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Published

2019

Journal Title

Acta Paediatrica

Version

Accepted Manuscript (AM)

DOI

[10.1111/apa.15079](https://doi.org/10.1111/apa.15079)

Downloaded from

<http://hdl.handle.net/10072/389108>

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Low physical activity and high sedentary behaviour are associated with adolescents' suicidal vulnerability: evidence from 52 low- and middle-income countries

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This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the [Version of Record](#). Please cite this article as [doi: 10.1111/APA.15079](https://doi.org/10.1111/APA.15079)

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Article type : Regular Article

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Abstract

Aim: To examine the relationships of physical activity (PA) and sedentary behaviour (SB) with suicidal thoughts and behaviour among adolescents in low- and middle-income countries (LMICs).

Methods: Global School-based Student Health Survey data from 206,357 students (14.6±1.18 years; 51% female) in 52 LMICs were used. Students reported on suicidal ideation, suicide planning, suicide attempts, PA, SB, and socio-demographic characteristics. Multilevel mixed-effects generalised linear modeling was used to examine the associations.

Results: High SB (≥ 3 hrs/day) was independently associated with higher odds of suicidal ideation, planning, and attempts for both male and female adolescents. Insufficient PA (< 60 mins/day) was not associated with higher odds of ideation for either sex; however, was associated with planning and attempts for male adolescents. The combination of insufficient PA and high SB, compared to sufficient PA and low SB, was associated with higher odds of suicide ideation and planning for both male and female adolescents, and suicide attempts for male adolescents.

Conclusion: High SB may be an indicator of suicidal vulnerability among adolescents in LMICs. Low PA may be a more important risk for suicidal thoughts and behaviours among male, than female,

adolescents. Promoting active lifestyle should be integrated into suicide prevention programmes in resource-poor settings.

Keywords: physical activity; sitting-time, adolescent health; psychological health; developing country; suicidality

Key notes

- High sedentary behaviour was associated with suicidal vulnerability of adolescents in 52 developing countries.
- Insufficient physical activity was positively associated with suicide planning and attempts among male, but not female adolescents.
- This study emphasises the need to integrate promoting an active lifestyle into suicide prevention policy and programs in resource-poor countries, which are going through a lifestyle transition characterised by more sedentariness.

Introduction

Suicide is one of the leading causes of premature death worldwide (1) with a significant negative impact on family, friends, colleagues, and society (2). Death by suicide is the most common cause of mortality among 15-19 year old female adolescents, and is the second leading cause of global mortality among young people aged 10-24 years (3). The vast global majority (90%) of youth reside in low- and middle-income countries (LMICs) (4), and suicidal thoughts and behaviours are common among adolescents in these countries (5). However, LMICs typically lack the resources to identify or manage people at risk of suicide (6). Therefore, adolescents in LMICs are a priority population group for suicide prevention efforts. Identifying potentially modifiable risk behaviours of this group is important to reduce the burden of suicide.

Health promoting behaviours, such as physical activity (PA) participation and low levels of sedentary behaviour (SB), are associated with a lower risk of suicidal thoughts and behaviours among adolescents (7, 8). While studies from individual countries have provided insights about associations between youth suicide- and risk-behaviours, differences in variable definitions and measures, study populations, and analytical approaches can make it difficult to compare the relationships across different settings. Most of the studies that have examined the associations of PA and SB with youth suicidal thoughts and behaviours assessed the effects of one behaviour without taking into account the other. Insufficient PA and prolonged SB can operate synergistically in adolescents to increase poor psychological health such as depression, anxiety, and psychosocial difficulties (9-11), which are established risk factors of adolescent suicide (3). Therefore, it is possible that prolonged SB and insufficient PA interact and increase the risk of suicidal thoughts and behaviours among adolescents. However, little is known about the potential combined effects of insufficient PA and SB on youth suicidal thoughts and behaviours.

This study aimed to examine both the independent and combined associations of PA and SB with each of self-reported suicidal ideation, suicide planning and suicide attempts among adolescents in LMICs.

Methods

Data sources

This study used publicly available data from students aged 13-17 years from LMICs who participated in the Global School-based Student Health Survey (GSHS), conducted between 2003 and 2015. We defined LMICs using the World Bank 2018 fiscal year country classification by income scheme. For LMICs that had more than one GSHS dataset, we used the most recent one available. Detailed methods of the GSHS have been described on both the US CDC and the WHO websites (12, 13).

Outcome measures - suicidal thoughts and behaviours

Suicidal ideation and suicide planning were measured with the following questions “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?” respectively, with response options of “yes” and “no”. Suicide attempts were measured with the question “During the past 12 months, how many times did you actually attempt suicide?” with response options of 0, 1, 2 or 3, 4 or 5, or ≥ 6 times. For this study, suicide attempt responses were dichotomised as 0=“no attempt” and 1=“ ≥ 1 attempts” (14). Data were available from 59 countries for suicidal ideation, 58 countries for suicide planning, and 39 countries for suicide attempts.

Study factors - physical activity and sedentary behaviours

Overall PA was assessed using the item: “During the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day?” with response options of 0, 1, 2, 3, 4, 5, 6, or 7 days a week. “Sufficient PA” was defined as ≥ 60 mins/day of PA on seven days of the week, which is consistent with the WHO recommendations (15). Data on PA were available from 53 countries.

SB was assessed with the item “How much time do you spend during a typical or usual day sitting and watching television, playing computer games, talking with friends, or doing other sitting activities?” with the response options >1 , 1-2, 3-4, 5-6, 7-8, or >8 hours/day”. For this study, high SB was defined as ≥ 3 hrs/day of sitting-time (16). Data on SB were available for 52 countries.

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 LMICs that had data on at least one of the three suicide items and both PA and SB. Our analyses included an initial sample size of 206,357 students across 52 countries: Africa (11), Americas (13), Eastern Mediterranean and Europe (9), South-East Asia (5), and the Western Pacific region (14) (Additional Table S1). Six countries were classified as low-income, 25 lower-middle-income, and 21 upper-middle-income. The percentages of missing data were 2.44% for suicidal ideation; 2.60% for planning; 1.05% for attempt; 2.03% for PA; and 2.26% for SB.

In examining the associations of PA and SB with suicidal ideation, planning and attempts, a set of covariates was initially considered for adjustments. Before conducting multivariable modelling, the collinearity of the potential covariates was examined. The final set of covariates included: age, body mass index (BMI), alcohol use, loneliness, and hunger status. Given the binary outcomes were

nested within the countries, multilevel mixed-effects generalised linear modelling was used to examine the associations with binomial family and logit link. The GSHS sampling weights were used to adjust the estimates of the associations. The weighted estimates of the associations are presented in the form of odds ratios (ORs) and their 95% confidence interval (CI).

We conducted sensitivity analyses using different cut-offs for PA (60 mins/day on ≥ 5 days/week as sufficient) and SB (≥ 5 hrs/day of sitting-time) to examine whether different categorisations had any impact on results. Using meta-analysis, we performed further sensitivity analyses to examine robustness of the multilevel model-based weighted estimates obtained using student-level data. Initially, country-level weighted estimates of the associations were obtained using logistic regression modelling, adjusted for the same set of covariates. These estimates were then used to generate regional and overall pooled estimates of the associations using random effect meta-analysis with the DerSimonian and Laird inverse-variance method.

Results

Study participants

Of the 206,357 adolescents aged 13-17 years from 52 LMICs, the average age was 14.6 (SD=1.18) years and 51% were female. Response rates ranged from 69% in Uganda to 99.8% in Jordan (Additional Table S1).

Suicidal ideation

Overall, insufficient PA was not significantly associated with suicidal ideation, for male and female adolescents (hereafter identified as males and females), adjusted for SB and the potential confounders. In the African region, however, there was a meaningful positive association between insufficient PA and suicidal ideation for males (OR 1.36; 95% CI 1.15, 1.60) (Figure 1).

Overall, high SB was significantly associated with suicidal ideation for males and females. Males with high SB had 45% [1.45 (1.35, 1.57)] higher odds of having thoughts about suicide than those with low SB, adjusted for PA and the potential confounders, and females had 41% higher odds [1.41 (1.30, 1.54)]. A meaningful positive association between high SB and suicidal ideation were seen across all WHO regions for males and all but the African region for females (Figure 1).

--Figure 1 about here--

Overall, combination of insufficient PA and high SB were significantly associated with suicidal ideation for males and females. Males with a combination of insufficient PA and high SB had

51% higher odds of suicidal ideation [1.51 (1.33, 1.72)] than those with sufficient PA and low SB. For females with insufficient PA and high SB, the odds were 43% higher [1.43 (1.12, 1.83)].

Suicide planning

Overall, insufficient PA was significantly associated with higher odds of suicide planning [1.18 (1.05, 1.32)] than those with sufficient PA for males, but not for females. We did not find any meaningful region-based associations between insufficient PA and suicide planning for either males or females (Figure 2).

Overall, high SB was significantly associated with suicide planning for males and females. Males with high SB had 29% [1.29 (1.16, 1.42)], and females had 40% [1.40 (1.30, 1.52)], higher odds of reporting suicide planning than those with low SB. While females with high SB across all WHO regions had higher odds of suicide planning than those with low SB, for males the odds were higher only in South-East Asia, the Americas, and the Western Pacific region (Figure 2).

--Figure 2 about here--

Overall, combination of insufficient PA and high SB were significantly associated with suicide planning ideation for males and females. Males with a combination of insufficient PA and high SB had 52% higher odds of making plans about suicide [1.52 (1.33, 1.72)] than those with sufficient PA and low SB. For females with insufficient PA and high SB, the odds were 32% higher [1.32 (1.11, 1.57)].

Suicide attempts

Overall, insufficient PA was significantly associated with suicide attempts for males, but not for females. Males with insufficient PA had 46% higher odds of suicide attempts than their counterparts with sufficient PA [1.46 (1.18, 1.81)]. Regional estimates suggested that males with insufficient PA in all but two WHO regions (the Americas, and Eastern Mediterranean and Europe) had higher odds of suicide attempts; however, for females we did not find such meaningful region-based relationships between insufficient PA and suicide attempts (Figure 3).

Overall, high SB was significantly associated with suicide attempts for males and females. The odds of suicide attempts were 29% higher for males [1.29 (1.16, 1.45)] and 25% higher for females [1.25 (1.12, 1.40)] with high SB than for those with low SB. The positive associations between high SB and suicide attempts were seen for females in all regions, and for males in all but the Americas region (Figure 3).

--Figure 3 about here--

Overall, combination of insufficient PA and high SB were significantly associated with suicide attempts for both males and females. Males with a combination of insufficient PA and high SB had double the odds of suicide attempts [2.07 (1.46, 2.17)] than those with sufficient PA and low SB. For females with insufficient PA and high SB, the evidence was marginal [1.30 (1.01, 1.69)].

Sensitivity analyses

Our sensitivity analyses with different cut-offs for insufficient PA and high SB produced very similar results without any meaningful changes except for the association of high SB with suicide attempts for males with an OR 1.23 with 95% CIs 0.95, 1.60), which contrasted the association in the main modelling [1.29 (1.16, 1.45)]. Further sensitivity analyses based on random effects meta-analysis did not markedly change the results with the exception of the association between insufficient PA and suicidal ideation among males [1.09 (1.01, 1.19)] while in the main modelling the estimates were 1.05 (0.92, 1.18).

Discussion

To our knowledge, this is the first multi-country study to offer a global assessment of the independent and combined associations of PA and SB with suicidal thoughts and behaviours. The main consistent finding of our study is that high SB was positively associated with suicidal ideation, suicide planning and suicide attempts among both male and female adolescents. Insufficient PA was positively associated with suicide planning and suicide attempts among male, but not female, adolescents.

Our finding that high SB is associated with an increased risk of suicidal thoughts and behaviours is consistent with previous studies that reported positive associations between different types of SB and suicidal thoughts and behaviours among adolescents (17-19). Data from the US Youth Risk Behaviour Survey reported ≥ 5 hrs/day of internet use/video game time to increase the odds of suicidal ideation, suicide planning, and suicide attempts (18). In addition, high internet-time has been positively associated with suicidal ideation among Korean adolescents (17). There is also evidence among adolescents that high SB is positively associated with poor mental health, especially depressive symptoms (8, 20), which are known risk factors for increased suicidal vulnerability (3). Feeling depressed can precipitate suicidal thoughts and those adolescents with suicidal thinking may be more likely to be sedentary (8). More research is needed to understand the directionality of these associations and potential mediating effects of factors such as depression in the relationship between SB and suicidal thoughts and behaviours among adolescents. Prolonged SB may also limit the opportunities for social interactions, promote isolation, interrupt self-development, and increase psychosocial vulnerability among adolescents (21).

Findings that insufficient PA increased the odds of suicidal planning and attempts among male adolescents is consistent with other research indicating that insufficient PA participation is associated with poor mental health among adolescents (22, 23). In our study, however, insufficient PA was not meaningfully associated with suicidal thoughts and behaviours for female adolescents. Previous studies have demonstrated that the types of PA participation are more critical than PA participation *per se* in adolescents' suicidal vulnerability (7, 24, 25). For example, it has been reported that team sports were associated with lower odds of suicidal thoughts and behaviours among middle-school students in the USA, but overall PA was not (24). Teammates, friends, parents and coaches may provide social, emotional, and moral support to adolescents who participate in team sports, which may buffer stress and promote coping with difficult situations and consequently reduce the risk of suicidality during difficult times (26). Adolescents with high levels of social support may feel more integrated than those with less support, and this can confer a sense of social belonging (25). Such supports can help adolescents to develop high levels of resilience, and decrease hopelessness, which in turn can reduce suicidal thoughts and behaviours (25). Physical activity may also improve other aspects of wellbeing. One study for example, demonstrated that team-based football to improved self-esteem and body image among adolescents (27). In LMICs, men may have more opportunities for team and outdoor sports than women because of gender based socio-cultural norms. Women in many LMICs may be restricted in recreational activities and expected to engage in household chores or taking care of the elderly family members (28). Sports participation is considered "unfeminine" in the context of many LMICs (29). This division of labour and gender-role patterning are taught from childhood with girls often constrained from playing outside and meeting their peers (29). In some societies and cultures, female adolescents participating in regular PA may be considered maladjusted or divergent, and PA participation may jeopardise their "feminine identity" (30). This can increase psychological distress and suicidal vulnerability. More research is needed to understand how different types of PA are associated with suicidal thoughts and behaviours among adolescents and how participation in team sports can reduce the risk of suicidality among female adolescents in LMICs.

In our study, both male and female adolescents with insufficient PA and high SB reported higher suicidal ideation, planning, and attempt than those with sufficient PA and low SB. The strongest combined effect of insufficient PA and high SB was observed for male adolescents' suicide attempts, where the odds were double that of sufficient PA and low SB. We are unaware of any study that has examined the combined effects of PA and SB on suicidal thoughts and behaviours. There is evidence that insufficient PA and high SB can operate synergistically and increase the risk of depressive disorders, anxiety, and psychosocial difficulties including attention deficit hyperactivity disorders among adolescents (9-11). These psychological problems are known risk factors of adolescent suicide (3). The estimates of our study suggest that high SB is a greater risk behaviour for

female adolescents' suicidality than insufficient PA, and meeting the WHO PA recommendations may not offer strong protection against suicidal thoughts and behaviours.

Implications

Suicide among young people carries a considerable burden of preventable morbidity and mortality at a time of otherwise generally good health, and has enormous economic costs (3). This burden is especially pronounced in LMICs, many of which demonstrate a high prevalence of suicidal thoughts and behaviours among adolescents (5) and have limited or even non-existent infrastructure and resources to assist psychologically vulnerable people (6). Our findings that meeting PA guidelines and low SB are inversely associated with risks of suicidal thoughts and behaviours can help inform interventions among adolescents in LMICs. Furthermore, the findings of our study compliment the emerging literature (20) that high SB is positively associated with adolescents' poor mental health in LMICs regardless of sex. Therefore, expanding suicide prevention strategies to include PA and reduce SB may contribute to reducing suicide vulnerability and burden among young people. Importantly, LMICs need a comprehensive mental health care system with a strong focus on assisting adolescents with conditions underlying suicide, such as depression, anxiety, or psychological distress.

Methodological considerations

The strengths of our study include the large sample size, with data that were nationally representative and from many LMICs across all the WHO regions. The GSHS used a standardised method and used the same survey items to assess PA, SB and suicidal thoughts and behaviours in all countries. This facilitated regional comparisons. In all our analyses, we used the GSHS weighting, which accounted for distribution of the population by age and sex in respective countries. Any skewness, by sex or age, in the observed data is unlikely to have an impact on the weighted analysis results. The independent associations of PA and SB were mutually adjusted to minimise their possible confounding effects.

The findings of our study should be interpreted in the context of its limitations. The analyses are based on cross-sectional data and as such, no causal inferences can be made. Because of the lack of data on known risk factors of suicide, such as depression or anxiety, we could not assess the potential mediating effects of these factors on suicidal vulnerability. There is limited evidence of the reliability and validity of the GSHS measures across different cultures. The self-reported assessments used in the GSHS are susceptible to social desirability and recall bias. It is possible that some adolescents may have had poor reading skills and difficulties with understanding the questionnaire. In the GSHS, SB was measured as a composite sitting-time that included time spent in "talking with friends". As talking with friends can provide peer support, help to overcome isolation, and reduce distress, sitting-time in the context of "talking with friends" may buffer against suicidal thoughts and

behaviours. Future research should examine how context-specific SBs are associated with suicidal vulnerability among adolescents. Data for our study were collected from 2003 to 2015; therefore, a period effect may have biased the results.

As suicide is a socially sensitive issue, willingness to responding to suicide-related survey items may have affected results. The GSHS suicide-items refer to 'intent to die', rather than 'non-suicidal self-injuries' where self-harm may be done with other intentions (e.g., release of pain) as an emotional regulation tool. We can not determine how the participants understood suicide-related items across the countries and/or cultures, nor can we make assumptions about how the participants interpreted suicide in regards to 'intent to die', and have therefore relied on the structure of the survey items. Furthermore, we reduced suicide attempt item responses to a dichotomous value, and the number of attempts may add more nuance than is presented here.

Conclusion

Findings of our study show that high SB and insufficient PA were independently associated with suicidal planning and behaviour among male adolescents, and high SB, but not sufficient PA, was independently associated with suicidal ideation, planning and behaviour in female adolescents. The combination of insufficient PA and high SB increased the odds of suicidal ideation and planning for both male and female adolescents, and the odds of suicide behaviour among male adolescents.

Promoting PA and limiting SB could therefore be included in interventions to minimise suicidal risk among adolescents in LMICs. Our study provides good evidence for the integration of an active lifestyle into mental health care and public health policy and programs in resource-poor settings.

Funding source

No financial or nonfinancial benefits have been received or will be received from any party related directly or indirectly to the subject of this article.

Ethical approval

In each of the participating countries, the Global School-based Student Health Survey 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 data, we did not seek ethics approval from any Institutional Ethics Review Committee.

Conflict of interest

None to declare.

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Acknowledgements

The authors would like to thank the US Centers for Disease Control and the World Health Organization for making the Global School-based Student Health Survey data publically available for analysis. The authors also thank the Global School-based Student Health Survey country coordinators and other staff members.

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Figures

Figure 1 Associations of insufficient physical activity (<60 mins/day) and high sedentary behaviour (>3 hrs/day) with suicidal ideation among male and female adolescents in low-and middle-income countries, by region, Global School-based Student Health Survey, 2003-2015.

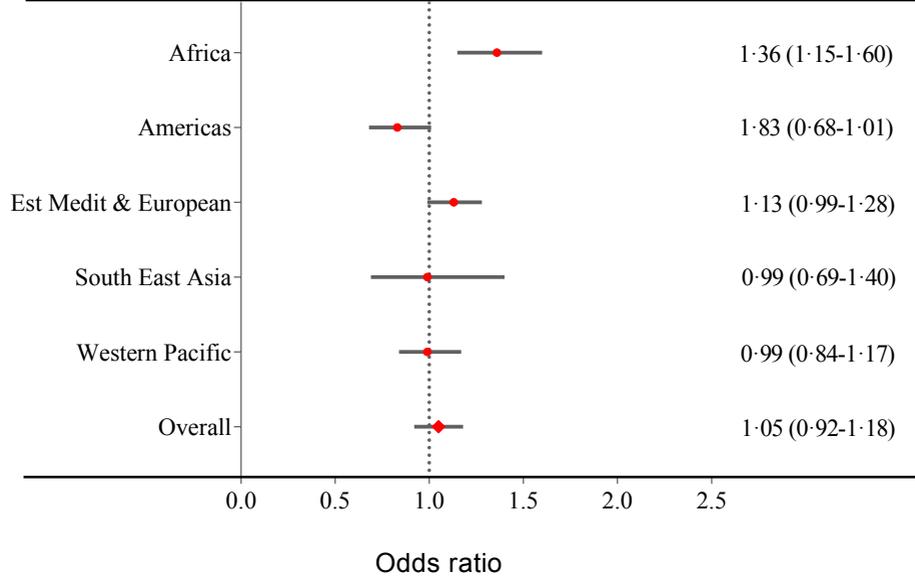
Figure 2 Associations of insufficient physical activity (<60 mins/day) and high sedentary behaviour (>3 hrs/day) with suicide planning among male and female adolescents in low-and middle-income countries, by region, Global School-based Student Health Survey, 2003-2015.

Figure 3 Associations of insufficient physical activity (<60 mins/day) and high sedentary behaviour (>3 hrs/day) with suicide attempts among male and female adolescents in low-and middle-income countries, by region, Global School-based Student Health Survey, 2003-2015.

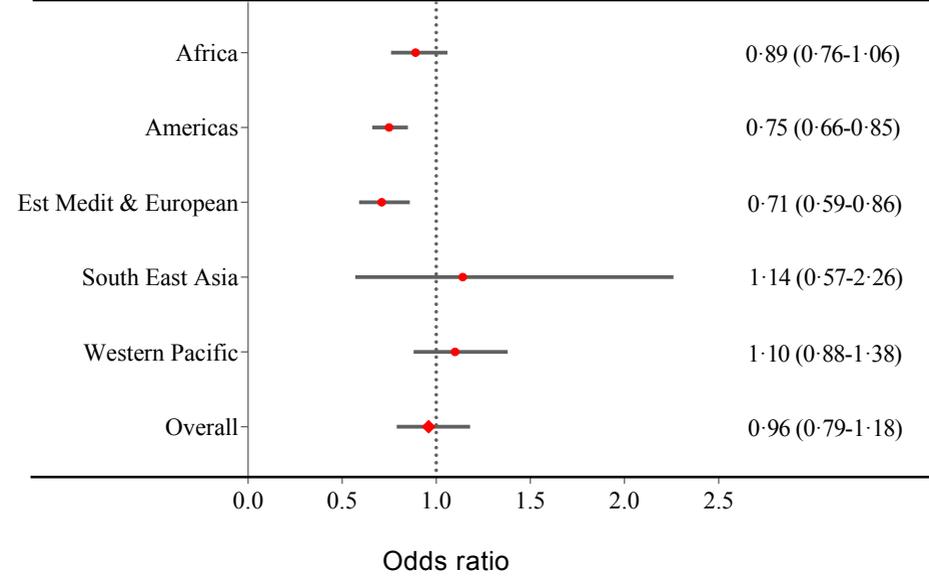
Additional file

Table S1 Characteristics of the Global School-based Student Health Surveys participants included in this study by country, 2003-2015.

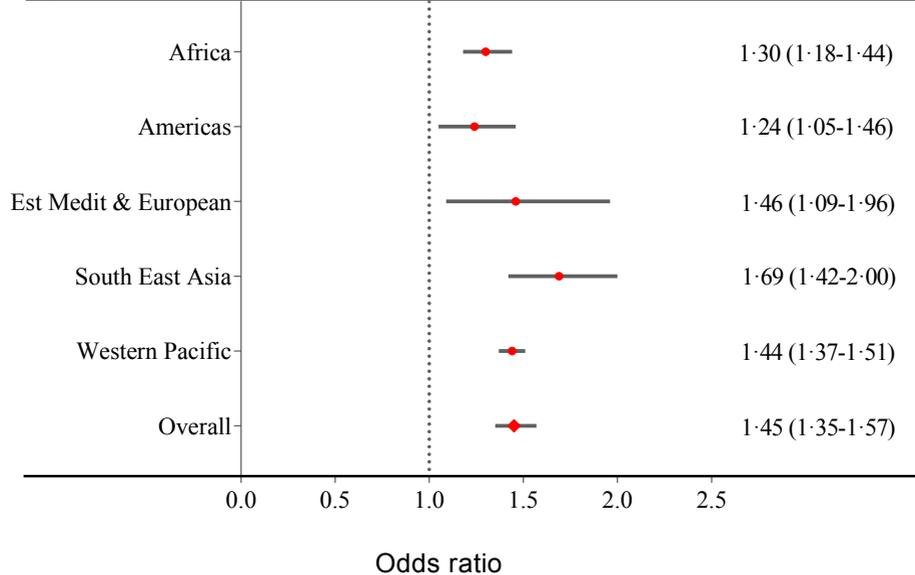
Insufficient PA on ideation (males)



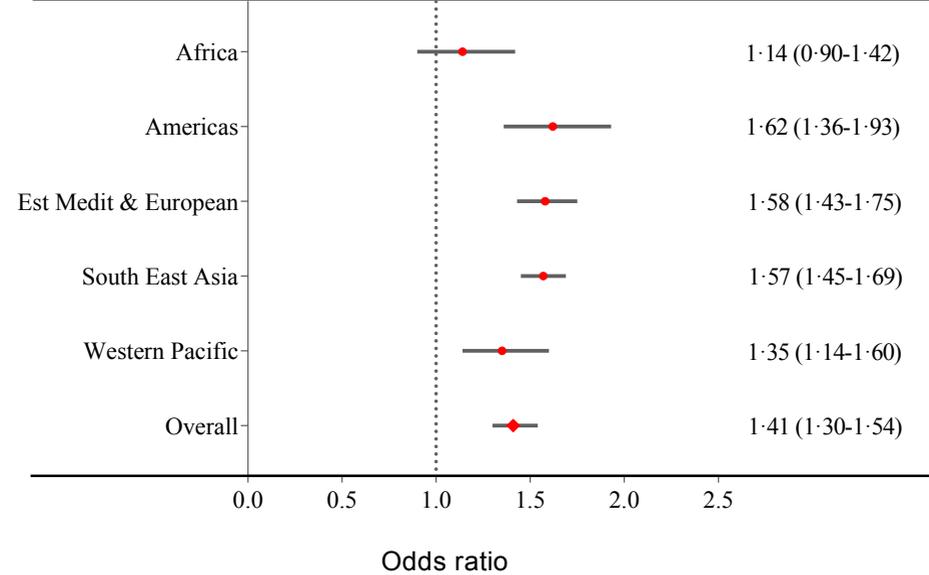
Insufficient PA on ideation (females)



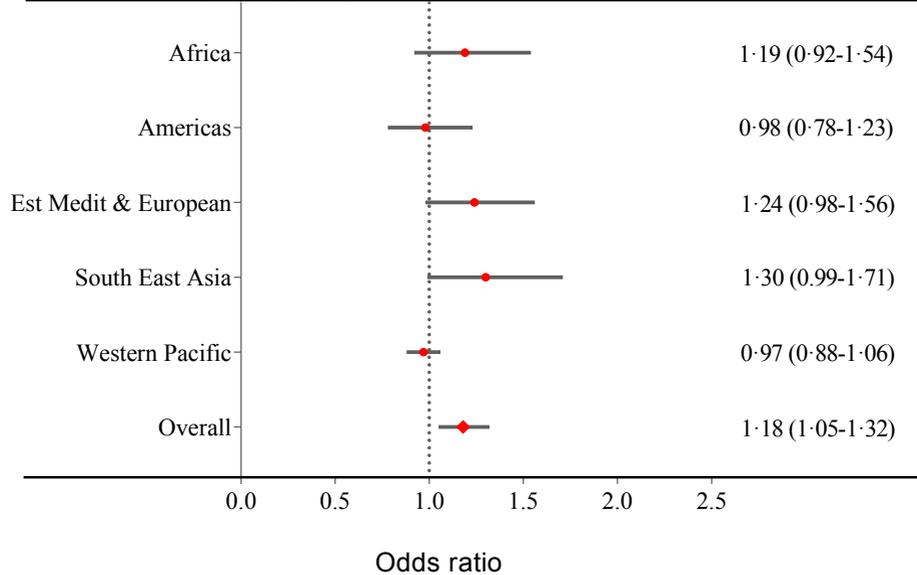
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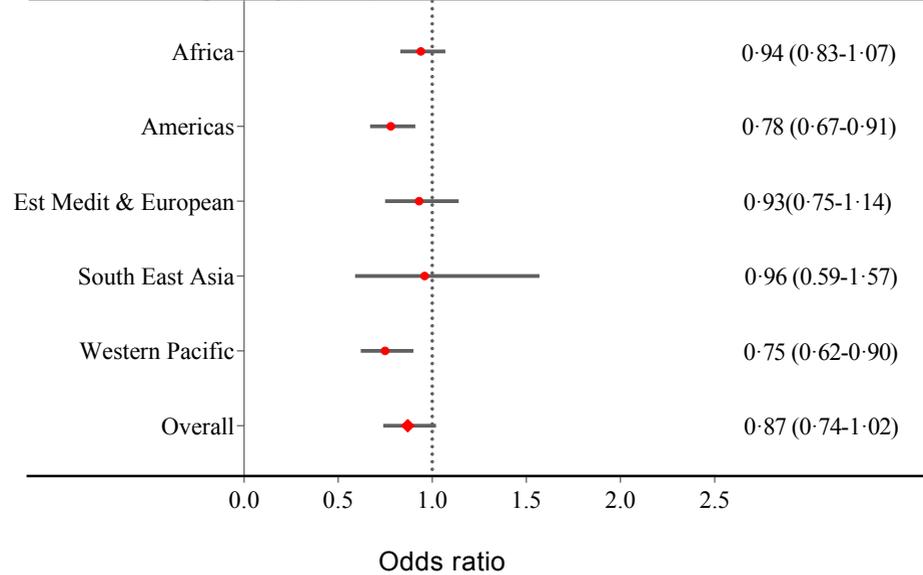
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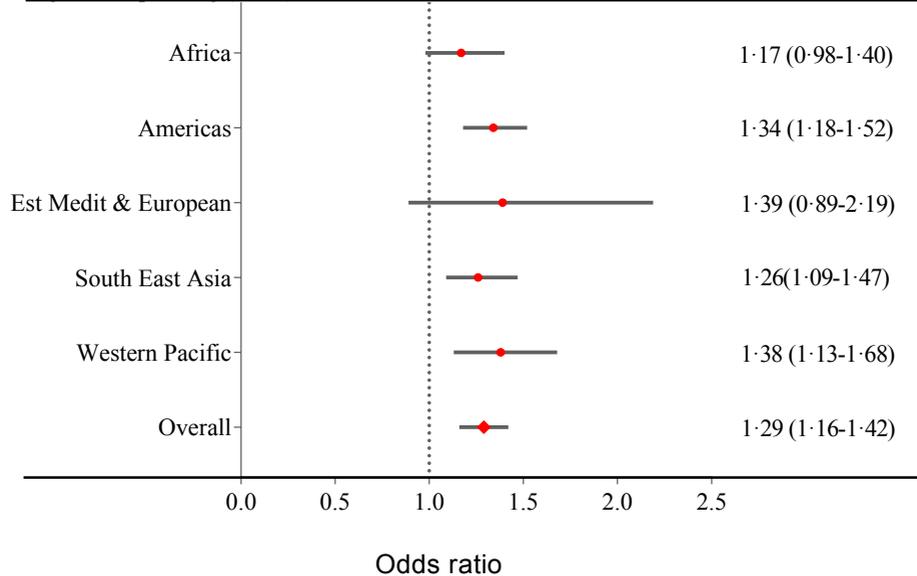
Insufficient PA on planning (males)



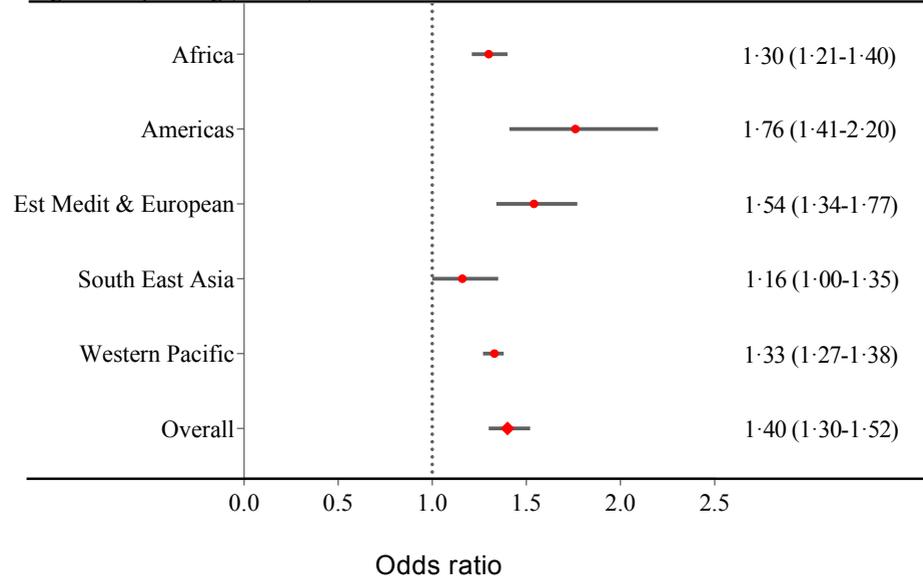
Insufficient PA on planning (females)



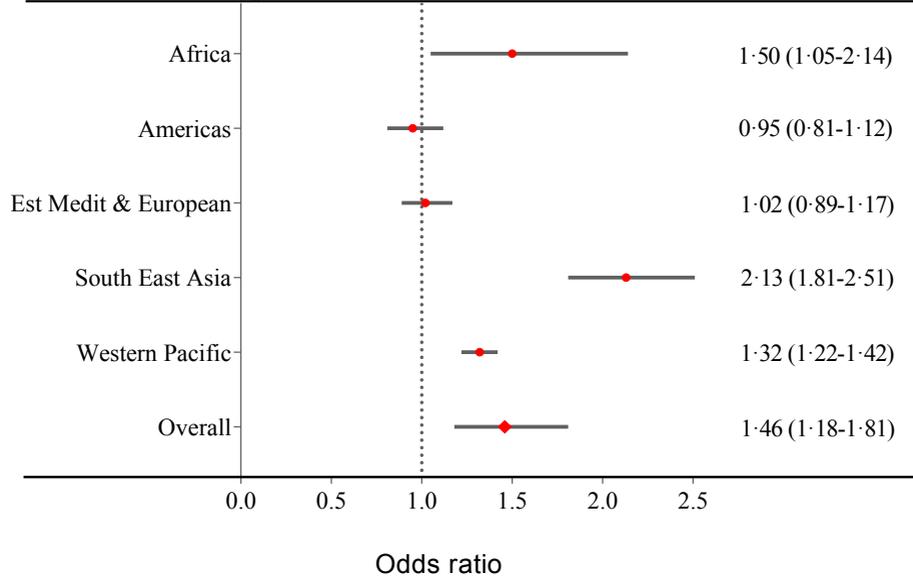
High SB on planning (males)



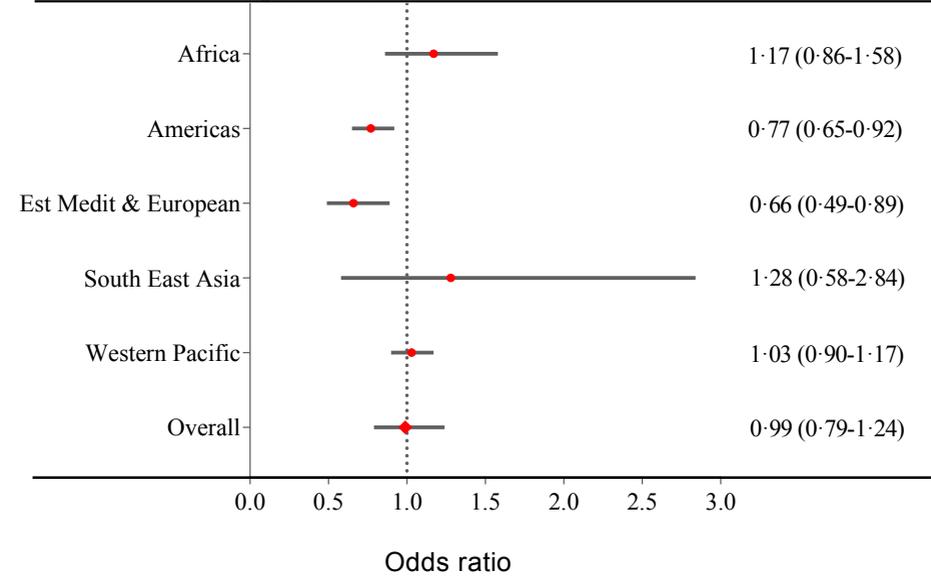
High SB on planning (females)



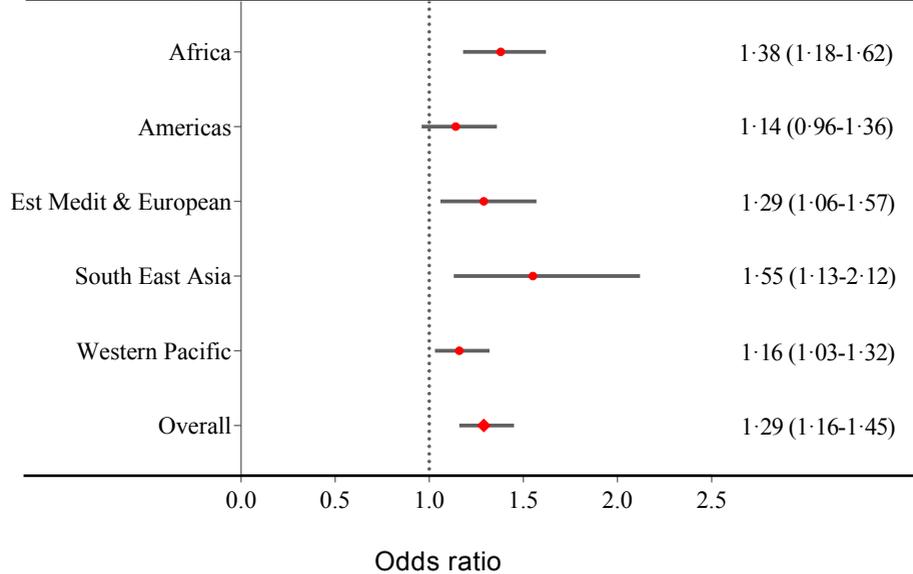
Insufficient PA on attempt (males)



Insufficient PA on attempt (females)



High SB on attempt (males)



High SB on attempt (females)

