fixed across countries. This would substantially improve comparability of prevalence rates across countries.	
Reviewer 4	
• Thank you for addressing my comments.	We would like to thank the reviewer for their appreciation.

Suicidal ideation, suicide planning and suicide attempts among 229 129 adolescents in 59 low-and-middle-income countries: a population-based study

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Ethical approval

In each of the participating countries, the GSHS received ethics approval from the Ministry of Education or a relevant Institutional Ethics Review Committee, or both. Only adolescents and their parents who provided written or verbal consent participated. As the current study used retrospective publicly available secondary data, we did not need ethics approval from any Institutional Ethics Review Committee.

Conflict of interest

None to declare.

Authors' contributions

RU and AK were involved in the conception and design of the study, and extraction and collation of data from the GSHS database. RU and AK analysed the data. RU, NWB, MM, SRK, and AK interpreted the data. RU, AK and NWB drafted the article. MM and SRK revised the article critically for intellectual content. RU, NWB, MM, SRK, and AK gave final approval of the version to be published. RU and AK had access to the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. AK attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. AK is the guarantor.

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Research in context

Evidence before this study

We searched PubMed, PsycINFO and Scopus to identify publications on the prevalence of suicidal thoughts and behaviours among children and adolescents in low- and middle-income countries (LMICs), and published in English between Jan 2000 and May 2018. We used the keywords ("suicide" OR "self-harm") and ("adolescents" OR "child*" OR "teenager" OR "youth") and ("developing country" OR "low socioeconomic status" OR "low income country" OR "middle income country" OR "low- and middle-income country" OR "LMIC"). Data were available for several individual LMICs. We identified only two publications on global comparisons of prevalence of suicidal thoughts and behaviours in adolescents from LMICs. The most recent one used the Global School-based Student Health Survey (GSHS) data from 2003 to 2012, and provided an overview of the prevalence of suicidal ideation and ideation with a plan among adolescents in 29 LMICs. We did not find any study that provided a global comparison of the prevalence of suicide attempts among children and adolescents in LMICs.

Added value of this study

Given the under-representation of LMICs in the global evidence base of suicide, this study provides new information on the prevalence of suicide attempts among adolescents in 39 LMICs. This study uses more recent GSHS data up to 2015 to provide an update on adolescents' suicidal ideation and suicide planning, and covers more LMICs (59 for ideation and 58 for plan) across all six World Health Organization regions than previous studies. Marked variation exists in the prevalence estimates of suicidal thoughts and behaviours across countries and regions.

Implications of all the available evidence

This study suggests that suicidal thoughts and behaviours, which have previously been associated with adverse physical and psychological outcomes, are an important public health issue among adolescents in LMICs. Variability in the prevalence across countries and regions highlights the need for prevention programs to address the contextual contributing factors. The findings of this study can be used as a base to inform such prevention programs and to examine future trends.

Suicidal ideation, suicide planning and suicide attempts among 229 129 adolescents in 59 low-and-middle-income countries: a population-based study

Abstract

Background: Suicide is a major global health challenge and a leading cause of death among adolescents. Research related to suicide has concentrated on high-income countries with little evidence from low- and middle-income countries (LMICs).

Methods: We used data from the Global School-based Student Health Survey conducted among schoolchildren aged 13–17 years (52% female) between 2003 and 2015 in 59 LMICs across six World Health Organization regions. Using a meta-analysis with random effects, we computed the sex and age-based estimates of regional and overall prevalence of suicidal ideation, suicide planning and suicide attempts.

Findings: The overall prevalence of suicidal ideation, suicide planning and suicide attempts in the 12 months preceding survey completion was 16·9% (95% CI: 15·0–18·8), 17·0% (14·8–19·2), and 17·0% (14·7–19·3), respectively. The African region had the highest prevalence of suicidal ideation and suicide planning, and the Western Pacific region had the highest prevalence of suicide attempts. The lowest prevalence of ideation, plan, and attempts was in the South-East Asian region. Females had higher prevalence than males for suicidal ideation [18·5% (16·4–20·6) vs. 15·1% (13·4–16·7)], suicide planning [18·2% (15·8–20·6) vs. 15·6% (13.7–17.6)], and attempts [17·4% (15·0–19·8) vs. 16·3% (14·0–18·6)]. Adolescents aged 15–17 years had higher prevalence than those aged 13–14 years of suicidal ideation [17·8% (15·8–19·8) vs. 15·9% (14·1–17·6)], plan [17·8% (15·7–20·0) vs. 16·3% (14·7–17·9)], and attempts [17·6% (15·2–20·0) vs. 16·2% (13·8–18·5)].

Interpretation: Suicidal thoughts and behaviours are prevalent among adolescents in LMICs, in particular in the African and the Western Pacific regions, and among females and those aged 15–17 years. Customised suicide prevention initiatives are needed in LMICs, taking into account the diverse range of cultural and socio-economic backgrounds of the countries.

Keywords: adolescent; developing country; GSHS; psychosocial health; suicidal behaviour; wellbeing

Suicidal ideation, suicide planning and suicide attempts among 229 129 adolescents in 59 low-and-middle-income countries: a population-based study

Introduction

Among young people, suicide is ranked as the second leading global cause of death for those aged 10–24 years, third among male adolescents, and is the most common cause of death among female adolescents aged 15–19 years.[1] While there is some evidence that suicidal thoughts and behaviours are predictors of future suicide,[2] a recent meta-analysis of longitudinal studies concludes these associations as weak.[3] Available evidence suggests that suicidal ideation and suicide attempts not only place the adolescents' life at risk (e.g., physical injury) but also lead to traumatic experiences and other psychological issues.[4] Suicidal thoughts are common during adolescence,[1] which is considered the peak time for suicidal ideation.[5]

Over three-quarters of global deaths by suicide occur in the low- and middle-income countries (LMICs),[6] which have limited resources to assist people with suicidal behaviours.[7] Due to social stigma and taboos, religious or cultural concerns, and lack of proper reporting systems, suicidal behaviours remain a hidden cause of disease burden in these countries.[7] Hence, suicide has become a significant public health challenge in LMICs.[2,7]

Although there are some country-specific data available, there is a paucity of data and global comparisons of the prevalence of suicidal thoughts and behaviours in adolescents from LMICs. A recent multi-country study of adolescents from 29 LMICs, reported that the prevalence of suicidal ideation was 16·2% among females and 12·2% among males, and the prevalence of ideation with a plan was 8·3% among females and 5·8% among males.[8] However, we are not aware of any study that provided a global comparison of the prevalence of suicidal attempts among adolescents in LMICs. In this study, we estimated the prevalence of suicidal ideation, suicide planning and suicide attempts in adolescents from 59 LMICs.

Methods

Data Sources

We used the Global School-based Student Health Survey (GSHS) data collected between 2003 and 2015 from 59 LMICs.[9] Briefly, the GSHS is a population-based survey of school going children and adolescents around the world. The GSHS provides data on different aspects of adolescent behaviours and protective factors, with an aim to help countries develop suitable school and adolescent health programmes and policies, and to facilitate comparison of these behaviours and related factors across countries.

The GSHS used the same methodology in all countries. This survey included a set of core questionnaire modules addressing leading causes of poor health and mortality, including suicidal thoughts and behaviours.[10] A number of questionnaire items, including suicidal thoughts and behaviours, were adapted from the Youth Risk Behavior Survey of American Adolescents, which has established reliability with adolescents in the USA.[8] To ensure socio-cultural adaptability, countries were allowed to include country-specific examples, options or phrasing.[10] The questionnaire was translated, if necessary, under a rigorous translation and back-translation protocol set out by WHO and CDC. The questionnaire was pilot-tested with schoolchildren aged 13–17 years in each participating country.[10] A study with Fijian adolescent girls found high test-retest reliability of the GSHS items on suicidal ideation and suicide planning, with both items exhibiting agreement above 90%, and kappa coefficients above 0·63.[11] However, there is a paucity of data on reliability or cross-cultural validity of the GSHS in other LMICs.

The GSHS participants were selected using a standardised two-stage cluster sampling design. At the first stage, schools were selected based on probability proportional to size sampling. At the second stage, classes were randomly selected from these schools and all students in the selected classes were included in the sampling frame. County-wise response rates were computed based on the school response rate and the student response rate.[10]

In each of the participating countries, the GSHS received ethics approval from the Ministry of Education or a relevant Institutional Ethics Review Committee, or both. Only adolescents and their

parents who provided written/verbal consent participated. As the current study used retrospective publicly available data, we did not require ethics approval.

Outcomes

We extracted data on suicidal ideation, suicide planning and suicide attempts from the GSHS, which assessed suicidal ideation and suicide planning with two items with a response option of 'yes' or 'no': '*During the past 12 months, did you ever seriously consider attempting suicide?*' and '*During the past 12 months, did you make a plan about how you would attempt suicide?*'. Another item assessed suicide attempts: '*During the past 12 months, how many times did you actually attempt suicide?*' with response options of '0', '1' '2/3', '4/5', and '≥6 times'. To examine the prevalence of attempts, we dichotomised responses on this item as 0='no attempt' and 1='one or more attempt(s)'.

Statistical analyses

Up to May 2018, 94 countries/territories across the six WHO regions had at least one GSHS dataset publicly available. From these, we included all LMICs who participated in GSHS (n=59), and had data on at least one suicide related-items: Africa (n=13 countries); the Americas (15); Eastern Mediterranean (8); Europe (2); South-East Asia (7); and Western Pacific (14). The analytical sample consists of 229 129 adolescents (13–17 years; 51·5% female). For LMICs that had more than one dataset, we used the most recent one.

We have collated all country data into a single dataset and then computed the average age and sex distribution. Country-specific estimates of the different outcome variables were computed by taking into account the weighing factor that was applied to each student record to adjust for non-response and the varying probability of selection. This weighting factor was applied in an identical way to estimate the outcome variables in each country survey where the GSHS was implemented. Within the GSHS protocol, weighting accounted for (i) the probability of selection of schools and class rooms, (ii) non-responding schools and students, and (iii) distribution of the population by grade and sex.

We computed weighted prevalence estimates of suicide items according to sex, age group, country, and region (defined by WHO) based on the GSHS sampling weights. Among young people, suicide is uncommon before the age of 15 years,[1] and as such, we dichotomised age as 13–14 years and 15–17 years. Random effects meta-analysis was used to generate regional and overall pooled estimates of suicide data, using the DerSimonian and Laird inverse-variance method. Exact method was used to compute 95% confidence intervals (CI) for the estimates. *metaprop*, a meta-analysis routine for binary outcomes, was used to compute the estimates using STATA 14·0. In addition to test whether the summary effect measure is equal to zero, and whether the true effect in all studies is the same, we have quantified the level of heterogeneity using the I-squared measure with I^2 >75% suggesting a substantial heterogeneity among the studies.

We conducted meta-regression analyses to examine whether the prevalence of each of the three suicide outcomes was associated with other factors including survey response rates, country income classification (low-income, lower-middle-income, upper-middle-income), religious affiliation [countires with majority population affiliated with religion (e.g., Buddism, Catholicism, Islam) that condemn suicide[12]: yes/no]), and legal status of suicide[13] (illegal by law vs. decriminalised or unknown legal status). We considered a difference between two prevalence estimates to be significant if the 95% CIs did not overlap. This article meets the requirements of the Guidelines for Accurate and Transparent Health Estimates Reporting.[14]

Role of the funding source

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The corresponding author had full access to all of the data and the final responsibility to submit for publication.

Results

Of the 229 129 adolescents aged 13–17 years from 59 LMICs, the average age was 14·6±1·18 years and 52% were female. Response rates ranged from 60% in Maldives to 99.8% in Jordan. Of the participating

LMICs, seven were classified as low-income countries, 28 as lower-middle-income, and 24 as upper-middle-income (appendix Table A1).

Prevalence of suicidal ideation

Data for suicidal ideation were available for 59 LMICs. The overall 12-month pooled prevalence of suicidal ideation was 16·9% (95% CI: 15·0–18·8), with substantial variation between regions and countries. The highest regional pooled prevalence was in Africa [20·4% (17·3–23·6)] and lowest in South-East Asia [8·0% (4·5–11·5)] (Figure 1A). Country-based weighted prevalence ranged from 0·9% (0·6–1·3) in Myanmar to 34·6% (32·2–37·1) in Kiribati (appendix Table A2). The prevalence exceeded 10% in 50 (85%) of the included 59 LMICs with 35 countries (59%) exceeding the overall pooled estimate of 16·9% (appendix Table A2). Adolescents in lower-middle-income countries had the lowest pooled prevalence of suicidal ideation [16·2% (13·3–19·1)], and the highest was in low-income countries [18·1% (13·8–22·5)] (Figure 2A).

In most of the countries (n=42; 71%), the prevalence of suicidal ideation was higher among females than males (appendix Table A2). The prevalence was 18·5% (16·4–20·6) in females (lowest in Myanmar and highest in Kiribati) and 15·1% (13·4–16·7) in males (lowest in Myanmar and highest in Samoa) (Figure 3). The prevalence of suicidal ideation for males and females was similar in all regions except for the Americas where females had a higher prevalence than males [22·1% (13·4–16·7) vs. 12·8% (11·4–14·2)].

The prevalence of suicidal ideation was 15·9% (14·1–17·6) at the age of 13–14 years (lowest in Myanmar and highest in Kiribati) and 17·8% (15·8–19·8) at the age of 15–17 years (lowest in Myanmar and highest in Samoa). In most of the countries (n=44; 75%), the prevalence was higher among adolescents aged 15–17 years than those aged 13–14 years (appendix Table A2).

Prevalence of suicide planning

The overall 12-month pooled prevalence of suicide planning was 17·0% (14·8–19·2) in 58 LMICs for which data were available. There was considerable between-region and -country variation with the

highest regional pooled prevalence in Africa [23·7% (19·1–28·3)] and the lowest in South-East Asia [9·9% (5·0–14·8)] (Figure 1B). Country-specific prevalence ranged from 0·2% (0·0–0·4) in Myanmar to 41·0% (38·7–43·3) in Zambia (appendix Table A3). The prevalence exceeded 10% in 45 (78%) of the included 58 countries, with 26 countries (45%) exceeding the overall pooled estimate of 17·0% (appendix Table A3). The lowest prevalence was among the adolescents in lower-middle-income countries [16·1% (12·9–19·3)] and the highest was in low-income countries [19·7% (13·8–25·6)] (Figure 2B).

The prevalence was 18·2% (15·8–20·6) in females (lowest in Myanmar and highest in Zambia) and 15·6% (13·7–17·6) in males (lowest in Myanmar and highest in Samoa) (Figure 4). The Americas region demonstrated a considerable sex difference in the prevalence of suicide planning with 19·9% (17·3–22·5) for females and 12·1% (10·3–13·8) for males. In most of the countries (n=43; 74%), there was a higher prevalence among females than males (appendix Table A3).

The prevalence was 16·3% (14·7–17·9) at the age of 13–14 years (lowest in Macedonia and highest in Zambia) and 17·8% (15·7–20·0) at the age of 15–17 years (lowest in Myanmar and highest in Zambia). In most of the countries, there was a higher prevalence among adolescents aged 15–17 years than those aged 13–14 years (n=43; 74%) (appendix Table A3).

Prevalence of suicide attempts

Data for suicide attempts were available for 39 LMICs. Overall, 17·0 % (14·7–19·3) adolescents reported that they had attempted suicide at least once during the past 12 months (Figure 1C). There was substantial variation across the regions and the countries (appendix Table A4). Across the regions, the prevalence of suicide attempts was highest in the Western Pacific [20·5% (14·3–26·7)] and lowest in South-East Asia [9·2% (5·1–13·3)]. Across the countries, the highest prevalence was in Samoa [61% (58·9–63·1)] and lowest in Indonesia [3·9% (3·5–4·3)]. The prevalence exceeded 10% in 31 (79%) of the included 39 countries with 16 countries (41%) exceeding the overall pooled estimate of 17·0% (appendix Table A4). The pooled prevalence was lowest among adolescents in low-income countries [16·2% (10·3–22·1)] and the highest was in upper-middle-income countries [17·6% (13·3–21·9)] (Figure 2C).

The prevalence was 17.4% (15·0–19·8) in females (lowest in Tuvalu and highest in Samoa) and 16·3% (14·0–18·6) in males (Lowest in Laos and highest in Samoa) (Figure 5). In the Americas, suicide attempts were more common among females [18·6% (16·3–20·9)] than males [12·7% (10·3–15·1)]. In two-thirds of the included 39 countries (n=26; 67%), the prevalence was higher among females than males (appendix Table A4).

The prevalence was 16·2% (13·8–18·5) at the age of 13–14 years and 17·6% (15·2–20·0) at the age of 15–17 years (lowest in Indonesia and highest in Samoa between both age groups) (appendix Table A4). In most of the countries (n=28; 71%), adolescents aged 15–17 years had a higher prevalence than those aged 13–14 years (appendix Table A4).

Additional analyses show that 6·2% (6·0–6·3) of adolescents reported more than one attempted suicide during the past 12 months, with 1·23% (1·2–1·3) reporting ≥6 attempts. The prevalence of >1 suicide attempts was highest among adolescents in Africa [8·6% (8·2–9·0)] and lowest in South-East Asia [3·7% (3·5–4·0)]. The prevalence of suicide attempts ≥6 times was also highest in Africa [2·0% (1·8–2·2)] and lowest in South-East Asia [0·6% (0·5–0·7)].

Suicidal thoughts and behaviours by other factors

Random effects meta-analyses suggest that adolescents in countries where the majority population is affiliated with a religion that condemns suicide had significantly lower prevalence of suicidal ideation [14·7% (12·5–17·0) vs. 19·7% (17·4–22·1)] and suicide planning [13·9% (11·4–16·4) vs. 21·2% (17·5–24·9)] than those countries that did not. The differences were significant among both male and female adolescents for suicide planning, and among males for suicidal ideation. However, there were no significant difference in prevalence of suicide attempts by religious affiliation.

The meta-regression analyses, adjusted for age, sex, religious affiliation, and country income, showed no significant associations between response rates and suicidal ideation, suicide planning or suicide attempts. Additional meta-regression models were estimated with the prevalence of suicidal ideation, suicide planning and suicide attempts as outcome variables, and response rates, age, sex,

country income status, religious affiliation, and legal status of suicide as predictors. The modelling demonstrated no evidence of associations between the predictors and the outcomes except for legal status and ideation (*p=0·05*). Countries where suicide is criminalised had lower prevalence of ideation than the countries where suicide is decriminalised or the legal status is unknown.

Discussion

This study examined the prevalence of suicidal ideation, suicide planning and suicide attempts among 229 129 adolescents aged 13–17 years across 59 LMICs, and differences by region, sex and age. The findings suggest that the prevalence of suicidal ideation, suicide planning and suicide attempts during the past 12 months in the included LMICs was approximately 17% in adolescents with differences across the countries and the WHO regions. This information is important to understand the potential magnitude of this public health challenge, and to inform policy and related actions.

The prevalence of suicidal ideation in the current study is comparable with other research among US adolescents[4] and lower than the prevalence reported in other high-income countries such as South Korea.[15] The later study, however, had a more age-varied sample of 12–19 years. Suicide attempts in the current study is much higher than what has been reported for high-income countries.[4,15] Although comparable in our study, suicidal ideation is considerably higher than suicide attempts in many high-income countries. For example, suicidal ideation among adolescents was 17·2% compared to 7·4% for suicide attempts in the USA, and 23·3% vs 5·3% in South Korea.[15] Suicide is often thought to occur along a continuum, where ideation precedes plans, which precedes attempts. However, there is evidence to suggest that this is not always the case with some people directly engaging in suicidal behaviours without going through other phases such as ideation.[16] For example, in Bangladesh, there are many cases of suicide attempts and death by suicide among adolescents due to failure to pass exams or sexual/street harassments, which may preclude a period of prior ideation or planning. In LMICs, adolescents with different socio-cultural backgrounds may interpret questionnaire items assessing suicidal items differently, which might influence the reporting. However, without longitudinal data, it is difficult to ascertain any possible pathway of suicidal thoughts and behaviours in LMICs. Furthermore, suicidal ideation in the GSHS was assessed as 'seriously considering suicide', which represents highly specific

'active' suicidal ideation with an 'intent to act', and therefore is less likely to include 'passive' suicidal ideation. The assessment of suicidal ideation may therefore under-represent general suicidal ideation.

Suicidal thoughts were highest in Africa, where approximately one in four-to-five adolescents reported suicidal ideation or planning. The highest prevalence was in Zambia, with approximately two in five reporting that they had made a suicide plan. Sub-Saharan Africa has a disproportionally high burden associated with HIV and other infectious diseases.[17] Africa is the least successful region in the world for reducing poverty, and the history of political tensions, violence and human rights violations contributes to distress, displacement and poverty.[17] Child marriage is associated with a high adolescent pregnancy rate and vulnerability to sexual and reproductive ill health.[17] Adverse child experiences have also been found to increase risk of suicidal behaviours, with cumulative exposures increasing risk.[18] These factors all have an adverse impact on wellbeing, and may precipitate suicidal thoughts.

Suicide attempts were highest in the Western Pacific region, with approximately one in five reporting at least one suicide attempt. The highest prevalence was in Samoa, with three in five reporting suicide attempt(s). Young people in most of the Pacific Island countries are more vulnerable to suicide than the other age groups in the region.[19] Previous research has reported levels of youth suicide in Pacific populations as high by global standards, and a decreasing median age for suicide in Western Samoa and Micronesia.[20] Research in the Philippines indicates that suicide attempts and mortality are increasing among adolescents, and are likely underreported and misclassified to undetermined injury.[21]

A high prevalence of bullying victimisation, adolescent fighting and injury from physical fights has been observed among adolescents in the Western Pacific countries,[22] and has been associated with suicidal ideation and attempts among adolescents. Suicide has been reported as more common in Western Pacific countries with faster growing populations,[23] and may reflect a societal transition from traditional to modern society with intergenerational conflict and family pressures. One of the major challenges in this region is unemployment and lack of future security. In general, labour markets are unskilled and subsistence farming is the primary economic activity for countries such as Samoa and Fiji.[24] In Papua New Guinea, youth unemployment and underemployment is three times higher than for the general

population.[24] Such labour market issues can precipitate family financial and psychosocial distress; as well as low self-esteem, low self-worth and depression among adolescents, which are all recognised risk factors for suicidal behaviours.[25,26] Across the region, many young people have limited education, which is also associated with suicide attempts.[25] Other research has indicated that depression literacy is low among people in this region, and that this compromises professional help seeking and social support.[27]

In most countries studied, the prevalence of suicidal thoughts and attempts was higher among female adolescents than males. Although suicide mortality rate among adults varies considerably by sex with fewer females than males (8 females vs. 15 males per 100 000)[2], our study demonstrated comparable prevalence of suicidal attempts by sex (17·4% females; 16·3% males). The sex difference in mortality but not attempts may be explained by the lethality of suicide methods used. The pattern of a high suicide rate among males is consistent across all regions except for Western Pacific where the rates are comparable (7·9 vs. 7·2 per 100 000) [2]. Other research has noted that ingestion of the highly toxic herbicide paraquat is a common method of suicide in the Western Pacific,[20] and this may explain the lack of sex differences in mortality in this region. Our study demonstrated significantly higher prevalence of attempts among female than male adolescents in the Americas (18·8% vs. 12·7%), while the suicide rate is much lower among females than males in the region (2·7 vs. 9·8 per 100 000)[2]. Earlier research indicates that females are more likely than males to think about suicide and to attempt to end their life by suicide.[28,29] This is often attributed to gender differences in vulnerability to psychosocial distress. Compared to their male counterpart, female adolescents have higher likelihood to demonstrate internalising problems such as depression and anxiety.[29] Depression, which peaks during adolescence, is a major risk factor for suicide, and twice as prevalent among female than male adolescents.[30] Other suicide risk factors more prevalent among females include eating disorders, trauma and stress-related disorders, menstruation phases with low levels of oestrogen (and serotonin), unwanted pregnancies, abortion, domestic violence, and childhood sexual abuse.[31] Suicide prevention programs should therefore incorporate female specific strategies, which should take into account the socio-cultural and socio-economic context where they live and socialise.

Methodological considerations

The strengths of the study include a large number of adolescents from 59 LMICs across the six WHO regions, most of which included nationally representative samples. The GSHS used the same standardised methods such as the type of sample (e.g., school-based), data collection procedures, and wording of questions across surveys, which facilitated valid assessments of cross-national or regional differences in the suicide-related phenomenon.[8]

The results presented in this manuscript are obtained using weighted analyses where the GSHS weighting accounted for distribution of the population by sex and age. The weighting was used to ensure that the results could be generalised to the entire target population, not just those who participated in the survey. Therefore, any skewness in the observed data by sex (or age) is unlikely to influence the weighted analysis results.

The GSHS measures have limited evidence of reliability and validity across different cultural settings. The use of a self-reported questionnaire is susceptible to social desirability and recall bias. Some adolescents may have had problems in understanding the questionnaire (e.g., poor reading skills), and similarly parental consent for offspring to participate is vulnerable to literacy skills to provide consent. Because of the sensitive nature of suicide, the willingness of the survey participants from diverse socio-cultural backgrounds to respond to these items may have affected the results.[8] Countries were allowed to use translated versions of the GSHS; therefore, translation into local languages may also have affected the findings,[8] particularly where local languages may not have clear words to describe suicide. The study includes data collected over a 13-year period (2003-2015). The period effect, therefore, may have biased the results.

The GSHS explicitly asked about suicidal thoughts and behaviours, which clearly refer to 'intent to die', rather than 'non-suicidal self-injuries' (where intent to die is lacking, and self-harm has other intentions such as release of pain as an emotional regulation tool). We cannot determine how suicide items were understood across the participating countries and cultures. We also cannot make assumptions about how the questions were interpreted in regards to 'intent to die' or not, and have relied on the

structure of the questionnaire items. This could be a possible reason for having prevalence estimates, for some countries, counter to the usual expectation.

Socio-cultural stigma and taboos in LMICs may discourage people to report suicidal behaviours and as such, the prevalence data may be underreported.[7] The diversity across the countries and regions may limit the interpretation and generalisation of the results. The heterogeneity in the estimates may be due to various reasons – different predisposition of certain risk factors, scarcity of resources for prevention, and other sociocultural and socio-economic risk and protective factors. More research is needed to explore the diversity within regions and across countries.

Conclusions

This study of 229 129 adolescents aged 13–17 years in 59 countries confirmed that suicidal thoughts, suicide planning and suicide attempts are a major public health concern in LMICs with African and Western Pacific regions having the highest burden. Adolescents in these countries are vulnerable to many predisposing conditions, which compromise their health and wellbeing. Many of these countries may be affected by political tensions, poverty, limited health care resources, and disease burden. For most countries, there was a trend for higher prevalence among females than male adolescents. The findings of the current study therefore is important to inform policy and related actions to address suicide prevention across the countries. Adolescent suicide prevention strategies should include female specific initiatives taking into account the socio-cultural context. Given the significant variation among countries and regions, more work is needed to understand the socio-cultural context of the antecedents of adolescents' suicidal thoughts and related behaviours in LMICs.

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Figures:

Figure 1: Forest plot for the pooled prevalence of suicidal ideation (A), suicide planning (B), and suicide attempts (C), by region, among adolescents aged 13-17 years

Figure 2: Forest plot for the pooled prevalence of suicidal ideation (A), suicide planning (B), and suicide attempts (C), by the World Bank income groups, among adolescents aged 13-17 years

Figure 3: Prevalence of suicidal ideation in the 12 months preceding survey completion among adolescents aged 13-17 years for 59 LIMCs between 2003 and 2015

Note: A change in colour from green to red indicates a higher prevalence.

Figure 4: Prevalence of suicide planning in the 12 months preceding survey completion among adolescents aged 13-17 years for 58 LIMCs between 2003 and 2015

Note: A change in colour from green to red indicates a higher prevalence.

Figure 5: Prevalence of suicide attempts in the 12 months preceding survey completion among adolescents aged 13-17 years for 39 LIMCs between 2003 and 2015

Note: A change in colour from green to red indicates a higher prevalence.