

Comprehensive assessment of depression risk and its behavioral determinants among adolescents: a multi-country study

Sabera Sultana (✉ suravi15@yahoo.com)

The University of Tokyo

Md. Mizanur Rahman

The University of Tokyo

Masahiro Hashizume

The University of Tokyo

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Abstract

Background: Mental illness has become a widespread public health concern internationally. This study aimed to generate a depression risk index for adolescents. Furthermore, we developed risk indexes for potential lifestyle and social risk factors of depression among adolescents. In addition, we investigated the country-specific prevalence for each risk index. Finally, we conducted comprehensive assessment of the associations between depression risk and lifestyle and social risk factors.

Methods: We used the most recent data available from 20 nationally representative Global School-based Student Health Surveys. Our analytical sample included 51,597 adolescents. The outcome of interest was depression risk, which considered feelings of anxiety, loneliness, and suicidal attempts or tendencies. We developed four lifestyle risk indexes (dietary habits, physical activity, sedentary behavior, and tobacco use) and three social risk indexes (exposure to school violence, interactions with parents, and interactions with friends) which were considered as exposure variables in this study. Multilevel logistic regression models were used to estimate adjusted odds ratios (ORs) with 95% confidence intervals (CIs).

Results: In total, 26.4% of the participants had a risk of depression. Increased odds of depression risk were found among participants with high risk index values for unhealthy dietary habits (OR, 1.15; 95% CI, 1.07–1.23), unhealthy sedentary behavior (OR, 1.53; 95% CI, 1.43–1.63), tobacco use (OR, 1.57; 95% CI, 1.41–1.76), exposure to school violence (OR, 3.06; 95% CI, 2.88–3.26), insufficient interactions with parents (OR, 2.09; 95% CI, 1.92–2.28), and insufficient interactions with friends (OR, 1.82; 95% CI, 1.69–1.96) compared with participants with low risk index values. However, there were no significant associations between physical inactivity and risk of depression among adolescent boys or girls.

Conclusions: High prevalence rates for depression risk, as well as unhealthy lifestyle factors and social behaviors among adolescents were found in every country, and higher risk index values were associated with increased risk of depression.

Introduction

The global prevalence of depression among adolescents is increasing internationally,[1] with an increase of 18% between 2005 and 2015.[2] Because of stark differences between countries, depression was traditionally considered to be a problem that primarily affected first world countries. However, recent studies have reported that most countries have relatively similar rates of depression, but social stigma, lack of data availability, and non-recognition of mental illness are more common in developing countries.[3-4] Previous research indicated that the regions with the highest rates of depression were eastern Europe, North Africa and the Middle East, and, by country, the highest number of years lost because of depression-related disability was in Afghanistan.[4]

Mental health conditions account for 16% of the global burden of disease and injury in people 10–19 years of age.[5] Depression is the leading cause of global disability, and unipolar depression is the 10th leading cause of early death. [5] A clear link has been established between depression and suicide, which is the third leading cause of death for young people aged 15–29 years.[5] Depression not only affects psychological health but also increases the risk of cardiovascular disease, diabetes and cancer.[6-7] Depression can also lead to serious social and educational impairments, smoking, substance abuse, and obesity among adolescents.[8-11] Moreover, depression takes an economic toll on individuals, families, organizations, and society. On the basis of data from 2010, the World

Economic Forum estimated that the combined direct and indirect cost of mental disorders was US\$2.5 trillion, and this cost is predicted to reach US\$6.1 trillion by 2030.[12]

Depression results from complex interactions between social, psychological, and biological factors. Increased access to and use of technology, peer and family relationships, quality of home life, unhealthy lifestyle behavior, violence and socioeconomic problems, and poor physical health are recognized as risk factors for adolescent depression. [5,13-15] Although adolescent depression is treatable, it often remains untreated because of difficulty in diagnosis and a lack of treatment services.[5,16] Between 76% and 85% of people with depression in low- and middle-income countries receive no treatment for their disorder.[16] In 2018, the American Academy of Pediatrics recommended regular depression screening for all adolescents 12 and over.[17] Early recognition of the risk of depression and identification of modifiable risk factors is critically needed to reduce the burden of depression.

Therefore, the current study aimed to develop a depression risk index by combining several psychological signs of adolescent depression, providing a quick and comprehensive tool for self-screening of depression risk. Furthermore, we generated risk indexes for potential lifestyle and social risk factors of depression among adolescents using cross-country data and assessed their relationships with depression risk index values. These findings will provide guidelines to reduce the risk of depression among adolescents through lifestyle and social behavioral modifications.

Methods

Data sources

We used data from the Global School-based Student Health Survey (GSHS) for this study. The data were downloaded from the Centers for Disease Control and Prevention (CDC) website (CDC Global School-based Student Health Survey (GSHS)). All countries with data available for 2013 or later were included, resulting in a total of 20 countries. For each country, we used only the latest available dataset in the study period. The GSHS used a two-stage cluster design to produce a nationally representative sample of all students enrolled in grades 7 to 11. The participants' ages ranged from 13 to 17 years. In the first stage of sampling, schools were selected with probability proportional to student enrollment. In the second stage, systematic random sampling was used to select classes from each sampled school. All students in the selected classes were eligible to participate. Survey procedures were designed to protect students' privacy by allowing for anonymous and voluntary participation. Details survey procedure of GSHS is available on WHO's website (Bangladesh - Global School-Based Student Health Survey 2014 (who.int)).[18] Participants who had missing values for any variable of interest were excluded from the study. The basic survey characteristics of the GSHS datasets are presented in **Table 1**. We used the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting. Because we used secondary data, public and patient involvement was not possible. Our study was exempted by the ethics committee of the university of Tokyo as we employed secondary data that are available for public use.

Legend:

CI: confidence interval

¹ Countries with Global School-based Student Health Survey data available for 2013 or later.

² Descriptive analyses were used to estimate mean age and percentage of depression risk among adolescents. Probability sampling weights were applied in all analyses.

Outcome variable

The outcome variable in this study was the risk of depression among adolescents. According to the CDC, anxiety and self-harming behaviors, including suicide, are common depressive symptoms among adolescents.[19] Another previous study reported that approximately 50% of all people diagnosed with depression are also diagnosed with anxiety disorder.[20] Moreover, one study reported that young people who are lonely are as much as three times more likely to develop depression in the future, and this finding was supported by subsequent studies.[21–23] Hence, we considered four components while developing a depression risk index for adolescents: frequency of anxiety, loneliness, thoughts of suicide, and suicide attempts in the last 1 year. Anxiety and loneliness had three cut-off points while thoughts of or attempts of suicide had two cutoff points because suicide was a severe indicator of depression.

One risk score corresponded to each cut-off point. Risk scores ranged from healthy (0) to unhealthy (2). The risk scores for each component were combined to produce a risk score range for each risk index. The risk score range was then categorized into three risk levels.[24] Lower risk index values represented lower risk levels, whereas higher risk index values represented higher risk levels. **Table 2** shows the components and composition of the depression risk index.

Exposure variables

Four risk indexes were developed for four lifestyle risk factors: dietary habits, physical activity, sedentary behavior and tobacco use. Three risk indexes were developed for three social risk factors: exposure to school violence, interactions with parents, and interactions with friends. These risk indexes were considered as the primary exposure variables in this study. The dietary risk index included four components: fruit, vegetables, fast foods, and carbonated soft drinks. Cut-off points were determined using World Health Organization (WHO) guidelines where available, or in accordance with previous literature.[25–27] To determine the risk index for physical activity, we used the WHO guidelines, which categorized adolescents as physically active if they were involved in vigorous physical movement for at least 60 minutes each day.[28]

The risk index for sedentary behavior was generated using the amount of time each day participants spent watching television, looking at tablets, or playing video games. We used the American Association of Pediatrics' recommendations for adolescent media use to set the cut-off points for different risk levels of unhealthy sedentary behavior.[29] The tobacco use risk index was developed using two components: cigarette smoking and the use of any other tobacco products. For adolescents, there are no safe limits, and there are no clear guidelines for classifying the use of tobacco products. We defined occasional, irregular, and frequent users of tobacco following a previous study and assigned three risk levels.[30]

The risk index for exposure to school violence was developed using four components: physical attacks, fights, injuries, and bullying.[31–32] The risk index for interactions with parents was developed considering two components: how frequently participants missed school without permission and how often they felt that their parents understood their problems. The risk index for interactions with friends was generated using two components: how frequently participants found their classmates to be kind and helpful, and the number of close friends they had. **Table 3** shows the components and composition of these risk indexes.

Detailed information regarding the four lifestyle risk indexes (dietary habits, physical activity, sedentary behavior and tobacco use) were provided elsewhere.[33]

Covariates

Covariates included the student's age (13–17 years), sex (boys or girls), and the experience of hunger in the past 30 days (never, rarely, sometimes, most of the time, or always), as well as the national literacy rate. Consistent with a previous study, the frequency of hunger because of insufficient food at home in the past 30 days was treated as a proxy variable for socioeconomic status.[34]

Data analyses

We used Cronbach's alpha to assess the internal reliability of the risk indexes (**supplementary table 1**). A descriptive analysis was performed to estimate summary statistics such as means, percentages, and 95% confidence interval (CIs). Following previous studies, we used multilevel logistic regression models to estimate odds ratios (ORs) and corresponding 95% CIs to assess the relationships between depression risk and its behavioral determinants among adolescents.[14–15] Let j denote the level-two units (countries) and let i denote the level-one units (items or observations). Assume that there are $j = 1, 2, \dots, C$ countries and $i = 1, 2, \dots, N_j$ individuals in each country. The multilevel regression model can be written as

$$\log \left(\frac{\pi_{ij}}{1 - \pi_{ij}} \right) = y_{ij} = X_{ij}\beta + Z_j\gamma + u_j + \epsilon_{ij}$$

where outcome y_{ij} for each adolescent i in country j is assumed to depend on both observed predictors and unobserved factors, y_{ij} is the log odds of adolescent i in country, and j being overweight or obese. β represents a vector of regression coefficients associated with the individual-level variables X_{ij} . These individual-level characteristics were the seven risk scores, age, gender, and socioeconomic status. Z_j contains variables summarizing the country-level characteristics such as the literacy rate in the study context. Unobserved individual effects are represented as ϵ_{ij} , and country effects are represented as u_j . In the multilevel model, ϵ_{ij} and u_j are assumed to be normally distributed and uncorrelated individual-level (X_{ij}) and country-level (Z_j) predictors. The parameters associated with the observed predictors β and γ are fixed regression parameters. Parameters ϵ_{ij} and u_j are treated as random terms. Stata/SE 15.0 (StataCorp, College Station, TX, USA) was used in this study for data management, statistical analysis, and graph generation. Probability sampling weights were applied in all descriptive analyses.

Results

Sample characteristics

A total of 83,695 adolescents aged 13–17 years were surveyed. Participants with missing values for any of the variables of interest were excluded from the analysis. This resulted in an analytical sample size of 51,597, representing a total adolescent population of 22,945,384 individuals, after applying the sampling weights. As shown in Table 1, 45% of the participants were boys, and the mean age was 14.8 years.

Country-specific scenarios of depression risk

As shown in Table 1, 26.4% of adolescents had risk of depression. The highest proportion of adolescents with a risk of depression was found in Afghanistan (50%), followed by Namibia (43%), Benin (40%), Kuwait (37%), Bahrain (37%), Yemen (37%), and Timor-Leste (32%). The lowest prevalence of depression risk was reported in Laos (12%) followed by Indonesia (13%) and Bangladesh (18%). **Supplementary Fig. 1** shows that depression risk among girls was highest in Afghanistan (59%), followed by Kuwait (44%), Bahrain (43%), Benin (43%), Yemen (42%), the Bahamas (36%), Mongolia (35%), and the Philippines (34%). In the countries included in this study, the risk of depression was reported to be higher among girls than among boys, except in Timor-Leste (boys: 26%; girls: 12%).

Country-specific scenarios of lifestyle and social risk indexes

Figure 1 shows the percentage of lifestyle and social risk indexes among adolescents in each country. The prevalence of unhealthy (moderate and high risk) dietary habits ranged from 77% (the Cook Islands) to 94% (Timor-Leste, Mongolia, Nepal). The highest percentage of physical inactivity was observed in the Philippines (91%) followed by Thailand (87%), Timor-Leste (87%), Tuvalu (86%), Indonesia (85%), and Brunei (85%), whereas the lowest percentage was seen in Bangladesh (48%). The prevalence of unhealthy (moderate and high risk) sedentary behavior varied from 34% (Nepal) to 88% (Kuwait). The prevalence of high-risk unhealthy sedentary behavior (daily sedentary time \geq 4 hours) was highest in Kuwait (42.0%), followed by Bahrain (37.2%), the Bahamas (34.4%), Thailand (31.1%), and Brunei (27.3%). Approximately 15% of adolescents in Kuwait, Bahrain, and Polynesia used tobacco. In the other countries in this study, less than 10% of adolescents reported using tobacco.

Overall, 27% of the participants were exposed to school violence (moderate and high risk). The prevalence of exposure to school violence (moderate and high risk) varied from 7% (Laos) to as high as 47% (Tuvalu). Around 25% adolescents in Nepal and Tuvalu, and around 20% adolescents in Namibia, Afghanistan, the Philippines, Timor-Leste, Yemen, and Bangladesh reported a high risk of exposure to school violence. Furthermore, 71% of participants had insufficient interactions with parents (moderate and high risk). The prevalence of insufficient interactions with parents (moderate and high risk) was lowest in Nepal (56%) and highest in Timor-Leste (93%). Around 20% adolescents in Bahrain, Kuwait, Timor-Leste, Laos, Tuvalu, Yemen, Brunei, and the Philippines had a high risk of insufficient interactions with parents. 62% of participants had insufficient interactions with friends (moderate and high risk). The highest proportions of adolescents with insufficient interactions with friends (moderate and high risk) were observed in Benin and Laos (82%) and the lowest proportion was observed in Bahrain (37%). Around 17% adolescents in Tuvalu, Namibia, Afghanistan, and Benin reported a high risk of insufficient interactions with friends.

Gender-based lifestyle factors and social risk index values

The prevalence of unhealthy dietary habits was similar for boys and girls, but in most examined countries, girls were 5–20% more physically inactive than boys. The largest gender differences in physical inactivity were observed in Laos (boys: 73% vs. girls: 91%), followed by Brunei (boys: 78% vs. girls: 93%), Polynesia (boys: 69% vs. girls: 84%), the Cook Islands (boys: 69% vs. girls: 84%), and Thailand (boys: 78% vs. girls: 94%). See **supplementary table 2**, available online, for gender-specific prevalence of unhealthy dietary habits and insufficient physical activity by country. No gender-based differences were found in sedentary behavior, except in Bahrain, where the percentage of unhealthy sedentary behavior was substantially higher among girls than among boys (boys: 77% vs. girls: 91%). The use of tobacco was higher among boys (10%) than that among girls (3%), except in Polynesia, where the percentage of tobacco use was much higher among girls than that among boys (boys: 11% vs. girls: 18%). Significant gender differences in tobacco use were found in Bahrain (boys: 25% vs. girls: 4%), Kuwait (boys: 22% vs. girls: 6%), and

Timor-Leste (boys: 18% vs. girls: 4%). See **supplementary table 3**, available online, for gender-specific prevalence of unhealthy sedentary behavior and tobacco use by country.

The prevalence of exposure to school violence was 5–15% higher among boys than that among girls across countries. The largest gender differences in exposure to school violence were found in Mongolia (boys, 38.0% vs girls, 14.0%), followed by Tuvalu (boys, 62.0% vs girls, 34.0%), Thailand (boys, 30.0% vs girls, 13.0%), Kuwait (boys, 37.0% vs girls, 22.0%), Yemen (boys, 47.0% vs girls, 19.0%), and Bahrain (boys, 42.0% vs girls, 21.0%). The prevalence of insufficient interactions with parents was higher among boys than that among girls. Major gender differences for insufficient interactions with parents were observed in Bangladesh (boys, 67.7% vs girls, 57.2%), Benin (boys, 76.0% vs girls, 69.4%), Fiji (boys, 63.0% vs girls, 55.2%), Mongolia (boys, 78.7% vs girls, 71.6%), and Afghanistan (boys, 55.4% vs girls, 40.7%). There were no gender-specific differences in the prevalence of insufficient interactions with friends. Significant gender differences in insufficient interactions with friends were observed in Bangladesh (boys, 53.0% vs girls, 63.4%), the Cook Islands (boys, 50.3% vs girls, 57.4%), Indonesia (boys, 66.0% vs girls, 57.0%), Tuvalu (boys, 80.0% vs girls, 70.0%), Thailand (boys, 69.4% vs girls, 56.3%), Bahrain (boys, 41.4% vs girls, 32.0%), and Yemen (boys, 71.0% vs girls, 63.0%). See **supplementary table 4**, available online, for gender-specific prevalence of exposure to school violence and insufficient interactions with parents and friends by country.

Associations between the risk of depression and lifestyle and social risk index values

A multilevel logistic regression analysis was performed to determine the associations between the four lifestyle and three social risk indexes and the risk of depression among adolescents. Total and gender specific ORs with 95% CIs for overweight or obese status in relation to different lifestyle risk scores are presented in **Table 4**.

Regarding the dietary risk index, the odds of depression risk were 15% (OR = 1.15; 95% CI, 1.07–1.23) higher for participants with high risk index values compared with those with a low dietary risk index. However, for total samples and each subgroup, there were no significant associations between physical inactivity and the risk of depression. Regarding unhealthy sedentary behavior, participants with high risk index values had 53% (OR = 1.53; 95% CI, 1.43–1.63) higher odds of depression risk than those with a low risk score for unhealthy sedentary behavior. The association between unhealthy sedentary behavior and depression risk was stronger among girls (OR = 1.65; 95% CI, 1.51–1.80) than among boys (OR = 1.33; 95% CI, 1.21–1.47). Participants with moderate and high risk scores for tobacco use had 65% (OR = 1.65; 95% CI, 1.46–1.86) and 57% (OR = 1.57; 95% CI, 1.41–1.76) higher odds of depression risk, respectively, compared with those with a low risk score of tobacco use. The association between tobacco use and depression risk was stronger among girls (OR = 2.54; 95% CI, 2.01–3.22) than among boys (OR = 1.44; 95% CI, 1.26–1.64).

Compared with participants with a low risk score of exposure to school violence, those with moderate (OR = 1.79; 95% CI, 1.69–1.90) or high (OR = 3.06; 95% CI, 2.88–3.26) risk scores of exposure to school violence had higher odds of depression risk. Participants with high risk scores for insufficient interactions with parents (OR = 2.09; 95% CI: 1.92–2.28) and friends (OR = 1.82; 95% CI: 1.69–1.96) showed higher odds of depression risk than those with low risk scores of insufficient interactions with parents and friends, respectively. Associations between insufficient interactions with parents and depression risk were stronger among boys (OR = 2.33; 95% CI: 2.05–2.65) than among girls (OR = 1.95; 95% CI: 1.74–2.19), whereas associations between insufficient interactions with friends and depression risk were stronger among girls (OR = 2.24; 95% CI: 2.03–2.48) than among boys (OR = 1.39; 95% CI: 1.25–1.55).

Discussion

The aim of the current study was to provide a comprehensive assessment of depression risk and its behavioral determinants (unhealthy dietary habits, physical inactivity, unhealthy sedentary behavior, tobacco use, exposure to school violence, insufficient interactions with parents, and insufficient interactions with friends) among adolescents under 18 years of age. The results revealed that the prevalence of depression risk and unhealthy lifestyle and social behaviors was relatively high, although it varied widely by country and gender. Multilevel analyses showed that, except for insufficient physical activity, having higher risk scores for lifestyle and social behavior increased adolescents' odds of depression risk.

The current results revealed that more than one in every four adolescents was at risk of depression. We found that Afghanistan had the highest prevalence of adolescent depression risk, which was in line with a previous study reporting that depression rate was highest among Afghan adults.[5] War and conflict, domestic violence, child sexual abuse, poverty, and unavailability of adolescent counselling services could be contributing factors for high depression risk in Afghanistan.[35] The current study found a high prevalence of depression risk in Middle Eastern countries (Kuwait, Bahrain, and Yemen), in accord with the results of a previous study.[36] Developmentally and culturally appropriate community-based detection efforts may be helpful for addressing depression among adolescents in Arab countries.[36] In the current study, the prevalence of depression risk was higher among girls (28%) than among boys (23%), in accord with the findings of several previous studies.[4, 35, 36] Social roles, socialization differences, coping style, and response to stressful life events have been reported to make girls more vulnerable to depression than boys.[37]

The current study revealed that four out of five adolescents exhibited unhealthy dietary habits, and this increased the odds of depression risk among girls, although there was no significant association among boys. A previous study also found a positive association between unhealthy dietary habits and the risk of depression.[38] There are several potential pathways of influence between unhealthy dietary habit and depression. For example, people who consume foods that are high in sodium and low in potassium are more likely to develop symptoms of depression.[39] Furthermore, a lack of amino acids and zinc in the diet may cause depression because of enhanced levels of serotonin and dopamine in the body.[38] These findings suggest that countries should reconsider their existing policies and initiate programs for promoting healthy dietary habits among adolescents. For example, several studies have found that school-based nutrition education programs increase healthy eating habits, including more fresh fruit and vegetable consumption.[40–41] Thus, school-based nutrition education programs might provide a useful tool for improving dietary habits among adolescents.

The current study revealed no significant associations between physical inactivity and depression risk among adolescents, which was similar to previously reported findings.[42] Although another previous study found that physical activity played a protective role against depression among adolescents.[43] Therefore, further research into this issue may be valuable.

The current results revealed that two out of three adolescents exhibited an unhealthy level of sedentary behavior, which increased the odds of depression risk for boys and for girls, in accord with several previous reports.[14, 42] Plausible biological pathways for this effect include central nervous system arousal, sleep disturbances, and poor metabolic health resulting from prolonged sedentary behavior.[44] In addition, extended periods of sedentary behavior, such as television viewing and playing video games, has been found to lead to social solitude and withdrawal from interpersonal relationships, which has been linked to increased feelings of anxiety.[44] Our results revealed that one in four adolescents spent more than 4 hours of daily sedentary time in the Bahamas, Thailand,

Bahrain, Brunei, and Kuwait, which warrants immediate action. Programs for promoting awareness among adolescents and parents about the harmful effects of unhealthy sedentary behavior may help to limit adolescents' daily sedentary time.

The current study revealed that the use of tobacco was positively associated with depression risk, which is consistent with a previous report.[11] Moreover, we found that the use of tobacco was considerably higher among boys than that among girls, but the association between tobacco use and depression risk was stronger among girls than that among boys. Therefore, it may be valuable to emphasize community and school-based tobacco awareness and cessation programs in Kuwait, Bahrain and Polynesia to suppress the use of tobacco among adolescents.

In the current study, 27% adolescents reported exposure to school violence. In addition, we found a strong association between exposure to school violence and depression risk among adolescents. A previous study also revealed that children who had high levels of exposure to school violence were more likely to experience depression. [15] A new United Nations Educational Scientific and Cultural Organization study reported that effective systems for reporting and monitoring school violence and bullying, evidence-based programs and interventions, training and support for teachers, support and referral for affected students can reduce the prevalence of school violence.[45] Therefore, the countries in our study that showed a high prevalence of school violence (Nepal, Tuvalu, Namibia, the Philippines, and Timor-Leste) may find it useful to implement interventions to provide a safe and positive school climate and classroom environment.

The current findings revealed that two out of three adolescents had insufficient interactions with friends, and three out of four adolescents had insufficient interactions with parents. Importantly, insufficient interactions with parents and friends increased the risk of depression among adolescents. This finding is consistent with the results of a previous study reporting that parents and peers could provide supportive environments to offset stressors such as loneliness.[13] Moreover, rapid urbanization and the changing social and economic context and technological advancement have caused drastic lifestyle changes. For example, one recent study reported that many teens did not socialize in the real world, and that this behavior pattern caused severe loneliness.[46] A recent survey of parents reported that 25% children were addicted to devices and games and in the home, and that the constant use of devices among family members can cause children to feel lonely and isolated.[47] Therefore, in Bahrain, Kuwait, Timor-Leste, Laos, Tuvalu, Yemen, Brunei, the Philippines, and the Cook Islands, improved relationships between adolescents and their parents should be emphasized. One possible mechanism might be parental involvement in school activity on a voluntary basis. Furthermore, our study revealed that insufficient interactions with friends made girls more vulnerable to depression risk than boys. One possible reason is that, during adolescence, girls have tighter, more cohesive friendship networks than boys, which consequently elevates the risk of expulsion from their social network. According to the current study findings, a focus on improved peer relationships among adolescents may be helpful in Benin, Tuvalu, and Namibia.

We conducted comprehensive assessment of depression risk and its modifiable risk factors among adolescents. Additionally, we reported country-specific scenarios of adolescent lifestyle factors and social behaviors. We used the most recent available nationally representative data from multiple countries with different ethnic and cultural compositions, with a large sample size (> 50,000), and the results are likely to be generalizable to other countries with high rates of schooling. However, the GSHS only included adolescents who were enrolled in school, and school-going adolescents may not be representative of all adolescents in a country. Despite this limitation, because school enrollment rates among adolescents were high in most of the included countries, the results are unlikely to be severely affected by sample selection bias.[48] Furthermore, because of the self-reported nature of the data,

misreporting is possible, although this should be minimized by the anonymity of the questionnaire and the data cleaning techniques used.

In conclusion, widespread prevalence of depression risk and its behavioral determinants were observed among adolescents in most of the countries studied. Moreover, higher lifestyle and social risk scores considerably increased the odds of depression risk. The current findings will increase awareness of adolescent depression and consequently may help to reduce stigma related to depression. Moreover, our findings may facilitate early recognition and cost-effective management of adolescent depression. These outcomes can also inform population-based interventions to improve lifestyles and social behaviors among adolescents.

Abbreviations

GSHS Global School-based Student Health Survey

OR Odds Ratio

CI Confidence Interval

WHO World Health Organization

CDC Center for Disease Control and Prevention

Declarations

Ethics approval and consent to participate:

Our study was exempted by the ethics committee of the university of Tokyo as we employed secondary data that are available for public use.

Consent for publication:

Not applicable

Availability of data and materials:

The data used in this study was downloaded from the website ([CDC Global School-based Student Health Survey \(GSHS\)](#)) of Centers for Disease Control and Prevention (CDC). Analysis sheets are presented in the manuscript and also as supplementary files. The code book, and analytic code will be made available upon request to the corresponding author.

Conflict of interest:

None of the authors had any biomedical financial interests or potential conflicts of interest or personal affiliation that compromised the scientific integrity of this work.

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Authors contributions:

SS, MMR, and MH conceived the article. SS carried out the background study, data extraction, statistical analysis, and interpretation of the data under the supervision of MMR. SS conducted the quality assessment, in consultation with MH. SS wrote the manuscript. MH and MMR checked the consistency of the study. MH and MMR revised it critically for intellectual content. All authors have reviewed and approved the final manuscript.

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Tables

Table 1

Survey characteristics of the Global School-based Student Health Survey datasets for the selected countries.

Country ¹ (n=20)	Survey year	Survey sample size (n=83,695)	Analysis sample size (n=51,597)	Response rate (%)	% Boys (95% CI) (n=23,192)	Mean age ² , (years) (95% CI)	Prevalence of depression ² (95% CI) (n=13,635)
Afghanistan	2014	2579	1,048	79	56.6 (53.7, 59.7)	15.2 (15.1, 15.3)	49.9 (46.5, 53.2)
Bahamas	2013	1357	786	78	45.4 (41.8, 48.9)	13.4 (13.3, 13.5)	31.4 (28.1, 34.9)
Bahrain	2016	7141	2,515	89	47.9 (46.0, 49.9)	14.4 (14.4, 14.5)	37.1 (35.2, 39.0)
Bangladesh	2014	2989	1,909	91	66.6 (64.2, 68.9)	14.1 (14.2, 14.2)	18.5 (16.1, 21.2)
Benin	2016	2536	1,840	78	72.9 (71.0, 74.8)	16.4 (16.3, 16.5)	39.8 (37.3, 42.4)
Brunei	2014	2599	1,961	65	49.0 (46.7, 51.4)	14.6 (14.6, 14.7)	23.9 (21.9, 26.0)
Cook Islands	2015	701	521	65	48.1 (43.8, 52.4)	15.4 (15.3, 15.6)	29.1 (25.2, 33.2)
Fiji	2016	3705	2,432	79	46.2 (44.2, 48.2)	15.8 (15.8, 15.9)	27.6 (25.8, 29.5)
Indonesia	2015	11,142	8,251	94	46.5 (45.4, 47.7)	14.0 (14.0, 14.1)	12.9 (12.2, 13.8)
Kuwait	2015	3637	2,018	78	50.1 (48.0, 52.3)	15.1 (15.0, 15.2)	37.3 (35.1, 39.5)
Laos	2013	3683	2,853	70	53.1 (51.1, 55.1)	15.6 (15.6, 15.7)	11.7 (10.5, 13.1)
Mongolia	2013	5393	4,189	88	47.4 (45.9, 49.0)	14.5 (14.5, 14.6)	30.2 (28.8, 31.7)
Namibia	2013	4531	2,861	89	46.2 (44.4, 48.1)	15.8 (15.8, 15.9)	43.0 (41.2, 44.9)
Nepal	2015	6529	4,189	69	48.7 (47.0, 50.6)	14.4 (14.4, 14.5)	19.8 (18.3, 21.4)

Philippines	2015	8761	5,790	79	49.1 (47.8, 50.6)	14.5 (14.6, 14.6)	30.2 (28.9, 31.6)
Polynesia	2015	3216	2,298	70	48.2 (46.1, 50.4)	15.1 (15.0, 15.2)	27.1 (25.2, 29.1)
Thailand	2015	5894	3,521	89	43.2 (41.1, 45.5)	14.5 (14.5, 14.6)	21.4 (19.7, 23.3)
Timor-Leste	2015	3704	1,011	79	53.4 (50.4, 56.5)	15.5 (15.4, 15.6)	32.2 (29.2, 35.3)
Tuvalu	2013	943	207	90	42.9 (37.7, 48.4)	13.9 (13.9, 14.1)	18.4 (13.6, 24.3)
Yemen	2014	2655	1,397	75	54.5 (51.9, 57.1)	14.9 (14.8, 15.0)	37.3 (34.6, 40.1)

Legend:

CI: confidence interval

¹ Countries with Global School-based Student Health Survey data available for 2013 or later.

² Descriptive analyses were used to estimate mean age and percentage of depression risk among adolescents. Probability sampling weights were applied in all analyses.

Table 2

Development of depression risk variable for adolescents.

Variable	Components	Frequency (Last 1 year)	Risk index	Risk index range	Risk levels ¹		
					Low	Moderate	High
					No risk group	At risk group	
Risk of depression	1. Feel lonely ³	Rarely	0	0-8	0-2 ²	2 ² -3	4-8
		Sometimes	1				
		Always	2				
	2. Too worried ³	Rarely	0				
		Sometimes	1				
		Always	2				
	3. Considered suicide ³	Never	0				
			2				
			≥ 1				
	4. Attempted suicide ³	Never	0				
			2				
			≥ 1				

Legend: Depression risk variable was developed for adolescents (aged 13–17 years) using the Global School-based Student Health Survey datasets for 20 countries with survey data available for 2013 or later.

¹ This method of grouping composite risk indexes to produce risk levels has been used in another study.[23]

² The composite risk index could equal two 1) if any two of the four components were at moderate risk (0+0+1+1) or 2) if any one of the four components were at high risk (0+0+0+2). The former criterion was included as a low risk index and the latter criterion was included as a moderate risk index. The reason was participants with low risk indexes should not have any component assessed as high risk.

³ Cut-off points were determined based on previous studies.

Table 3

Composition of lifestyle and social risk indexes for adolescents.

Risk indexes	Components	Frequency	Risk index	Risk index range	Risk level ¹		
					Low	Medium	High
Dietary habits	1. Fruits, times/d ²	≥ 3	0	0-8	0-2 ⁶	2 ⁶ -3	4-8
		2	1				
		≤ 1	2				
	2. Vegetables, times/d ²	≥ 3	0				
		2	1				
		≤ 1	2				
	3. Fast food, d/w ³	≤ 1	0				
		≥ 2 & ≤ 3	1				
		≥ 4	2				
	4. Soft drinks, times/d ³	≤ 1	0				
		2	1				
		≥ 3	2				
Physical activity	1. 60 minutes per day, d/w ⁴	≥ 6	0	0-2	0	1	2
		≥ 3 & ≤ 5	1				
		≤ 2	2				
Sedentary behavior	1. Daily sedentary time, h/d ⁵	< 1	0	0-2	0	1	2
		≥ 1 & < 4	1				
		≥ 4	2				
Tobacco use	1. Cigarette, days last month ³	≤ 2	0	0-4	0	1	2-4
		≥ 3 & ≤ 19	1				
		≥ 20	2				
	2. Other tobacco products, days last month ³	≤ 2	0				
		≥ 3 & ≤ 19	1				
		≥ 20	2				
Exposure to school violence	1. Physically attacked, times last year ³	0	0	0-8	0-2 ⁶	2 ⁶ -3	4-8
		≥ 1 & ≤ 2	1				
		≥ 3	2				
	2. Physical fight, times last year ³	0	0				
		≥ 1 & ≤ 2	1				
		≥ 3	2				

			2				
	3. Seriously injured, times last year ³	0	0				
		≥ 1 & ≤ 2	1				
		≥ 3	2				
	4. Bullied, days last month ³	0	0				
		≥ 1 & ≤ 2	1				
		≥ 3	2				
Interactions with parents	1. Missed school without permission, days last month ³	0	0	0-4	0	1-2	3-4
		≥ 1 & ≤ 2	1				
		≥ 3	2				
	2. Parents understand problems, times last month ³	Always	0				
		Sometimes	1				
		Rare	2				
Interactions with friends	1. Students being helpful, times last month ³	Always	0	0-4	0	1-2	3-4
		Sometimes	1				
		Rare	2				
	2. Number of close friends ³	2	0				
		1	1				
		0	2				

Legend: Risk indexes were developed for adolescents (aged 13–17 years) using the Global School-based Student Health Survey datasets for 20 countries with survey data available for 2013 or later.

¹ This method of grouping risk indexes to produce risk levels was used in another study.[23]

² 2006 World Health Organization dietary guidelines.[24]

³ Based on previous studies.

⁴ 2010 World Health Organization physical activity guidelines.[27]

⁵ American Association of Pediatrics' 2016 recommendation on screen time for adolescents.[28]

⁶ The composite risk indexes could equal two 1) if any two of the four components were at moderate risk (0+0+1+1) or 2) if any one of the four components were at high risk (0+0+0+2). The former criterion was included as a low risk index and the latter criterion was included as a moderate risk index. The reason was participants with low risk indexes should not have any component assessed as high risk.

Table 4

Associations between lifestyle and social risk indexes and risk of depression among adolescents.

Risk indexes	Total sample (n=51,597)		Boys (n=23,192)		Girls (n=28,405)	
	OR (95% CI)	P for trend	OR (95% CI)	P for trend	OR (95% CI)	P for trend
Unhealthy dietary habit ¹		<0.001		0.184		<0.001
Low	1		1		1	
Moderate	1.13 (1.05, 1.22)		1.08 (0.97, 1.21)		1.17 (1.07, 1.29)	
High	1.15 (1.07, 1.23)		1.09 (0.98, 1.21)		1.20 (1.10, 1.31)	
Physical inactivity ²		0.114		0.055		0.934
Low	1		1		1	
Moderate	1.03 (0.96, 1.11)		1.02 (0.93, 1.13)		1.03 (0.93, 1.14)	
High	1.04 (0.98, 1.10)		1.07 (0.99, 1.17)		1.00 (0.92, 1.09)	
Unhealthy sedentary behavior ³		<0.001		<0.001		<0.001
Low	1		1		1	
Moderate	1.06 (1.01, 1.11)		0.98 (0.91, 1.06)		1.12 (1.04, 1.19)	
High	1.53 (1.43, 1.63)		1.33 (1.21, 1.47)		1.65 (1.51, 1.80)	
Tobacco use ⁴		<0.001		<0.001		<0.001
Low	1		1		1	
Moderate	1.65 (1.46, 1.86)		1.49 (1.28, 1.73)		2.14 (1.73, 2.65)	
High	1.57 (1.41, 1.76)		1.44 (1.26, 1.64)		2.54 (2.01, 3.22)	
Exposure to school violence ⁵		<0.001		<0.001		<0.001
Low	1		1		1	
Moderate	1.79 (1.69, 1.90)		1.58 (1.45, 1.73)		2.07 (1.90, 2.25)	
High	3.06 (2.88, 3.26)		2.83 (2.61, 3.07)		3.40 (3.10, 3.73)	
Insufficient interaction with parents ⁶		<0.001		<0.001		<0.001
Low	1		1		1	
Moderate	1.17 (1.12, 1.22)		1.16 (1.08, 1.24)		1.18 (1.11, 1.25)	

	1.23)	1.25)	1.26)
High	2.09 (1.92, 2.28)	2.33 (2.05, 2.65)	1.95 (1.74, 2.19)
Insufficient interaction with friends ⁷		<0.001	<0.001
Low	1	1	1
Moderate	1.39 (1.32, 1.47)	1.21 (1.12, 1.32)	1.51 (1.41, 1.62)
High	1.82 (1.69, 1.96)	1.39 (1.25, 1.55)	2.24 (2.03, 2.48)

Notes: OR: odds ratio; CI: confidence interval. Multilevel logistic regression models were used to estimate the ORs and corresponding 95% CIs. The total sample analysis was adjusted for age, sex, socioeconomic status, and national literacy rate. The subgroup analyses used the same model and was adjusted for age, socioeconomic status, and national literacy rate.

¹Unhealthy dietary habit considered intake of fruits, vegetables, fast food, and soft drinks.

²Low risk of physical inactivity for adolescents was defined as engaging in vigorous physical activity for at least 1 hour 6 days per week.

³Low risk of unhealthy sedentary behavior for adolescents was defined as having less than 1 hour of screen time per day.

⁴Low risk of tobacco use for adolescents was defined as using cigarettes or any other form of tobacco on fewer than 3 days last month.

⁵ Exposure to school violence considered physical attack, fight, injury, and bullying.

⁶ Interactions with parents considered frequency of missing school without permission and participants think their parents understand problems.

⁷Interactions with friends considered number of close friends and if participants found their classmates kind and helpful.

Figures

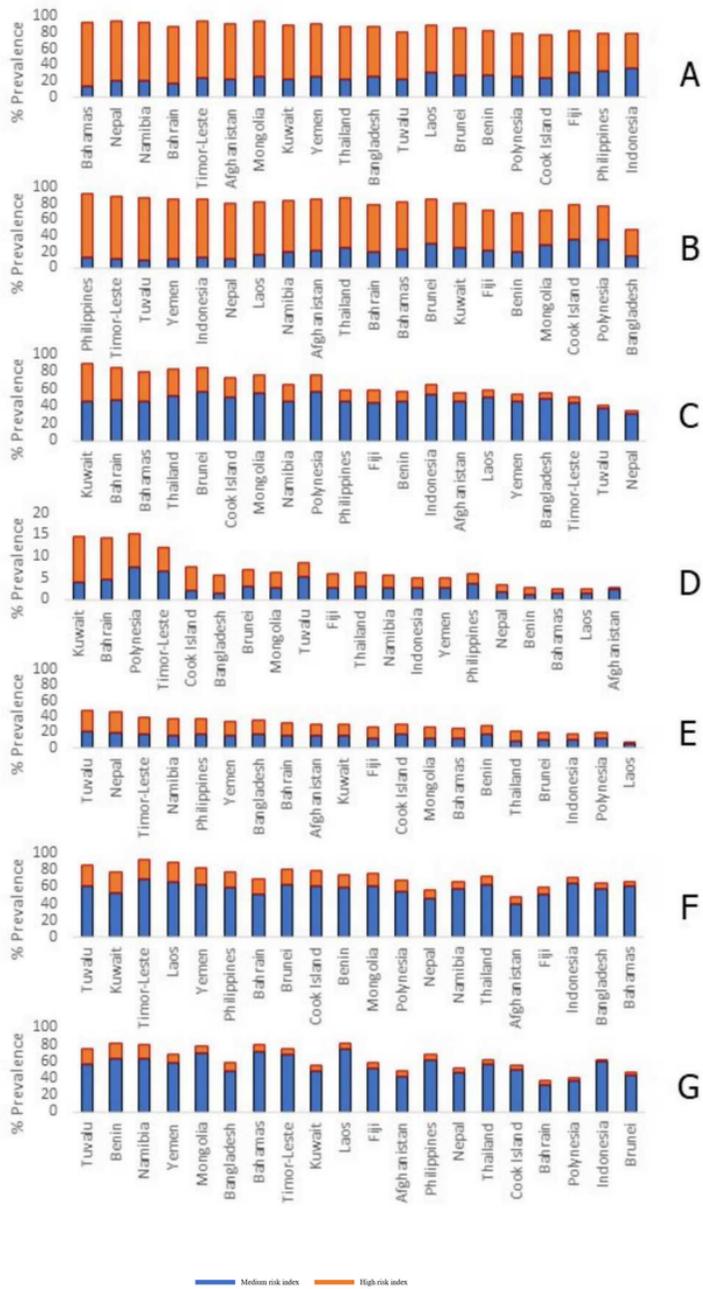


Figure 1

Prevalence of lifestyle and social risk indexes among adolescents by country.

Subtitles:

- A. Unhealthy dietary habits
- B. Insufficient physical activity
- C. Unhealthy sedentary behavior
- D. Tobacco use

- E. Exposure to school violence
- F. Insufficient interactions with parents
- G. Insufficient interactions with friends

Colour legend:

n/Country: 1048/Afghanistan, 786/The Bahamas, 2515/Bahrain, 1909/Bangladesh, 1840/Benin, 1961/Brunei, 521/The Cook Islands, 2432/Fiji, 2298/ Polynesia, 8251/Indonesia, 2018/ Kuwait, 2853/Laos, 4189/Mongolia, 2861/Namibia, 4189/ Nepal, 5790/The Philippines, 3521/Thailand, 1011/Timor-Leste, 207/Tuvalu, 1397/Yemen.

Selection and sequence of the countries: Countries with Global School-based Student Health Survey data available for 2013 or later were included. Countries have been arranged in graph by the prevalence of high-risk index from the largest to the smallest.

Descriptive analyses were used to estimate medium and high-risk proportions. Probability sampling weights were applied in all analyses.

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