**Association between depression and smoking: a global perspective from 48 low- and middle-income countries**

*Running title – Depression and smoking*

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**Abstract (250/250)**

**Background**

Smoking is a leading modifiable cause of global morbidity and mortality. Research from high-income countries has found a high prevalence of smoking among people with depression and suggested that this may partially contribute to the increased premature mortality in this population. Limited research has investigated smoking behaviors across the depression spectrum and in low- and middle-income countries (LMICs). This study explored the relationship between depression and smoking across 48 LMICs.

**Methods**

We conducted a cross-sectional, community-based study comprising 242,952 people [mean age 38.4 (SD=16.1) years, 50.8% females] from the World Health Survey. Multivariable binary logistic regression analyses were performed to investigate the relationship between depression (including subsyndromal, brief depressive episode and depressive episodes) and smoking behaviours.

**Results**

Overall, the prevalence of current smoking was lowest in Africa (13.5%) and highest in Asia (32.2%). A depressive episode was present in 6.7% of the sample. Compared to people without depression, subsyndromal depression, brief depressive episode, and depressive episodes were all significantly associated with smoking with similar effect sizes (ORs: 1.36-1.49). Countrywide meta-analysis found that the pooled overall OR for smoking in depression was 1.42 (95%CI=1.32-1.52, I2=39.7%). Furthermore, alcohol consumption and male gender were consistently associated with smoking across all regions and smoking was consistently less common in those who were wealthier and had a higher education.

**Conclusion**

These data suggest the depression spectrum is consistently associated with high levels of smoking behaivours in LMICs. Given that most of the world’s smokers reside in LMICs, future smoking cessation interventions are required to target people with depression.

**Key words**: smoking, health promotion, morbidity, mortality, depression, cancer, mental illness

**Introduction**

Tobacco use is a substantial global public health issue and approximately one billion people smoke in the world, with 80% of smokers currently residing in low- and middle-income countries (LMICs) (Ng, Freeman et al. 2014). There is a plethora of research demonstrating that smoking tobacco is a leading modifiable contributor to global mortality causing 7 million deaths annually; approximately half of smokers will experience a premature death due to cardiovascular, respiratory, neoplastic or other associated diseases attributed to smoking (Association 2013, Organisation 2013, Hoffman and Tan 2015). Recent research has suggested that people with mental illness smoke a disproportionate amount of cigarettes. They smoke more heavily, have more severe nicotine dependence and face worse health outcomes as a result of tobacco use (Lê Cook, Wayne et al. 2014). Despite the higher burden, this population is not benefitting from wider public health campaigns that have reduced smoking in people without mental illness (Lê Cook, Wayne et al. 2014).

There is robust research demonstrating that, compared to the general population, people with depression are at increased risk of cardiovascular disease (Correll, Solmi et al. 2017), respiratory diseases (Salte, Titlestad et al. 2015, Stubbs, Vancampfort et al. 2017), cancer (Mitchell, Chan et al. 2011), and premature mortality due to such physical diseases (Chesney, Goodwin et al. 2014), and that this may be largely attributable to factors such as an increased prevalence of unhealthy behaviors in this population, in particular smoking. Indeed, previous research has demonstrated that people with depression, including major depressive disorder (MDD), are more likely to smoke tobacco (Mathew, Hogarth et al. 2017, Weinberger, Kashan et al. 2017) and less likely to quit smoking (Ho, Alnashri et al. 2015). Specifically, a meta-analysis of 66 cross-sectional studies found that current smokers were more likely to be categorized as depressed versus non-smokers (OR = 1.50, CI = 1.39–1.60) whilst a smaller number of studies suggested that smokers were more likely to develop incident depression (OR=1.62, CI=1.10-2.40) (Luger, Suls et al. 2014). Another large systematic review demonstrated high levels of smoking in people with depression but stated the literature lacked clarity over the directionality of the relationship between smoking and depression (Fluharty, Taylor et al. 2017), while a large meta-analysis of Mendelian Randomization studies found no evidence of a causal relationship between smoking and depression (Taylor, Fluharty et al. 2014). Whilst there have been concerns that stopping smoking may result in a deterioration of mental health (Choi, Ota et al. 2015), another recent meta-analysis found that this notion is unwarranted and that anxiety, depression and stress all significantly decreased after smoking cessation (Taylor, McNeill et al. 2014).

Nonetheless, it is clear that many people with depression currently smoke and understanding the factors influencing smoking in this population is essential given the high levels of smoking, increased physical health comorbidities commonly associated with smoking and premature mortality from these conditions. Whilst some progress has been made in this important area, a number of limitations persist. First, despite the fact that 80% of smokers reside in LMICs (Pampel 2005, Pampel 2008, Pampel and Denney 2011, Hosseinpoor, Parker et al. 2012, Ng, Freeman et al. 2014, Thomas and Hefler 2016) and that depression is very common and burdensome in these settings (Gelaye, Rondon et al. 2016), there is a paucity of studies from these regions. Second, relatively little information about correlates of smoking is known in LMICs and understanding such information is a potentially important factor for public health interventions (Anderson, Becher et al. 2016). Furthermore exploring smoking correlates in LMICs is of relevance as findings in high income countries may not be generalizable to LMICs given different reasons for smoking (e.g., more stressful and poor living conditions) (Stubbs, Veronese et al. 2017), the lack of knowledge regarding the health disadvantages of smoking (Chow, Corsi et al. 2017) and different socio-cultural views regarding smoking (Hosseinpoor, Parker et al. 2011). Third, there is a paucity of multinational studies that have adopted the same methods to enable country and region specific comparisons across diverse regions on the relationship between smoking and depression. Fourth, little is known about the relationship between smoking and the different classifications and subtypes of depression such as subsyndromal, brief depressive episode and depressive episodes.

Given the aforementioned gaps in the current literature, a large population-wise cross-sectional survey across 48 LMICs investigating the associations of depression (including subsyndromal, brief depressive episode and depressive episodes) and smoking was conducted.

**METHODS**

***Data source***

Secondary data analysis of the World Health Survey (WHS) was conducted. This was a cross-sectional study undertaken in 2002-2004 in 70 countries worldwide. The data are publically available through the WHO website (<http://www.who.int/healthinfo/survey/en/>). Data were collected using single-stage random sampling and stratified multi-stage random cluster sampling in 10 and 60 countries respectively. Full details of the WHS are available in the above-mentioned WHO website. In brief, individuals aged ≥18 years with a valid home address were eligible to participate. Each member of the household had equal probability of being selected by utilizing Kish tables. A standardized questionnaire, translated accordingly was used across all countries. Linguists were utilized to ensure that the translation was conducted to a high standard.

 The individual response rate (i.e., ratio of completed interviews among selected respondents after excluding ineligible respondents from the denominator) ranged from 63% (Israel) to 99% (Philippines) (Moussavi, Chatterji et al. 2007). Ethical approval to conduct the study was obtained from the ethical boards at each study site. Informed consent was obtained from all participants.

Sampling weights were generated to adjust for non-response and the population distribution reported by the United Nations Statistical Division.

 Of the 70 countries, data were publicly available for 69. Of these, 10 countries (Austria, Belgium, Denmark, Germany, Greece, Guatemala, Italy, Netherlands, Slovenia, and UK) were excluded due to lack of data on sampling information. Furthermore, 10 high-income countries (Finland, France, Ireland, Israel, Luxembourg, Norway, Portugal, Spain, Sweden, United Arab Emirates) were excluded in order to focus on LMICs. Moreover, Turkey was also excluded due to missing information on some of the variables of interest. Thus, the final sample consisted of 48 countries (n=242,952) which corresponded to 21 low-income and 27 middle-income countries according to the World Bank classification at the time of the survey (2003). According to the United Nations’ classification system (http://unstats.un.org/unsd/methods/m49/m49regin.htm), these countries corresponded to 20 countries in Africa (n=82,424), 6 in the Americas (n=62,732), 13 in Asia (n=81,633), and 9 in Europe (n=16,163). The data were nationally representative for all countries with the exception of China, Comoros, the Republic of Congo, Ivory Coast, India, and Russia.

***Variables***

*Current smoking (outcome variable)*

The question ‘Do you currently smoke any tobacco products such as cigarettes, cigars, or pipes?’ with the answer options being ‘daily’, ‘yes, but not daily’, or ‘no, not at all’ was used to identify current smokers. Those who replied ‘daily’ or ‘yes, but not daily’ were considered to be current smokers.

*Depression (exposure variable)*

Depressive symptoms were classified based on individual questions from the WHS version of the World Health Organization World Mental Health Composite International Diagnostic Interview which captures the duration and persistence of depressive symptoms in the preceding 12 months (Kessler and Ustun 2004). The same algorithm as in a previously published paper from the WHS (Ayuso-Mateos, Nuevo et al. 2010) was utilized, which includes four mutually exclusive groups based on the ICD-10 Diagnostic Criteria for Research (ICD-10-DCR) (World Health Organization 1993) where criterion B referred to symptoms of depressed mood, loss of interest, and fatigability. The algorithms used to define the four groups were the following: (a) Depressive episode group: At least two criterion B symptoms with a total of at least four depressive symptoms lasting two weeks most of the day or all of the day. (b) Brief depressive episode group: Same criteria as depressive episode but did not meet the two-week duration criterion. (c) Subsyndromal depression: At least one criterion B symptom with the total number of symptoms being three or less, lasting two weeks most of the day or all of the day. The criteria of duration of at least two weeks and presence of symptoms during most of the day had to be met. (d) No depressive disorder group: None of the above. In the current analysis, any depression refers to the presence of depressive episode, brief depressive episode, or subsyndromal depression.

*Control variables*

The control variables included age, sex, wealth quintiles, highest education attained (no formal education, primary education, secondary completed, or tertiary education completed), marital status (married/cohabiting, never married, separated/divorced/widowed), setting (rural or urban), self-reported health (not poor or poor), and alcohol consumption (lifetime abstainer, non-heavy, infrequent heavy, frequent heavy). Country-wise wealth quintiles were created using principal component analysis based on 15-20 assets including country-specific items for some countries. Self-rated health was assessed by the question ‘In general, how would you rate your health today?’ with answer options very good, good, moderate, bad, and very bad. Those who answered bad or very bad were considered to have poor self-rated health. Alcohol consumption was assessed by first asking the question ‘Have you ever consumed a drink that contains alcohol (such as beer, wine, etc)?’ Respondents who replied ‘no’ were considered lifetime abstainers. If the respondent replied affirmatively, then he/she was asked how many standard drinks of any alcoholic beverage he/she had on each day of the past 7 days. The number of days in the past week in which 4 (female) or 5 (male) drinks were consumed was calculated (World Health Organization 2002), and a total of 1-2 and >3 days in the past 7 days were considered infrequent and frequent heavy drinking respectively. All other respondents, apart from lifetime abstainers, were considered non-heavy drinkers. The selection of these control variables was based on past literature (Byeon 2015).

*Statistical analysis*

Descriptive analysis was conducted to characterize the study sample. Multivariable binary logistic regression analyses were used to estimate the association between depression (exposure) and current smoking (outcome). First, this was done by using the overall and region-wise samples with the four-category variable on depression types as the exposure variable while adjusting for age (18-29, 30-39, 40-49, 50-59, 60-69, 70-79, ≥80 years), sex, wealth, education, marital status, setting (rural or urban), self-reported health, alcohol consumption, and country. Second, in order to assess whether the association between depression and smoking is consistent across countries, we conducted country-wise binary logistic regression analysis with any depression as the exposure variable while adjusting for age (18-34, 35-69, ≥60 years) and sex. In this analysis, we used a variable with fewer categories for age to obtain more stable estimates, as the sample size was small in some countries. The estimates for each country were also combined into a random-effect meta-analysis with the Higgins’ I2 statistic being calculated. The Higgins’ I2 represents the degree of inconsistency between countries that is not explained by sampling error with a value of <40% often considered as negligible and 40-50% as moderate inconsistency (Higgins and Thompson 2002).

 Adjustment for country was conducted by including dummy variables for each country as in previous WHS publications (Stubbs, Koyanagi et al. 2016, Koyanagi, Oh et al. 2017). All variables were included in the models as categorical variables. Results from the binary logistic regression models are presented as odds ratios (ORs) with 95% confidence intervals (95%CIs). The level of statistical significance was set at P<0.05. The sample weighting and the complex study design were taken into account in all analyses with Taylor linearization methods. Analyses were conducted with Stata statistical software version 14.1 (Stata Corp LP, College Station, Texas).

**RESULTS**

The final sample included 242,952 people with an average age (SD) of 38.4 (16.1) years and 50.8% were females. The prevalence of current smoking and any depression by country is demonstrated in **Table 1**. The prevalence of smoking ranged widely between countries with the lowest and highest prevalence observed in Ethiopia (3.9%) and Bangladesh (44.6%) respectively. Most countries with low prevalence of smoking were from Africa while countries with prevalence >40% also included Bosnia and Herzegovina (44.0%), Latvia (42.1%), Nepal (41.1%), and Laos (40.5%). In terms of the prevalence of depression, this ranged from 0.6% (Vietnam) to 31.8% (Morocco), with countries with low prevalence mostly concentrated in Asia.

*Insert table 1 here*

The overall and region-wise sample characteristics are shown in **Table 2**. Overall, the prevalence of current smoking was lowest in Africa (13.5%) while the prevalence exceeded 30% in Asia (32.2%) and Europe (30.2%). Depressive episode was present in 6.7% of the individuals overall with the highest prevalence observed in the Americas (10.6%). Europe was distinctly different from other continents as it consisted of older individuals, more females and individuals with higher education, while alcohol consumption was most common.

*Insert table 2 here*

The association of depression type and other characteristics with current smoking estimated by multivariable binary logistic regression is shown in **Table 3**. In the overall sample, compared to no depression, subsyndromal depression, brief depressive episode, and depressive episodes were all significantly associated with smoking with similar effect size (OR 1.36-1.49). However, in the region-wise analyses, the association between depression subtypes and smoking differed by region. For example, smoking was significantly associated with subsyndromal depression and brief depressive episode only in the Americas/Asia and Asia/Europe respectively, while depressive episode was significantly associated with smoking in all regions apart from Asia. In terms of other correlates of smoking, age patterns differed by region while alcohol consumption was consistently and strongly associated with smoking across all regions. Notably, males were substantially more likely to smoke across all regions versus females and smoking was consistently less common in population who were wealthier and those with a higher degree of education (data in table 3).

*Insert table 3 here*

Finally, in the country-wise meta-analysis (**Figure 1**), any depression was significantly associated with smoking in nearly half of the countries with the OR (95%CI) for individual countries ranging from 0.72 (0.40-1.29) in Zimbabwe to 2.47 (1.45-4.19) in Czech Republic. The pooled overall OR (95%CI) was 1.42 (1.32-1.52) with a moderate-low level of inconsistency being observed (I2=39.7%).

*Insert figure 1 here*

**Discussion**

To the best of our knowledge, the current study is the first multinational study to investigate the relationship between smoking and the depression spectrum in LMICs and our data contain a number of potentially relevant results. First, our data suggest that in the overall sample, all subtypes of depression were associated with current smoking (OR 1.36-1.49), although there was some variation in each of the four major geographical regions. Second, our data found consistent and strong evidence for greatly increased current smoking in males across all regions. In addition, current smoking was lower in those with higher education and income. Finally, we found that current smoking was frequently accompanied by alcohol consumption.

These data provide compelling evidence that smoking is a major public health issue among people with depression spectrum in LMICs and it is likely that the premature mortality in people with depression may be partly attributable to smoking related diseases (Correll, Solmi et al. 2017). Previous research in predominantly high income countries has confirmed this high level of comorbidity, and has suggested that this relationship is bidirectional (Fluharty, Taylor et al. 2017). This suggests that the interplay of environmental or genetic factors may have a key role in explaining this relationship (Tsuang, Francis et al. 2012). Although a meta-analysis of Mendelian Randomization studies could not establish the causality of the association of depression and smoking, included studies were limited by the use of relatively weak instrumental (i.e., genetic) variables (Taylor, Fluharty et al. 2014). Furthermore, a previous study found among 8319 male twins that there was a significant genetic influence of major depression, smoking and nicotine withdrawal symptoms (Lyons, Hitsman et al. 2008). Cleary, there are other important environmental shared characteristics that may also explain this relationship. For instance, alcohol use disorder is known to be highly comorbid with both depression (Beaulieu, Saury et al. 2012, Briere, Rohde et al. 2014) and smoking (Grucza and Bierut 2006, Cavazos-Rehg, Breslau et al. 2014) and we found in our study that alcohol use was strongly related to smoking and depression. This suggests that in order to address the issue of the high levels of smoking in depression, a multifaceted approach is required. Indeed, previous research has shown that smoking cessation resulted in reductions in both depressive symptoms and drinking among adolescents (Cavazos-Rehg, Breslau et al. 2014).

The finding of the high levels of comorbidity between smoking and depression in our study is of public health relevance given the increased premature death among male smokers (Peters, Huxley et al. 2014) and males with depression (Cuijpers, Vogelzangs et al. 2014). Whilst targeting smoking cessation should be aimed at all smokers, a particular focus among male smokers with depression may be important given the relationships we observed. Interestingly, we also found that there were high levels of smoking in people with subsyndromal depression or brief depressive episodes, with a broadly similar magnitude to major depression. Thus, our data suggest that any interventions that seek to address the high levels of smoking in people with depression should also consider the entire depression spectrum. Previous research that has analysed population trends of smoking rates in nationally representative data has found that rates amongst people with mental illnesses such as depression are not declining at the same rate as people without metal illness (Cook, Wayne et al. 2014). This suggests that targeted and tailored individualised interventions which take into account other explanatory factors (e.g., alcohol use) are required to be successful. In addition, it should be noted that the use of first-line pharmacological agents (e.g., varenicline, nicotine replacement therapy) for smoking cessation appear safe and effective (Roberts, Eden Evins et al. 2016) in people with depression.

In our country wide meta-analysis we found some variation in the relationship between smoking and depression. For instance, higher comorbidity was seen in Croatia and the Czech Republic, while there was no evidence for a significant association between smoking and depression in Zimbabwe. The exact reasons for this finding are unclear, but may be related to differences in social factors and affordability. However, research is required to explore such geographical variations. Interestingly, we found that low income and education were associated with higher odds of smoking and depression. The reasons for this are unclear and clearly warrant further investigation, particularly given that poorer and less well educated people already experience a shortened life expectancy. This seems a double travesty for the poorest people in these regions, with previous research suggesting that in some regions such as China, 10% of their total household expenditures are on cigarettes (Hu, Mao et al. 2005). In order to address this poverty trap, previous research has suggested that interventions to reduce the burden of tobacco related ill health should also be directed at poverty itself and on improving the standard of living among smokers (Peretti-Watel, Seror et al. 2009).

Given the current findings, it would seem necessary that greater attention should be devoted to understanding and reducing the problem of smoking among people across the depression spectrum in the community and interventions should not be limited to those who seek help. As smoking seems to be strongly related to alcohol consumption, it may be beneficial to target both behaviours together. Public health and clinical efforts are needed to reduce smoking among persons with current depression and to improve outcomes when those with depression attempt to quit smoking. While there may be concerns about smoking abstinence leading to an increase in depressive symptoms, recent reviews of the literature have reported that quitting smoking does not increase depressive symptoms in the general population and in adults with depressive disorders (Taylor, McNeill et al. 2014, Weinberger, Kashan et al. 2017). Second our findings of differing effects by gender may have implications for how and which policies should be prioritised, especially in countries in which there are large differences between male and female smoking rates. Previous research did show that women's quitting behavior may be more responsive to certain policy or environment factors, such as knowledge and social unacceptability (Chow, Corsi et al. 2017). In particular, the degree of social unacceptability and knowledge of the health impacts of smoking are clearly important overall in motivating quitting, but especially so for women (Chow, Corsi et al. 2017). Another important area of future research is to consider the potential mediating role of smoking on premature mortality among people with depression and the potential impact of smoking cessation on life expectancy in this population.

Whilst our data provide a number of novel insights, some study design limitations need to be considered. First of all, due to the cross-sectional design of the study, causality or temporal associations cannot be established. However, as mentioned above it is likely that a bidirectional relationship exists between smoking and depression. Second, potential confounding variables may mediate the association between depression and smoking which we could not cater for such as genetic factors. Third, whilst the outcomes have been used previously in numerous publications, it should be noted that smoking behavior and depression were self-reported. Fourth, whilst we considered the relationship between the depression spectrum and smoking, we could not consider the relationship between smoking and bipolar disorder. Future research should consider this important research question. Finally, we did not have information on medication (e.g., antidepressant or smoking cessation medication).

**Conclusion**

In conclusion, we found a consistent relationship between the depression spectrum and smoking behaviour across 48 countries. Notably, we found that males, people with lower income/lower education and those that use alcohol had high levels of comorbidity. Given the fact that most of the world’s smokers reside in LMICs, clearly future interventions are required to prevent the premature mortality from smoking related diseases in depressed smokers. The development of health systems to identify and target people with depression who smoke may be warranted to address this high level of comorbidity and ultimately prevent premature mortality in this group.

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**Conflict of interest**

All authors report no conflict of interest

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| **Table 1** Prevalence of current smoking and any depression by region and country |
|   |   |   | Current smoking | Any depressiona |
| Region | Country | N | % | 95%CI | % | 95%CI |
| Africa | Burkina Faso | 4,948 | 17.5 | [15.3,19.9] | 17.1 | [14.4,20.3] |
|  | Chad | 4,870 | 11.0 | [9.3,13.0] | 18.7 | [16.2,21.5] |
|  | Comoros | 1,836 | 22.5 | [19.5,25.8] | 8.3 | [6.8,10.1] |
|  | Congo | 3,075 | 8.7 | [6.9,10.8] | 12.3 | [9.3,16.1] |
|  | Ethiopia | 5,089 | 3.9 | [3.0,5.0] | 12.2 | [11.0,13.6] |
|  | Ghana | 4,165 | 5.6 | [4.7,6.5] | 8.4 | [7.2,9.9] |
|  | Ivory Coast | 3,251 | 13.3 | [11.7,15.2] | 12.2 | [10.5,14.1] |
|  | Kenya | 4,640 | 14.3 | [11.8,17.3] | 13.3 | [11.3,15.6] |
|  | Malawi | 5,551 | 15.6 | [14.4,17.0] | 10.1 | [8.9,11.4] |
|  | Mali | 4,886 | 14.2 | [12.8,15.8] | 9.6 | [8.4,11.0] |
|  | Mauritania | 3,902 | 17.0 | [15.1,19.1] | 6.6 | [5.2,8.4] |
|  | Mauritius | 3,968 | 22.5 | [20.6,24.4] | 10.7 | [9.2,12.3] |
|  | Morocco | 5,000 | 16.2 | [13.9,18.8] | 31.8 | [28.8,35.0] |
|  | Namibia | 4,379 | 19.9 | [17.9,22.1] | 7.2 | [6.1,8.4] |
|  | Senegal | 3,461 | 12.7 | [10.9,14.7] | 15.5 | [13.6,17.5] |
|  | South Africa | 2,629 | 25.3 | [22.9,27.8] | 7.2 | [5.8,9.0] |
|  | Swaziland | 3,117 | 8.4 | [6.9,10.1] | 10.9 | [8.9,13.2] |
|  | Tunisia | 5,202 | 27.5 | [25.8,29.3] | 11.0 | [9.5,12.6] |
|  | Zambia | 4,165 | 14.5 | [13.2,16.0] | 8.0 | [7.0,9.2] |
|  | Zimbabwe | 4,290 | 14.4 | [12.8,16.1] | 5.6 | [4.7,6.7] |
| Americas | Brazil | 5,000 | 22.4 | [20.9,24.0] | 22.6 | [21.0,24.3] |
|  | Dominican Republic | 5,027 | 15.0 | [13.5,16.5] | 16.1 | [14.6,17.8] |
|  | Ecuador | 5,675 | 18.1 | [16.0,20.3] | 8.0 | [6.6,9.8] |
|  | Mexico | 38,746 | 25.3 | [24.4,26.2] | 10.8 | [10.2,11.4] |
|  | Paraguay | 5,288 | 27.3 | [25.8,28.9] | 10.6 | [9.6,11.7] |
|  | Uruguay | 2,996 | 33.4 | [31.0,35.9] | 9.1 | [8.1,10.2] |
| Asia | Bangladesh | 5,942 | 44.6 | [42.5,46.7] | 18.1 | [16.3,20.0] |
|  | China | 3,994 | 30.0 | [27.9,32.1] | 2.0 | [1.4,2.9] |
|  | Georgia | 2,950 | 31.4 | [29.4,33.5] | 10.7 | [8.6,13.3] |
|  | India | 10,687 | 35.9 | [33.2,38.6] | 13.9 | [12.3,15.7] |
|  | Kazakhstan | 4,499 | 30.0 | [27.1,33.1] | 6.8 | [5.0,9.3] |
|  | Laos | 4,988 | 40.5 | [38.2,42.9] | 2.7 | [2.2,3.2] |
|  | Malaysia | 6,145 | 28.1 | [26.7,29.6] | 2.9 | [2.4,3.7] |
|  | Myanmar | 6,045 | 30.9 | [28.7,33.3] | 0.9 | [0.6,1.5] |
|  | Nepal | 8,820 | 41.1 | [39.5,42.7] | 16.8 | [15.8,17.9] |
|  | Pakistan | 6,501 | 20.2 | [18.2,22.2] | 10.1 | [9.1,11.2] |
|  | Philippines | 10,083 | 35.0 | [33.6,36.4] | 4.8 | [4.2,5.5] |
|  | Sri Lanka | 6,805 | 22.2 | [20.3,24.2] | 2.9 | [2.4,3.6] |
|  | Vietnam | 4,174 | 26.2 | [23.6,28.9] | 0.6 | [0.4,0.9] |
| Europe | Bosnia Herzegovina | 1,031 | 44.0 | [37.4,50.8] | 8.3 | [5.8,11.9] |
|  | Croatia | 993 | 26.6 | [23.6,29.8] | 13.6 | [11.4,16.2] |
|  | Czech Republic | 949 | 31.8 | [27.5,36.4] | 12.6 | [10.2,15.5] |
|  | Estonia | 1,020 | 39.1 | [36.1,42.2] | 14.6 | [12.8,16.6] |
|  | Hungary | 1,419 | 36.8 | [33.9,39.7] | 11.4 | [9.5,13.5] |
|  | Latvia | 929 | 42.1 | [38.0,46.3] | 13.1 | [10.6,16.0] |
|  | Russia | 4,427 | 27.5 | [24.9,30.3] | 11.6 | [9.9,13.5] |
|  | Slovakia | 2,535 | 30.7 | [26.2,35.6] | 10.3 | [6.5,16.0] |
|   | Ukraine | 2,860 | 30.3 | [27.8,32.8] | 13.0 | [10.8,15.4] |

Abbreviation: CI Confidence interval

Data are unweighted N and weighted %.

a Any depression refers to subsyndromal depression, brief depressive episode, or depressive episode.

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| --- |
| **Table 2** Sample characteristics (overall and by region) |
| Characteristic |  Category | Overall | Africa | Americas | Asia | Europe |
| Current smoking | Yes | 26.5 | 13.5 | 23.3 | 32.2 | 30.2 |
| Depression type | No depression | 87.9 | 87.1 | 83.2 | 89.6 | 87.9 |
|  | Subsyndromal depression | 2.5 | 2.6 | 2.0 | 2.7 | 1.7 |
|  | Brief depressive episode | 2.9 | 3.6 | 4.1 | 1.8 | 5.2 |
|  | Depressive episode | 6.7 | 6.7 | 10.6 | 5.8 | 5.2 |
| Age (years) | 18-29 | 36.9 | 43.4 | 35.2 | 37.9 | 18.5 |
|  | 30-39 | 21.6 | 22.0 | 22.6 | 21.8 | 16.9 |
|  | 40-49 | 17.0 | 15.3 | 17.7 | 16.9 | 19.6 |
|  | 50-59 | 11.6 | 9.7 | 12.3 | 11.6 | 14.8 |
|  | 60-69 | 7.6 | 6.0 | 7.0 | 7.2 | 14.2 |
|  | 70-79 | 4.2 | 2.9 | 3.9 | 3.5 | 12.5 |
|  | ≥80 | 1.2 | 0.7 | 1.4 | 1.0 | 3.5 |
| Sex | Female | 50.8 | 51.1 | 51.5 | 49.1 | 58.4 |
| Education | No formal | 26.5 | 37.2 | 6.3 | 33.7 | 0.7 |
|  | Primary | 30.9 | 35.6 | 34.1 | 31.4 | 8.9 |
|  | Secondary completed | 33.5 | 22.5 | 54.6 | 26.3 | 57.2 |
|  | Tertiary completed | 9.2 | 4.6 | 4.9 | 8.6 | 33.3 |
| Marital status | Married/cohabiting | 66.1 | 59.5 | 62.3 | 71.6 | 57.1 |
|  | Never married | 23.6 | 30.3 | 26.5 | 21.1 | 15.6 |
|  | Separated/divorced/widowed | 10.3 | 10.2 | 11.2 | 7.2 | 27.3 |
| Setting | Rural | 56.6 | 62.1 | 21.6 | 71.6 | 25.5 |
|  | Urban | 43.4 | 37.9 | 78.4 | 28.4 | 74.5 |
| Self-rated health | Poor | 9.6 | 7.9 | 7.1 | 9.6 | 18.9 |
| Alcohol consumption | Lifetime abstainer | 66.4 | 72.7 | 32.9 | 84.0 | 22.0 |
|  | Non-heavy | 28.8 | 21.9 | 58.3 | 13.8 | 68.0 |
|  | Infrequent heavy | 3.7 | 3.8 | 7.6 | 1.6 | 7.8 |
|   | Frequent heavy | 1.0 | 1.6 | 1.3 | 0.5 | 2.2 |

Data are weighted column %.

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| **Table 3** Association of depression type, sociodemographics, self-rated health, and alcohol consumption with current smoking estimated by multivariable binary logistic regression (overall and by region) |
|   |   | Overall | Africa | Americas | Asia | Europe |
|  Characteristic |  Category | OR | 95%CI | OR | 95%CI | OR | 95%CI | OR | 95%CI | OR | 95%CI |
| Depression type | No depression | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  |
|  | Subsyndromal depression | 1.49\*\*\* | [1.28,1.75] | 1.40 | [0.99,1.97] | 1.72\*\* | [1.21,2.44] | 1.41\*\* | [1.13,1.75] | 1.03 | [0.64,1.67] |
|  | Brief depressive episode | 1.36\*\*\* | [1.19,1.55] | 1.18 | [0.93,1.48] | 1.22 | [0.94,1.57] | 1.31\* | [1.05,1.64] | 1.62\*\* | [1.19,2.21] |
|  | Depressive episode | 1.41\*\*\* | [1.25,1.58] | 1.35\*\*\* | [1.13,1.60] | 1.53\*\*\* | [1.30,1.81] | 1.18 | [0.98,1.41] | 1.61\*\*\* | [1.22,2.13] |
| Age (years) | 18-29 | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  |
|  | 30-39 | 1.63\*\*\* | [1.51,1.75] | 1.56\*\*\* | [1.35,1.81] | 1.13 | [0.99,1.29] | 1.88\*\*\* | [1.68,2.09] | 0.92 | [0.73,1.17] |
|  | 40-49 | 1.98\*\*\* | [1.82,2.16] | 1.94\*\*\* | [1.65,2.28] | 1.37\*\*\* | [1.18,1.59] | 2.40\*\*\* | [2.11,2.74] | 0.75\* | [0.58,0.96] |
|  | 50-59 | 1.73\*\*\* | [1.56,1.91] | 1.82\*\*\* | [1.52,2.19] | 1.08 | [0.92,1.27] | 2.32\*\*\* | [1.99,2.70] | 0.47\*\*\* | [0.37,0.61] |
|  | 60-69 | 1.38\*\*\* | [1.24,1.54] | 1.34\* | [1.07,1.67] | 0.86 | [0.70,1.05] | 2.11\*\*\* | [1.79,2.48] | 0.23\*\*\* | [0.17,0.32] |
|  | 70-79 | 0.90 | [0.77,1.05] | 1.04 | [0.81,1.33] | 0.58\*\*\* | [0.46,0.74] | 1.60\*\*\* | [1.29,1.98] | 0.11\*\*\* | [0.07,0.18] |
|  | ≥80 | 0.75\* | [0.59,0.95] | 1.71\* | [1.13,2.60] | 0.52\*\* | [0.34,0.77] | 1.12 | [0.75,1.68] | 0.08\*\*\* | [0.04,0.14] |
| Sex | Female | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  |
|  | Male | 5.42\*\*\* | [5.07,5.79] | 7.19\*\*\* | [6.29,8.21] | 1.98\*\*\* | [1.79,2.20] | 7.51\*\*\* | [6.78,8.32] | 6.42\*\*\* | [5.38,7.67] |
| Wealth | Poorest | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  |
|  | Poorer | 0.88\*\* | [0.82,0.95] | 0.86 | [0.75,1.00] | 0.90 | [0.77,1.06] | 0.84\*\* | [0.76,0.94] | 0.87 | [0.70,1.07] |
|  | Middle | 0.83\*\*\* | [0.76,0.90] | 0.85\* | [0.73,0.99] | 0.78\*\* | [0.66,0.91] | 0.78\*\*\* | [0.69,0.87] | 0.79 | [0.61,1.02] |
|  | Richer | 0.76\*\*\* | [0.69,0.83] | 0.78\*\* | [0.65,0.92] | 0.74\*\*\* | [0.63,0.88] | 0.70\*\*\* | [0.61,0.80] | 0.66\*\* | [0.50,0.86] |
|  | Richest | 0.63\*\*\* | [0.57,0.69] | 0.63\*\*\* | [0.52,0.76] | 0.87 | [0.72,1.05] | 0.50\*\*\* | [0.43,0.58] | 0.58\*\*\* | [0.44,0.76] |
| Education | No formal | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  |
|  | Primary | 0.68\*\*\* | [0.62,0.74] | 1.05 | [0.92,1.21] | 0.46\*\*\* | [0.36,0.59] | 0.68\*\*\* | [0.61,0.76] | 1.07 | [0.55,2.07] |
|  | Secondary completed | 0.52\*\*\* | [0.47,0.57] | 0.92 | [0.77,1.11] | 0.31\*\*\* | [0.24,0.40] | 0.52\*\*\* | [0.46,0.59] | 0.98 | [0.50,1.92] |
|  | Tertiary completed | 0.38\*\*\* | [0.33,0.43] | 0.52\*\*\* | [0.39,0.70] | 0.25\*\*\* | [0.16,0.38] | 0.34\*\*\* | [0.28,0.41] | 0.82 | [0.41,1.63] |
| Marital status | Married/cohabiting | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  |
|  | Never married | 0.92\* | [0.85,1.00] | 1.12 | [0.98,1.28] | 0.98 | [0.86,1.12] | 0.80\*\*\* | [0.71,0.91] | 0.76\* | [0.60,0.97] |
|  | Separated/divorced/widowed | 1.45\*\*\* | [1.33,1.58] | 1.49\*\*\* | [1.26,1.76] | 1.45\*\*\* | [1.23,1.72] | 1.67\*\*\* | [1.46,1.92] | 1.15 | [0.94,1.41] |
| Setting | Rural | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  |
|  | Urban | 1.06 | [0.99,1.14] | 1.16 | [0.99,1.36] | 1.35\*\*\* | [1.17,1.55] | 0.95 | [0.85,1.06] | 1.18 | [0.98,1.43] |
| Self-rated health | Not poor | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  |
|  | Poor | 1.05 | [0.96,1.14] | 1.24\* | [1.04,1.47] | 1.22\* | [1.01,1.48] | 1.06 | [0.94,1.20] | 1.04 | [0.83,1.30] |
| Alcohol  | Lifetime abstainer | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  |
| consumption | Non-heavy | 3.84\*\*\* | [3.58,4.12] | 4.30\*\*\* | [3.73,4.96] | 3.46\*\*\* | [3.05,3.91] | 4.11\*\*\* | [3.69,4.58] | 3.10\*\*\* | [2.44,3.94] |
|  | Infrequent heavy | 7.57\*\*\* | [6.72,8.52] | 7.59\*\*\* | [6.13,9.41] | 7.03\*\*\* | [5.72,8.63] | 7.83\*\*\* | [6.43,9.52] | 6.45\*\*\* | [4.63,8.98] |
|   | Frequent heavy | 6.82\*\*\* | [5.25,8.86] | 6.68\*\*\* | [4.94,9.03] | 9.86\*\*\* | [5.83,16.67] | 5.62\*\*\* | [3.28,9.62] | 5.80\*\*\* | [3.10,10.88] |

Abbreviation: OR odds ratio; CI Confidence interval

Models are mutually adjusted for all variables in the respective columns and country.

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001



**Figure 1** Country-wise association between any depression (independent variable) and current smoking (dependent variable) estimated by binary logistic regression adjusted for sex and age

Abbreviation: OR odds ratio; CI confidence interval

Any depression refers to subsyndromal depression, brief depressive episode, or depressive episode.

Estimates for Vietnam could not be calculated due to the small number of individuals with any depression.

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