for Tobacco-Free Kids). These countries are the following: Bangladesh, Brazil, China, Egypt, India, Indonesia, Mexico, Pakistan, Philippines, Russia, Thailand, Turkey, Ukraine, and Vietnam. Unfortunately, we were only able to include 12 of these countries as GATS data for Pakistan are not publicly available. In addition, we used a cutoff of at least 1% of the sample reporting one-day relapse for inclusion in the present analysis to prevent large 95% confidence intervals in the comparison models, thus excluding the Philippines. We further restricted our sample to people who smoked daily who tried to quit in the last year (n = 16,576) (Fig. 1).

2.2. Measures

2.2.1. Individual-level measures (Data source: GATS)

First, we selected only lifetime daily tobacco smokers. Second, we selected only those who reported at least one quit attempt in the last year.

The outcome of interest in this study—one-day relapse—was defined based on the longest period of tobacco smoking abstinence reported by the individual in the last quit attempt. Those who achieved 24 h or less of abstinence were coded as reporting one-day relapse. Those who reported more than 24 h of abstinence were coded as not endorsing one-day relapse.

Our main covariate of interest—sex—was self-reported as male or female. GATS did not include non-binary or transgender options (Whyte et al., 2018).

Nine individual-level covariates were included as control variables. We created six binary variables based on GATS questions: receipt of smoking cessation counseling; receipt of brief advice from a doctor to quit smoking; seeing any information about the dangers of smoking on television; seeing health warnings at point-of-purchase; belief about the

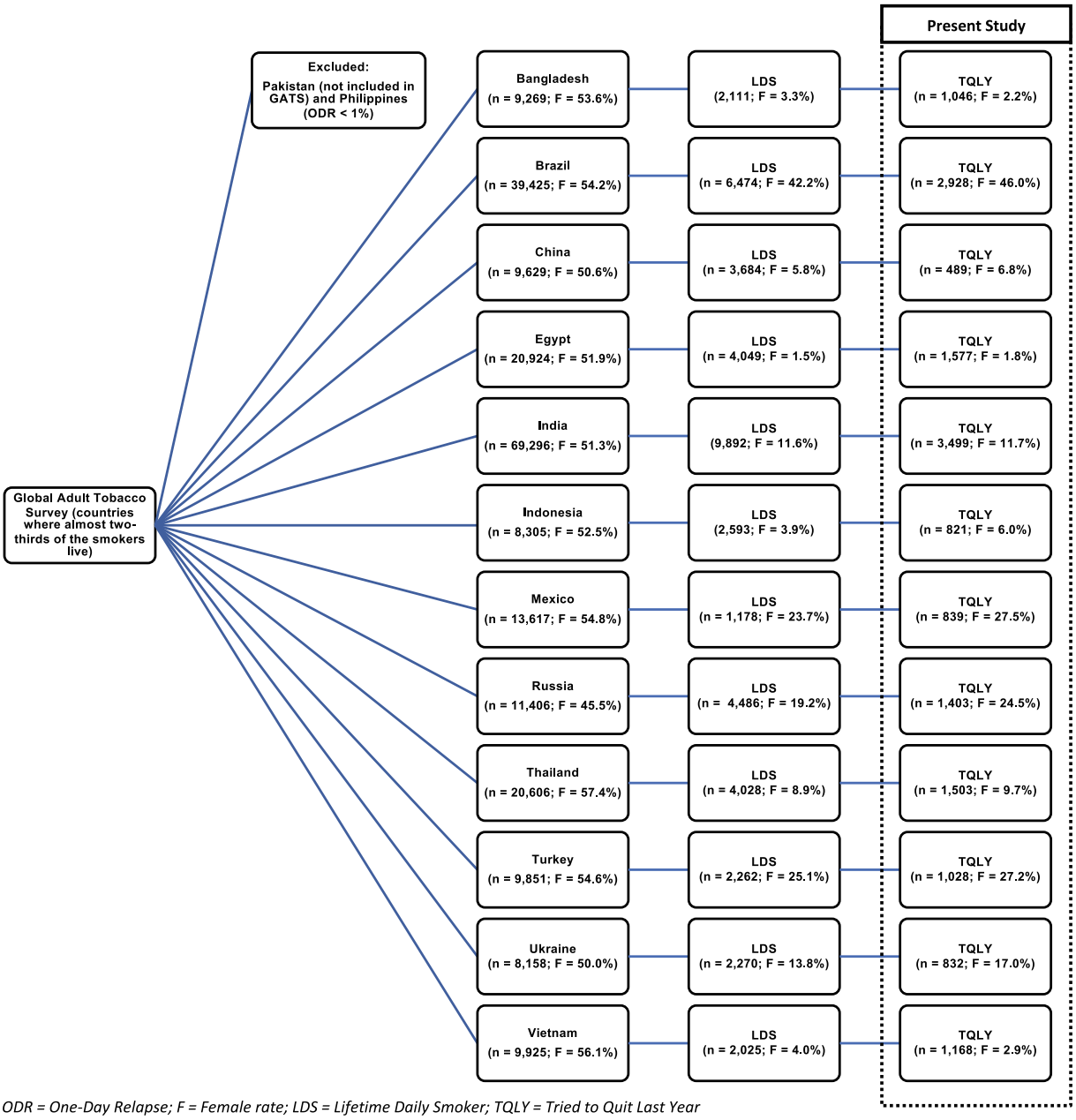

Fig. 1. Flowchart of national samples included in the present meta-analysis, Global Adult Tobacco Survey, 2008–2012.

dangers of second-hand smoke exposure. For each of these variables, the remaining individuals were coded as the reference group. For education, those who reported no formal education were compared to some formal education or more. We used a broad cross-national categorization in this variable because of the lack of standardization in education levels across countries.

Three covariates were continuous, including current age, age at smoking initiation, and Heaviness of Smoking Index (HSI). HSI is a reliable and valid measure of nicotine dependence comprised of two questions— (i) "how soon after waking do you smoke your first cigarette?" (Answer choices and associated point values: within 5 min[3 points]; 5–30 min[2]; 31–60 min[1]; 60 + minutes[0]) and "how many cigarettes a day do you smoke?" (Answer choices and point values: 31 or more[3]; 21 – 30[2]; 11 – 20[1]; 10 or less[0]) (Etter et al., 1999). HSI is summed on a range of 0–6, with 0–2 being low nicotine dependence, 3–4 indicating moderate dependence, and 5–6 indicating high dependence (Borland et al, 2010). HSI has been validated for international use (Borland et al, 2010).

2.2.2. *National-level measures (data sources: WHO report and tobacco Atlas)*

National-level measures of tobacco control policies and daily smoking prevalence were obtained from the WHO Report on the Global Tobacco Epidemic (WHO, 2009) and the Tobacco Atlas (Eriksen et al., 2012). We selected timely editions of both publications to correspond with GATS years of data collection (2008–2012). We included six MPOWER (monitor tobacco use and prevention policies (M); protect people from tobacco smoke (P); offer help to quit tobacco use (O); warn about the dangers of tobacco (W); enforce bans on tobacco advertising, promotion and sponsorship (E); raise taxes on tobacco (R) (WHO, 2009)) ratings that classify the Framework Convention on Tobacco Control policy implementation into four or five categories (Ngo et al., 2017). For example, "W" is measured by the percentage of a cigarette pack's surface covered by pictorial warnings. The score values for the M policy

dimension vary from 1 to 4 (1 = no recent data, or data that is not both current and representative, or no known data; 2–4 = policy's weakest to greatest level). The scores for the R policy dimension vary from 0 to 100 (share of total taxes in the retail price of the most widely sold brand of cigarettes). The score for the other 5-policy dimension (POWER) measures the overall strength of the policy on a scale of 1 to 5, with 1 representing a lack of data (missing data) and 2–5 representing the weakest to greatest policies (Ngo et al., 2017). We also included data on national prevalence of daily smoking (%), and percentage of daily smokers among women (%) (WHO, 2009).

From the Tobacco Atlas (Eriksen et al., 2012), we included level of youth secondhand smoke exposure (%, a strong proxy measure of implementation of policies to promote smoke-free indoor air) and the amount of cigarette consumption per capita (per 100,000 inhabitants).

2.3. Statistical analysis

We performed descriptive analyses of all individual- and national-level measures. To calculate initial models of the relationship between sex and one-day relapse in each country, we calculated multivariable logistic regression models adjusted for the nine covariates listed in section 2.2.1. We then included these adjusted odds ratios and their 95% confidence intervals in a cross-national meta-analysis model. We used a random-effects model because high heterogeneity was expected. We calculated I^2 as a measure of between-country heterogeneity.

To adjust for implementation of national-level anti-smoking policies, we calculated the initial meta-analysis regression models adjusting for covariates listed in section 2.2.2. This technique is an extension of standard meta-analysis; we use it here to investigate the extent to which statistical heterogeneity across different countries could be related to one or more characteristics of that country. Meta-regression was used instead of subgroup analyses (e.g., stratifying by different national levels of smoking policy implementation) to allow for the use of continuous covariates and to allow for more than one covariate at a time. Initially, these covariates were meta-regressed individually in a random-effects meta-regression model. We decided not to calculate multivariable meta-regression models, including more than one of these covariates, because covariates were highly correlated and potentially not independent (e.g., countries with fewer anti-tobacco policies tended to score lower in most of the variables, and vice-versa). Instead, we used random-effects meta-regression with residual restricted maximum likelihood to measure between-country variance ($\tau 2$) with a Knapp-Hartung modification (Higgins & Thompson, 2004). Forest plots for cumulative meta-analysis ordered by the most significant national-level variables were created. We used ascending and descending sort order for the variables with positive and negative associations in the meta-regression models, respectively.

We conducted sensitivity analyses in our meta-analysis models, excluding the countries with the heaviest weight in the cross-national model and outlier countries to address possible instability in the model.

Data were analyzed using STATA 16.1. The threshold for significance was set to $p < 0.05$.

3. Results

Table 1 presents the descriptive analysis of the individual-level measures among those who reported at least one quit attempt in the last year. Overall one-day relapse prevalences ranged from 2.7% (1.9–3.7%) to 13.6% (12.1–15.2%). The prevalence of women reporting at least one quit attempt varied considerably across countries—from 1.3% (95%CI=(0.8, 2.2)) in Egypt to 43.4% (95% CI=(41.2, 45.6)) in Brazil. Average age of survey participants ranged from 34.3 years (95% CI=(32.9, 35.7)) in Mexico to 42.1 years (95% CI=(41.1, 43.1)) in India. Average age of smoking initiation ranged from 17.8 years (95%CI=(17.4, 18.1)) in Turkey to 21.4 years (95% CI=(20.3, 22.6)) in China. Overall, the prevalences of individuals without any formal education, those who reported smoking cessation counseling, and levels of nicotine dependence were low. In contrast, those who received brief advice from a doctor to stop smoking, those who reported seeing any information about the dangers of smoking on television, and perception of serious illness caused by exposure to secondhand smoke rates were high. Point-of-purchase warnings varied greatly, from 12.5% (95% CI=(9.4, 16.4)) in Turkey to 71.8% (95% CI=(68.2, 75.3)) in Russia.

Supplemental Table S1 presents descriptive results for national-level tobacco consumption and policy measures. Russia, Turkey, and Ukraine presented high rates of daily smoking, female daily smoking, and cigarette consumption per capita. Russia (75.5%) and Indonesia (66.8%) presented the highest rates of youth second-hand smoke exposure. Regarding MPOWER policy measures, Brazil, Egypt, India, Thailand, and Turkey stood out with the highest number of tobacco control policies implemented across at least two categories. In comparison, China, Russia, and Indonesia reported the lowest number of policies in at least three categories.

Table 2 presents regression models for one-day relapse by sex in each country. In the adjusted models, six countries had significant findings. Female sex was significantly positively associated with one-day relapse in Bangladesh (aOR = 27.54; 95%CI = (5.28, 143.67)), Brazil (aOR = 1.23; 95%CI = (1.03, 1.47)), India (aOR = 3.26; 95%CI = (1.20, 8.88)), Indonesia (aOR = 6.32; 95%CI = (1.01, 39.63)), Mexico (aOR = 2.89; 95%CI = (1.36, 6.16)), and Russia (aOR = 3.14; 95%CI = (1.66, 5.94)). The remaining six countries had non-significant sex differences.

Fig. 2 presents the results of the cross-national meta-analysis model. We found a global female sex effect on one-day relapse (effect size [ES] = 0.78; 95%CI = (0.36, 1.20)) with moderate significant heterogeneity ($I^2 = 64.7\%$, $p < 0.01$). Brazil had the highest weight (17.2%), followed by Turkey (14.2%), Russia (12.5%), and Mexico (11.2%). We excluded Brazil in the first sensitivity meta-analysis. A significant female sex effect remained on one-day relapse (ES = 0.89; 95%CI = (0.45, 1.33)); heterogeneity decreased but remained moderate and significant ($I^2 = 45.5\%$; $p < 0.05$). We next excluded Turkey: female effect remained significant (ES = 1.01; 95%CI = 0.60–1.43), and heterogeneity decreased and was not significant ($I^2 = 20.3\%$; $p = 0.12$). We then excluded Russia, but the results did not vary (ES = 1.00; 95%CI = 0.42–1.58); heterogeneity increased moderately but not significantly ($I^2 = 41.1\%$; $p = 0.09$). Finally, we excluded Mexico, and the results were similar to the third sensitivity model (ES = 1.01; 95%CI = 0.28 to 1.74; $I^2 = 49.9\%$; $p = 0.06$). We also carried out a sensitivity model only excluding Bangladesh, which had an outlier result in the multivariable regression model. The results were similar to the initial model (ES = 0.61; 95%CI = 0.27–0.96; $I^2 = 48.1\%$; $p = 0.05$).

Table 3 presents the results of the meta-regression models for meta-analytic sex effects on one-day relapse. Level of tobacco health effects warning (W)—measured as the percent of the cigarette pack covered with health warning labels—was the only national-level variable significantly associated with sex and one-day relapse (Exp(beta) = -0.30; t = 0.08; SE = 0.13; $I^2 = 26.6\%$; $p < 0.05$). Supplemental Fig. S1 presents forest plots for cumulative meta-analyses ordered by warning label percent in descending sort order. Countries with larger warning labels (higher levels of W) had lower sex-related associations with one-day relapse.

4. Discussion

The present study aimed to investigate female sex effects on one-day relapse using representative samples of 12 LMICs with high smoking prevalence. Despite finding substantial differences in one-day relapse and female daily smoking prevalences across countries, female sex was consistently associated with one-day relapse—meaning the odds of one-day relapse were higher for women than for men in six countries included in our study, and there were no significant sex differences in the remaining six countries. Sensitivity analyses showed that the odds of one-day relapse for women remained significant when excluding

Table 1
Descriptive analyses of individual-level variables among those who reported at least one quit attempt in the last year across 12 low- and middle-income countries, 2008–2012 (n = 16,576).

	Prevalence % (95%CI)								Mean (95%CI)		
Country / Variable	24-hour relapse	Female sex	No formal education	Received Counseling	Brief advice from doctor	Seen TV health warnings	Point of purchase warnings	Perceived severity of secondhand smoke	Current Age	Age at smoking initiation	Heaviness of Smoking Index*
Bangladesh	7.2 (5.4–9.5)	2.2 (1.2–4.2)	46.2 (41.9–50.6)	14.4 (11.4–18.1)	47.8 (43.0–52.5)	51.0 (46.5–55.5)	60.1 (54.5–65.6)	97.4 (96.1–98.3)	40.0 (38.8–41.2)	18.8 (18.4–19.3)	1.3 (1.2–1.5)
Brazil	13.6 (12.1–15.2)	43.4 (41.2–45.6)	20.3 (18.4–22.4)	14.5 (13.0–16.0)	64.8 (62.6–67.0)	70.4 (68.3–72.4)	44.3 (41.9–46.8)	91.0 (89.7–92.1)	41.3 (40.6–41.9)	18.3 (18.0–18.7)	2.0 (1.9–2.1)
China	3.2 (1.9–5.4)	4.8 (2.9–7.9)	3.0 (1.9–4.8)	2.0 (0.7–5.7)	39.1 (32.1–46.4)	46.5 (37.455.8)	15.5 (11.1–21.2)	65.8 (57.5–73.2)	41.6 (38.4–44.8)	21.4 (20.3–22.6)	1.8 (1.6–2.1)
Egypt	2.7 (1.9–3.7)	1.3 (0.8–2.2)	29.7 (26.5–32.2)	4.2 (3.0–5.2)	31.1 (28.1–34.3)	63.1 (59.7–63.4)	19.5 (16.8–22.4)	95.1 (93.0–96.6)	38.8 (37.9–39.7)	17.9 (17.4–18.4)	1.9 (1.8–2.0)
India	6.8 (5.6–8.4)	10.1 (8.3–12.4)	35.1 (31.9–38.4)	8.7 (7.2–10.4)	57.0 (54.1–59.8)	46.6 (43.3–49.9)	29.0 (26.1–32.0)	89.0 (86.5–91.1)	42.1 (41.1–43.1)	21.3 (20.7–21.9)	1.8 (1.7–1.9)
Indonesia	4.0 (2.7–6.0)	5.3 (3.6–7.6)	18.5 (15.2–22.4)	7.2 (4.2–12.0)	36.9 (31.3–42.9)	25.2 (19.8–31.4)	42.1 (34.3–50.3)	89.4 (86.2–92.0)	38.2 (37.0–39.4)	19.1 (18.4–19.8)	1.0 (0.9–1.2)
Mexico	5.1 (3.5–7.4)	29.4 (25.8–33.3)	13.9 (11.3–17.1)	3.1 (0.1–5.1)	28.3 (24.2–32.8)	85.9 (82.2–88.9)	62.1 (57.6–66.4)	96.9 (94.8–98.2)	34.3 (32.9–35.7)	18.1 (17.4–18.7)	1.1 (0.9–1.3)
Russia	8.1 (5.9–10.9)	35.4 (31.4–39.7)	0.2 (0.0–1.5)	3.5 (2.5–4.8)	62.0 (57.9–65.9)	44.7 (40.5–48.9)	71.8 (68.2–75.3)	79.4 (76.0–82.4)	36.9 (35.7–38.0)	17.9 (17.4–18.3)	2.3 (2.2–2.4)
Thailand	3.7 (2.7–5.3)	6.1 (4.8–7.6)	2.3 (1.6–3.4)	4.2 (3.0–5.8)	43.0 (38.8–47.1)	67.9 (63.4–72.2)	21.1 (17.9–24.8)	92.6 (90.1–94.6)	39.9 (38.8–41.1)	19.1 (18.6–19.6)	1.7 (1.6–1.8)
Turkey	10.6 (8.4–13.3)	25.9 (22.9–29.1)	5.4 (3.8–7.8)	6.2 (4.8–8.0)	49.5 (44.9–54.1)	93.6 (91.5–95.2)	12.5 (9.4–16.4)	95.7 (94.0–96.9)	37.4 (36.4–38.4)	17.8 (17.4–18.1)	2.0 (1.8–2.1)
Ukraine	5.2 (3.6–8.1)	23.3 (19.6–27.5)	0.2 (0.0–1.0)	2.8 (1.7–4.9)	41.9 (37.5–43.4)	52.0 (47.6–56.4)	59.5 (55.2–63.7)	82.8 (79.3–85.9)	36.0 (34.8–37.3)	18.2 (17.7–18.6)	2.3 (2.2–2.5)
Vietnam	5.3 (3.9–7.0)	2.3 (1.5–3.4)	3.8 (2.5–5.4)	2.3 (1.5–3.6)	30.0 (26.6–36.4)	90.0 (87.2–92.3)	13.3 (10.9–16.0)	86.5 (83.7–88.8)	39.7 (38.7–40.7)	20.3 (19.9–20.7)	1.9 (1.8–2.0)

*Heaviness of Smoking Index is summed on a range of 0–6, with 0–2 being low nicotine dependence, 3–4 indicating moderate dependence, and 5–6 indicating high dependence.

Table 2
Univariable and multivariable logistic regression models for one-day quit attempt relapse by sex across 12 low- and middle-income countries, 2008–2012 (n = 16,576).

	Unadjusted model			Adjusted model*		
Country	OR	95%CI	p	aOR	95%CI	p
Bangladesh	8.24	2.75, 24.68	<0.001	27.54	5.28, 143.67	<0.001
Brazil	1.24	1.08, 1.43	0.002	1.23	1.03, 1.46	0.020
China	1.91	0.44, 8.20	0.375	1.14	0.14, 8.79	0.894
Egypt	2.53	0.73, 14.75	0.301	3.36	0.53, 1.16	0.196
India	1.98	1.14, 3.42	0.014	3.26	1.20, 8.88	0.020
Indonesia	2.64	0.62, 11.17	0.183	6.32	1.01, 39.63	0.049
Mexico	3.02	1.51, 6.04	0.002	2.89	1.36, 6.16	0.006
Russia	1.86	1.05, 3.29	0.033	3.14	1.66, 5.94	<0.001
Thailand	1.10	0.41, 2.95	0.843	1.08	0.37, 3.08	0.885
Turkey	1.05	0.67, 1.64	0.826	1.34	0.81, 2.19	0.242
Ukraine	0.79	0.24, 2.51	0.690	1.29	0.37, 4.53	0.682
Vietnam	1.17	0.24, 5.67	0.845	1.78	0.33, 1.65	0.489

*Models adjusted for age; education level; age at smoking initiation; Heaviness Smoking Index; receipt of smoking cessation counselling; receipt of brief advice from a doctor; viewing tobacco-related health warnings on television; point-of-purchase health warnings; perceived severity of smoking health effects.

countries with both higher and lower relative rates of female smoking. Moreover, this result remained significant after meta-regressions for national-level tobacco consumption and tobacco control policy measures.

Findings from this cross-national study were consistent across countries and suggest that early abstinence may be more challenging for women than men. Moreover, we also found significant associations between sex and one-day relapse in countries with low and high relative rates of female smoking, such as Indonesia and Brazil, respectively. This significant sex disparity was also present in countries with lower-middle- and upper-middle-income levels, such as Bangladesh and Russia, respectively. It suggests a universality of sex differences in one-day relapse that is not mitigated by country-level smoking prevalence, income, or geolocation.

A successful first day of abstinence is one of the most important predictors for prolonged smoking cessation, and little is known about why women may find this period more challenging than men (Westman et al., 1997). For example, withdrawal syndrome may play an essential role in one-day quit attempt outcomes among women as women typically report more withdrawal symptoms than men (Weinberger et al., 2016). Nicotine withdrawal symptoms typically present on the first day of abstinence and are cited by smokers as the main reason for relapse (Allenby et al., 2020). More inquiry is needed into how psychosocial symptoms differentially impact women's early quit attempts and how interventions can be tailored to address these barriers to sustained abstinence (Weinberger et al., 2016; Conti et al., 2020).

At the national level, we found that larger warning labels on cigarette packs were associated with reduced odds of one-day relapse among women. Health warning labels on cigarette packs have been shown to effectively reduce tobacco smoking by promoting a greater public understanding of the negative health consequences of smoking (Klein et al., 2017). Article 11 of the WHO Framework Convention on Tobacco Control supports the adoption of graphic warning labels, which should cover at least 50% of cigarette packaging (WHO, 2009). As of 2013, less than half of LMICs included in the GATS have implemented these warning labels on cigarette boxes (Shang et al., 2017). There are some studies investigating the effects of health warnings by sex, all supporting the positive impact of such policy interventions on women's smoking rates. Campbell et al. (2019) investigated reactions to graphic warning labels in the U.S. and found that, compared to male smokers, women rated graphic warning labels overall as more credible, evoking more

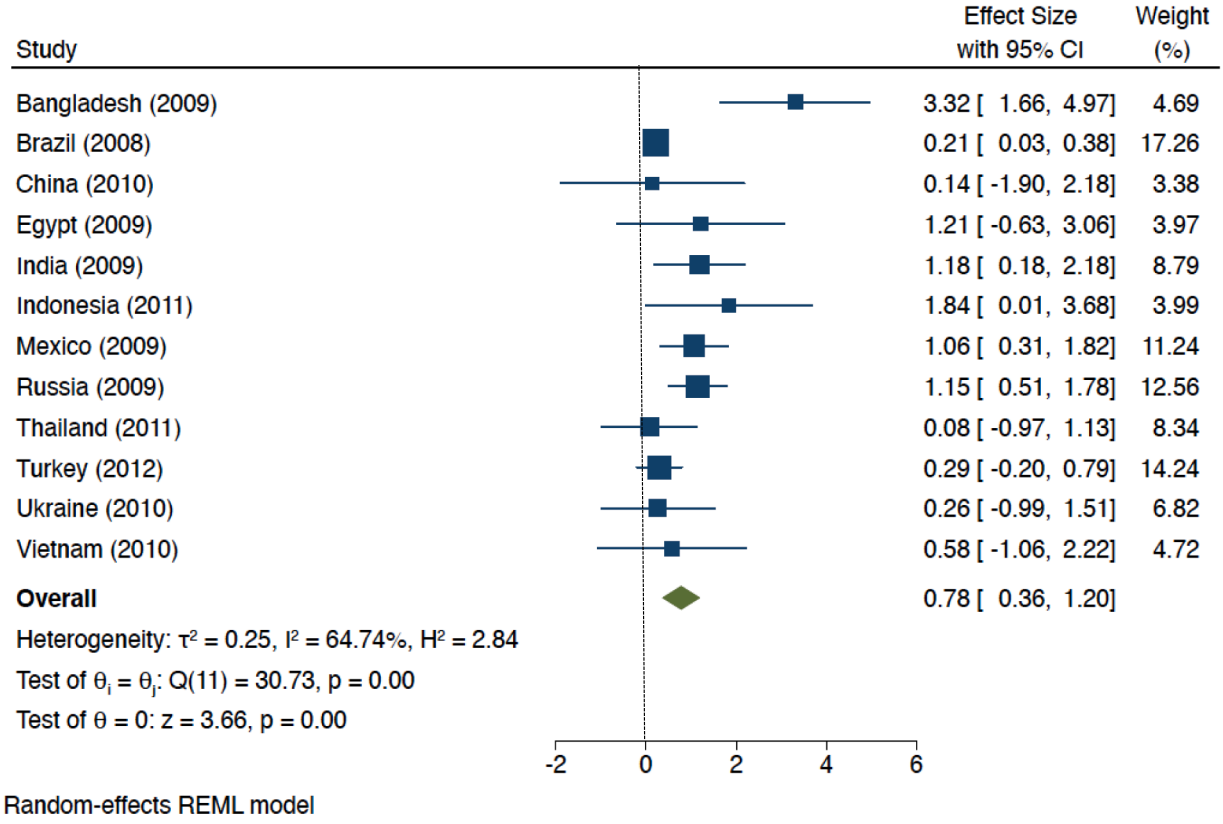

Fig. 2. Cross-national meta-analysis models for female sex effect on one-day quit attempt relapse across 12 low- and middle-income countries, 2008–2012 (n = 16,576).

Table 3
Meta-regression models for meta-analytic female sex effect on one-day quit attempt relapse combining measures from 12 low- and middle-income countries, 2008–2012.

Variable	Exp (b)	t	95%CI		I^2	p
Daily smoking prevalence overall	0.01	0.32	−0.03	0.04	62.9%	0.881
Daily smoking prevalence among women	−0.04	0.24	−0.10	0.02	63.7%	0.207
Level of tobacco use monitoring (M)	0.21	0.30	−0.41	0.84	63.8%	0.508
Level of protection from secondhand smoke (P)	−0.09	0.31	−0.50	0.31	63.4%	0.656
Cessation treatment availability (O)	−0.34	0.22	−0.86	0.17	47.5%	0.189
Percent of cigarette box covered with health warning label (W)	−0.30	0.08	−0.55	−0.04	26.6%	0.021
Level of enforcement of advertisement bans (E)	−0.14	0.21	−0.45	0.17	53.5%	0.382
Level of tobacco taxes (R)	−0.01	0.32	−0.03	0.03	69.3%	0.987
Youth exposure to secondhand smoke	−0.01	0.33	−0.03	0.01	62.2%	0.459
Cigarette consumption per capita	−0.01	0.34	−0.01	0.01	66.9%	0.418

Exp(b) = Coefficient beta. The beta coefficients (range: minus infinite to plus infinite), confidence intervals, and p-values and resulting from meta-regression are interpreted in the same manner as traditional coefficients from multi-level models. Significance is achieved when the confidence interval does not include zero.
Data sources: WHO Report on Global Tobacco Epidemic (2009); Tobacco Atlas (2012).

negative emotions, and eliciting higher motivation to quit. Mead et al. (2019) found that pregnant women who smoked were more likely than never-pregnant women smokers to report seeing health warning labels and decreasing cigarette consumption because of them, but were less likely to attempt to quit smoking because of warning labels. Little research on sex differences in warning label effectiveness has been conducted in LMICs. González Jiménez et al. (2019) evaluated warning labels in Colombia and found that there were no significant sex differences in encouragement to stop smoking. More research is needed on sex-specific differences in health warning labels in LMICs and how these warning labels can be effectively tailored to women in these countries.

In addition to policy interventions, there should be increased support for the implementation of evidence-based early smoking cessation treatment, especially for women. Lack of medication and/or psychotherapy may be a particularly important factor in decreasing the chance of successfully quitting smoking (Stead et al., 2016; Lancaster & Stead, 2017; Stead et al., 2017). Unfortunately, studies in high-income countries showed that women tend to receive less pharmacological treatment (Steinberg et al., 2006), even though they seek treatment more often (Huang et al., 2013). Future studies should investigate the early impact of different smoking cessation interventions for women. There are promising smoking cessation studies for women using bupropion (Collins et al., 2004; Chatkin et al., 2006), varenicline (Castellani et al., 2020), contingency management (Waters et al., 2018), cognitive-behavioral therapy (CBT), CBT plus pharmacotherapy (Chaim et al., 2019; Chatkin et al., 2006; Collins et al., 2004; Loreto et al., 2017), and brief interventions (Wray et al., 2018).

Limitations are noted. Our primary meta-analysis model had moderate significant heterogeneity. Brazil had the highest weight for the model; however, when we removed Brazil from our models, our results remained significant. The year of data collection and sample size varied across countries, and individual- and national-level data were not necessarily collected in the same year. However, we selected the shortest time period possible across data waves and data sources (2008–2012) to attenuate possible bias. In addition, all samples were large (>8000 subjects) and representative of the source countries. Furthermore, the most recent WHO global report on trends in tobacco smoking prevalence showed that from 2010 to 2020, daily smoking in these 12 countries decreased by only 1.5% on average (WHO, 2018), suggesting that our findings are still relevant to current trends in women's smoking in these countries. The paucity of information on women's one-day relapse in LMICs also necessitates inquiry despite the age of the data. The binary classification of sex is a limitation; investigating smoking among those who express nonbinary or transgender is crucial for improving clinical outcomes among this vulnerable population (Whyte et al., 2018). Finally, we were unable to include specific measures on uptake of specific types of counseling and pharmacotherapy treatment as these data were not available in all countries.

5. Conclusions

This cross-national study of smokers in 12 low- and middle-income countries found that the first day of a quit attempt is more challenging for women than men. This is particularly important as first day of abstinence is one of the most critical predictors of long-term smoking cessation. We also found that larger health warning labels on cigarette packs were associated with reduced odds of one-day relapse among women. Tailored interventions incorporating national policies, in addition to counseling and pharmacotherapy, could play an essential role in supporting women during the initial abstinence phase of smoking cessation in low- and middle-income countries.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

WHO, CDC, GATS Implementing Agency, Johns Hopkins Bloomberg School of Public Health, RTI International, and the National Governments of Bangladesh, Brazil, China, Egypt, India, Indonesia, Mexico, Philippines, Russia, Thailand, Turkey, Ukraine, and Vietnam, for carrying out such a critical survey and releasing data for public use.

Contributors

Authors JMCM, ZMS and SSM designed the study. JMCM, EN and DRL managed the literature searches and summaries of previous related work. JMCM, ZMS and SSM undertook the statistical analysis. JMCM, EN and DRL wrote the first draft of the manuscript. All the authors contributed to and have approved the final manuscript.

Funding

The present study had no specific funding. The Global Adult Tobacco Survey (GATS) functions as a multi-partner initiative representing global, regional, and national organizations. The protected time for the contribution of Dr. Castaldelli-Maia towards the research reported in this publication was supported by the National Institute on Drug Abuse (NIDA) of the National Institutes of Health under the NIDA INVEST Drug Abuse Research Fellowship. NIDA had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.addbeh.2021.107234.

References

Ahluwalia, I. B., Arrazola, R. A., Zhao, L., Shi, J., Dean, A., Rainey, E., et al. (2019). Tobacco Use and Tobacco-Related Behaviors - 11 Countries, 2008–2017. *Morbidity and mortality weekly report, 68*(41), 928–933.

Aldakhil, A. M., Nassani, A. A., Abro, M. M. Q., & Zaman, K. (2018). Food-beverage-tobacco consumption, smoking prevalence, and high-technology exports influenced healthcare sustainability agenda across the globe. *Environmental Science and Pollution Research, 25*(33), 33249–33263.

Allenby, C., Falcone, M., Wileyto, E. P., Cao, W., Bernardo, L., Ashare, R. L., et al. (2020). Neural cue reactivity during acute abstinence predicts short-term smoking relapse. *Addiction Biology, 25*(2). https://doi.org/10.1111/adb.v25.210.1111/adb.12733

Al-Nimr, Y. M., Farhat, G., & Alwadey, A. (2020). Factors Affecting Smoking Initiation and Cessation Among Saudi Women Attending Smoking Cessation Clinics. *Sultan Qaboos University Medical Journal, 20*(1), 95. https://doi.org/10.18295/squmj.2020.20.01.014

Bain, C., Feskanich, D., Speizer, F. E., Thun, M., Hertzmark, E., Rosner, B. A., et al. (2004). Lung cancer rates in men and women with comparable histories of smoking. *Journal of the National Cancer Institute, 96*(11), 826–834.

Brown, J., Welding, K., Cohen, J. E., Cherukupalli, R., Washington, C., Ferguson, J., et al. (2017). An analysis of purchase price of legal and illicit cigarettes in urban retail environments in 14 low- and middle-income countries. *Addiction, 112*(10), 1854–1860.

Bujarski, S., Roche, D. J., Sheets, E. S., Krull, J. L., Guzman, I., & Ray, L. A. (2015). Modeling naturalistic craving, withdrawal, and affect during early nicotine abstinence: A pilot ecological momentary assessment study. *Experimental and Clinical Psychopharmacology, 23*(2), 81–89.

Campbell, B. K., Le, T., Yip, D., Griffin, K. B., Gubner, N. R., & Guydish, J. R. (2019). Sex differences in graphic warning label ratings by addictions clients. *Tobacco Regulatory Science, 5*(1), 3–14.

Castellani, V., Gonçalves, P. D., Castaldelli-Maia, J. M., & Malbergier, A. (2020). Investigating gender differences for effectiveness and side effects of varenicline during smoking cessation treatment. *Revista da Associacao Medica Brasileira (1992), 66*(2), 146–152.

Chaim, C. H., Siu, E. R., Carvalho, C., Frallonardo, F. P., Ismael, F., Andrade, A. G., et al. (2019). Experimentation with tobacco during adolescence as a factor influencing treatment of smoking in adulthood. A retrospective cohort. *Sao Paulo Medical Journal, 137*(3), 234–240.

Chatkin, J. M., Abreu, C. M., Blanco, D. C., Tonietto, R., Scaglia, N., Wagner, M. B., et al. (2006). No gender difference in effectiveness of smoking cessation treatment in a Brazilian real-life setting. *The International Journal of Tuberculosis and Lung Disease, 10*(5), 499–503.

Collins, B., Wileyto, P., Patterson, F., Rukstalis, M., Audrain-McGovern, J., Kaufmann, V., et al. (2004). Gender differences in smoking cessation in a placebo-controlled trial of bupropion with behavioral counseling. *Nicotine & Tobacco Research, 6*(1), 27–37.

Conti, A. A., Tolomeo, S., Steele, J. D., & Baldacchino, A. M. (2020). Severity of negative mood and anxiety symptoms occurring during acute abstinence from tobacco: A systematic review and meta-analysis. *Neuroscience and Biobehavioral Reviews, 115*, 48–63.

Eriksen, M. P., Mackay, J., & Ross, H. (2012). *The tobacco atlas* (fouth ed.). Atlanta, GA: American Cancer Society.

Etter, J. F., Duc, T. V., & Perneger, T. V. (1999). Validity of the Fagerstrom test for nicotine dependence and of the Heaviness of Smoking Index among relatively light smokers. *Addiction, 94*(2), 269–281.

Evans-Polce, R. J., Castaldelli-Maia, J. M., Schomerus, G., & Evans-Lacko, S. E. (2015). The downside of tobacco control? Smoking and self-stigma: A systematic review. *Social Science & Medicine, 145*, 26–34.

Freedman, N. D., Leitzmann, M. F., Hollenbeck, A. R., Schatzkin, A., & Abnet, C. C. (2008). Cigarette smoking and subsequent risk of lung cancer in men and women: Analysis of a prospective cohort study. *The Lancet. Oncology, 9*(7), 649–656.

GBD 2017 Risk Factor Collaborators. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017 [published correction appears in Lancet. 2019 Jan 12;393(10167):132] [published correction appears in Lancet. 2019 Jun 22; 393(10190):e44]. *Lancet.* 2018;392(10159):1923-1994. doi:10.1016/S0140-6736(18)32225-6.

Global Tobacco Surveillance System Collaborating Group. (2005). Global Tobacco Surveillance System (GTSS): Purpose, production, and potential. *Journal of School Health, 75*(1), 15–24.

González Jiménez, N., Valero Ortiz, A., Rosas Gambindo, D., Quiroga Rocha, J., & Vargas Rodríguez, L. (2019). Evaluation of the educational material of the cigarette box of the campaigns for the control of tobacco consumption in the municipality of Barbosa, Santander- Colombia. *Revista Espanola de Salud Publica, 93*, Article e201906030.

Greaves, L. (2015). The meanings of smoking to women and their implications for cessation. *International Journal of Environmental Research and Public Health, 12*(2), 1449–1465.

Huang, Y., Britton, J., Hubbard, R., & Lewis, S. (2013). Who receives prescriptions for smoking cessation medications? An association rule mining analysis using a large primary care database. *Tobacco Control, 22*(4), 274–279.

Huxley, R. R., & Woodward, M. (2011). Cigarette smoking as a risk factor for coronary heart disease in women compared with men: A systematic review and meta-analysis of prospective cohort studies. *The Lancet, 378*(9799), 1297–1305.

Lancaster, T., & Stead, L. F. (2017). Individual behavioural counselling for smoking cessation. *The Cochrane Database of Systematic Reviews, 3*(3), CD001292.

Loreto, A. R., Carvalho, C. F. C., Frallonardo, F. P., Ismael, F., Andrade, A. G.d., & Castaldelli-Maia, J. M. (2017). Smoking cessation treatment for patients with mental disorders using CBT and combined pharmacotherapy. *Journal of Dual Diagnosis, 13*(4), 238–246.

Mead, E. L., Cruz-Cano, R., Groom, A., Hart, J. L., Walker, K. L., Giachello, A. L., et al. (2019). Responses to cigarette health warning labels, harm perceptions and knowledge in a national sample of pregnant and non-pregnant women of reproductive age. *Addictive Behaviors, 90*, 10–13.

Ngo, A., Cheng, K.-W., Chaloupka, F. J., & Shang, C.e. (2017). The effect of MPOWER scores on cigarette smoking prevalence and consumption. *Preventive Medicine, 105*, S10–S14.

Nguyen, K. H., Marshall, L., Brown, S., & Neff, L. (2016). State-specific prevalence of current cigarette smoking and smokeless tobacco use among adults - United States, 2014. *MMWR. Morbidity and Mortality Weekly Report, 65*(39), 1045–1051.

Piper, M. E., Cook, J. W., Schlam, T. R., Jorenby, D. E., Smith, S. S., Bolt, D. M., et al. (2010). Gender, race, and education differences in abstinence rates among participants in two randomized smoking cessation trials. *Nicotine & Tobacco Research, 12*(6), 647–657.

Reitsma, M. B., Fullman, N., Ng, M., Salama, J. S., Abajobir, A., Abate, K. H., et al. (2017). Smoking prevalence and attributable disease burden in 195 countries and territories, 1990–2015: A systematic analysis from the Global Burden of Disease Study 2015. *The Lancet, 389*(10082), 1885–1906.

Reynoso, J., Susabda, A., & Cepeda-Benito, A. (2005). Gender differences in smoking cessation. *Journal of Psychopathology and Behavioral Assessment, 27*(3), 227–234.

Sieminska, A., & Jassem, E. (2014). The many faces of tobacco use among women. *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research, 20*, 153–162.

Shang, C., Huang, J., Cheng, K. W., He, Y., & Chaloupka, F. J. (2017). The association between warning label requirements and cigarette smoking prevalence by education-findings from the global adult tobacco survey (GATS). *International Journal of Environmental Research and Public Health, 14*(1), 98.

Shkolnikov, V. M., Churilova, E., Jdanov, D. A., Shalnova, S. A., Nilssen, O., Kudryavtsev, A., ... & Leon, D. A. (2020). Time trends in smoking in Russia in the light of recent tobacco control measures: synthesis of evidence from multiple sources. *BMC Public Health* [Epub ahead of print].

Smith, P. H., Kasza, K. A., Hyland, A., Fong, G. T., Borland, R., Brady, K., et al. (2015). Gender differences in medication use and cigarette smoking cessation: Results from the International Tobacco Control Four Country Survey. *Nicotine & Tobacco Research, 17*(4), 463–472.

Smith, P. H., Bessette, A. J., Weinberger, A. H., Sheffer, C. E., & McKee, S. A. (2016). Sex/gender differences in smoking cessation: A review. *Preventive Medicine, 92*, 135–140.

Stead, L. F., Carroll, A. J., & Lancaster, T. (2017). Group behaviour therapy programmes for smoking cessation. *The Cochrane Database of Systematic Reviews, 3*(3), CD001007.

Stead, L. F., Koilpillai, P., Fanshawe, T. R., & Lancaster, T. (2016). Combined pharmacotherapy and behavioural interventions for smoking cessation. *The Cochrane Database of Systematic Reviews, 3*, CD008286.

Steinberg, M. B., Akincigil, A., Delnevo, C. D., Crystal, S., & Carson, J. L. (2006). Gender and age disparities for smoking-cessation treatment. *American Journal of Preventive Medicine, 30*(5), 405–412.

U.S. Department of Health and Human Services. *The Health Benefits of Smoking Cessation: A report of the Surgeon General.* Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 1990.

Waters, A. F., Businelle, M. S., Frank, S. G., Hébert, E. T., & Kendzor, D. E. (2018). Understanding the link between contingency management and smoking cessation: The roles of sex and self-efficacy. *Addictive Behaviors, 84*, 99–105.

Warren, C. W., Lee, J., Lea, V., Goding, A., O'hara, B., Carlberg, M., et al. (2009). Evolution of the Global Tobacco Surveillance System (GTSS) 1998–2008. *Glob Health Promot., 16*(2_suppl), 4–37.

Weinberger, A. H., Platt, J. M., Shuter, J., & Goodwin, R. D. (2016). Gender differences in self-reported withdrawal symptoms and reducing or quitting smoking three years later: A prospective, longitudinal examination of U.S. adults. *Drug and Alcohol Dependence, 165*, 253–259.

Westman, E. C., Behm, F. M., Simel, D. L., & Rose, J. E. (1997). Smoking behavior on the first day of a quit attempt predicts long-term abstinence. *Archives of Internal Medicine, 157*(3), 335–340.

World Health Organization. (2009). *WHO report on the global tobacco epidemic, 2009: Implementing smoke-free environments*. Geneva: WHO Press.

Whyte, S., Brooks, R. C., & Torgler, B. (2018). Man, woman, "other": Factors associated with nonbinary gender identification. *Archives of Sexual Behavior, 47*(8), 2397–2406.

Wray, J. M., Funderburk, J. S., Acker, J. D., Wray, L. O., & Maisto, S. A. (2018). A Meta-Analysis of Brief Tobacco Interventions for Use in Integrated Primary Care. *Nicotine & Tobacco Research, 20*(12), 1418–1426.

Yeh, V. M., McCarthy, D. E., & Baker, T. B. (2012). An ecological momentary assessment analysis of prequit markers for smoking-cessation failure. *Experimental and Clinical Psychopharmacology, 20*(6), 479–488.