

Title: Bullying victimization and obesogenic behavior among adolescents aged 12-15 years from 54 low- and middle-income countries

Running title: Bullying and obesogenic behavior among adolescents

Lee Smith^{1*}, Louis Jacob^{2,3}, Jae Il Shin⁴, Mark A Tully⁵, Damiano Pizzol⁶, Guillermo F. López-Sánchez⁷, Trish Gorely⁸, Lin Yang⁹, Igor Grabovac¹⁰, Ai Koyanagi^{3,11}

1. The Cambridge Centre for Sport and Exercise Sciences, Anglia Ruskin University, Cambridge, United Kingdom.

2. Faculty of Medicine, University of Versailles Saint-Quentin-en-Yvelines, Montigny-le-Bretonneux, France.

3. Research and Development Unit, Parc Sanitari Sant Joan de Déu, CIBERSAM, Dr. Antoni Pujadas, 42, Sant Boi de Llobregat, Barcelona 08830, Spain.

4. Department of Pediatrics, Yonsei University College of Medicine, Seoul, Korea.

5. Institute of Mental Health Sciences, School of Health Sciences, Ulster University, Newtownabbey, United Kingdom.

6. Italian Agency for Development Cooperation - Khartoum, Sudan.

7. Faculty of Sport Sciences, University of Murcia, Spain.

8. Department of Nursing and Midwifery, University of the Highlands and Islands, Inverness, Scotland, United Kingdom.

9. Department of Cancer Epidemiology and Prevention Research, Alberta Health Services, Holy Cross Centre, Canada.

10. Department of Social and Preventive Medicine, Centre for Public Health, Medical University of Vienna, Kinderspitalgasse 15/1, 1090, Vienna, Austria.

11. ICREA, Pg. Lluís Companys 23, 08010, Barcelona, Spain.

* Correspondence: Dr. Lee Smith. lee.smith@anglia.ac.uk

ABSTRACT

Background: Data on the association between obesogenic behaviors and bullying victimization among adolescents are scarce from low- and middle-income countries.

Objectives: To assess the associations between obesogenic behaviors and bullying victimization in 54 low- and middle-income countries.

Methods: Cross-sectional data from the Global school-based student health survey were analyzed. Data on bullying victimization and obesogenic behaviors were collected. The association between bullying victimization and the different types of obesogenic behavior (anxiety-induced insomnia, fast-food consumption, carbonated soft-drink consumption, no physical activity, sedentary behavior) were assessed by country-wise multivariable logistic regression analysis adjusting for age, sex, food insecurity, and obesity with obesogenic behaviors being the outcome.

Results: The sample consisted of 153,929 students aged 12-15 years [mean (SD) age 13.8 (1.0) years; 49.3% girls]. Overall, bullying victimization (vs. no bullying victimization) was significantly associated with greater odds for all types of obesogenic behavior with the exception of physical activity, which showed an inverse association. Specifically, the ORs (95% CIs) were: anxiety-induced sleep problems 2.65 (2.43-2.88); fast-food consumption 1.36 (1.27-1.44); carbonated soft-drink consumption 1.14 (1.08-1.21); no physical activity 0.84 (0.79-0.89); and sedentary behavior 1.34 (1.25-1.43).

Conclusions: In this large representative sample of adolescents from low- and middle-income countries, bullying victimization was found to be associated with several, but not all, obesogenic behaviors.

Key words: low- and middle-income countries, adolescents, bullying, victimization, obesogenic behavior

1. INTRODUCTION

Bullying may be defined as repeated undesired aggressive behaviors perpetrated by a peer or a group of peers that involve a power imbalance favoring the perpetrator.¹ There are verbal (e.g., name calling), relational (e.g., social exclusion), or physical (e.g., hitting) forms of bullying.² Among the global adolescent population, bullying victimization has a high prevalence at approximately 36%.³

One factor that has been shown to be associated with bullying victimization among adolescents is overweight and obesity.⁴⁻⁷ Adolescents with overweight or obesity may be more likely to be bullied owing to their physical appearance. Indeed, adolescents with overweight and obesity are often stigmatized as they may be perceived by their peers, to lack self-discipline, and to be incompetent and lazy.⁸ On the other hand, it is also possible that bullying victimization leads to obesogenic behaviors and resultant obesity via factors such as stress. For example, perceived stress can lead to impulse to eat in general, to eat or drink calorie-dense/palatable aliments or drinks (including alcohol), or to eat outside of a reasonable time structure (e.g., night eating).^{9,10} Moreover, bullying victimization has been associated with higher levels of sleep problems,¹¹ which is known to induce obesity.¹² Furthermore, children who are bullied have been reported to have low levels of physical activity¹³ potentially owing to staying at home to avoid bullying victimization episodes. For instance, in a sample of 7,786 US middle school students, it was found that bullying victimization was associated with fewer days in physical education and lower odds of reporting at least 60 minutes of physical activity more than once a week.^{13,14}

Thus, it is possible that a vicious cycle exists where obesity may lead to a higher risk of bullying victimization, which in turn may further lead to weight gain via obesogenic

behaviors due to associated perceived stress etc. However, the above-mentioned studies and others alike have predominantly focused on high-income countries (HICs) and utilized small samples. Moreover, to our knowledge there is no existing literature looking specifically at the relationship between bullying victimization and carbonated soft drink consumption or sedentary behavior.⁵

Studies from LMICs are particularly important as they represent 90% of the world's adolescent population,¹⁵ and LMICs are experiencing a rapid increase in overweight and obesity likely owing to lifestyle changes such as poor diet and lack of physical activity.¹⁶ Furthermore, one large cross-sectional study found that adolescents with overweight and obesity may be more likely to be bullied in LMICs,⁵ but this study did not assess the degree to which bullied adolescents engage in obesogenic behavior.

Therefore, the aim of the present study was to examine the cross-sectional association between bullying victimization and obesogenic behaviors (i.e., anxiety-induced sleep problems, fast-food consumption, carbonated soft-drink consumption, low physical activity, sedentary behavior) among a large sample of adolescents aged 12-15 years from 54 LMICs.

2. METHODS

Publicly available data from the global school-based health survey (GSHS) were analyzed.

Details on this survey can be found at <http://www.who.int/chp/gshs> and

<http://www.cdc.gov/gshs>. Briefly, the GSHS was jointly developed by the WHO and the US Centers for Disease Control and Prevention (CDC), and other UN allies. The core aim of this survey was to assess and quantify risk and protective factors of major non-communicable

diseases. The survey draws content from the CDC Youth Risk Behavior Survey (YRBS) for which test-retest reliability has been established.¹⁷ The survey used a standardized two-stage probability sampling design for the selection process within each participating country. For the first stage, schools were selected with probability proportional to size sampling. The second stage involved the random selection of classrooms which included students aged 13-15 years within each selected school. All students in the selected classrooms were eligible to participate in the survey regardless of age. Data collection was performed during one regular class period. The questionnaire was translated into the local language in each country and consisted of multiple choice response options; students recorded their response on computer scannable sheets. All GSHS surveys were approved, in each country, by both a national government administration (most often the Ministry of Health or Education) and an institutional review board or ethics committee. Student privacy was protected through anonymous and voluntary participation, and informed consent was obtained as appropriate from the students, parents and/or school officials. Data were weighted for non-response and probability selection.

From all publicly available data, we selected all nationally representative datasets from LMICs (based on the World Bank classification at the time of the survey) that included the variables used in the current analysis. If there were more than two datasets from the same country, we chose the most recent dataset. A total of 54 countries were included in the current study. The characteristics of each country or survey are provided in **Table 1**. For the included countries, the survey was conducted between 2009 and 2017.

2.1. Bullying victimization

First, the students were provided the following definition of bullying: “Bullying occurs when a student or group of students say or do bad and unpleasant things to another student. It is

also bullying when a student is teased a lot in an unpleasant way or when a student is left out of things on purpose. It is not bullying when two students of about the same strength or power argue or fight or when teasing is done in a friendly and fun way.” Subsequently, bullying victimization was assessed by the question “During the past 30 days, on how many days were you bullied?” and those who were bullied on at least one day were considered to be a victim of bullying, while those who were not bullied in the past 30 days were considered to not be a victim of bullying.¹⁸

2.2. Obesogenic behavior

2.2.1. Anxiety-induced sleep problems

Anxiety-induced insomnia was assessed with the question “During the past 12 months, how often have you been so worried about something that you could not sleep at night?” with answer options: ‘never’, ‘rarely’, ‘sometimes’, ‘most of the time’, and ‘always’. As in a previous GSHS study, those who answered ‘most of the time’ or ‘always’ were considered to have anxiety-induced insomnia.¹⁹ Data on anxiety-induced sleep problems were not available from Algeria, Egypt, and Vietnam.

2.2.2. Fast-food consumption

Fast food consumption was assessed with the question “During the past 7 days, on how many days did you eat food from a fast food restaurant?” with country specific examples on fast food restaurants (e.g., McDonalds, KFC, Pizza Hut). This variable was dichotomized as at least once or not at all. Data on fast-food consumption were not available from Malawi and Myanmar.

2.2.3. Carbonated soft-drink consumption

Consumption of carbonated soft drinks was assessed with the question “During the past 30 days, how many times per day did you usually drink carbonated soft drinks?” Country specific examples of carbonated soft drinks were provided (e.g., Coca Cola, Sprite, Pepsi), and the student was instructed not to include diet soft drinks. Answer options included ‘I did not drink carbonated soft drinks during the past 30 days’, ‘less than 1 time per day’, ‘1 time per day’, ‘2 times per day’, ‘3 times per day’, ‘4 times per day’, and ‘5 or more times per day’. This variable was dichotomized as at least <1 time per day or not at all. Data on carbonated soft-drinks were not available from Malawi.

2.2.4. No physical activity

Levels of physical activity were assessed with the PACE+ Adolescent Physical Activity Measure,²⁰ and the students were asked about the number of days with any kind of physical activity of at least 60 minutes during the past 7 days. For the current study, responses were dichotomized as 0 days (no physical activity; coded 1) and ≥ 1 days (coded 0). Data on physical activity were not available from Malawi, Maldives, and Swaziland.

2.2.5. Sedentary behavior

Sedentary behavior was assessed with the question “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 answer options: <1, 1-2, 3-4, 5-6, 7-8, and ≥ 8 hours/day. This excluded time at school and when doing homework. In accordance with previous research showing that engaging in sedentary behavior for ≥ 3 hours/day is associated with significant health risks,²¹⁻²³ the variable was dichotomized (≥ 3 hours/day or <3

hours/day). Data on sedentary behavior were not available from Dominica, Malawi, Maldives, and Swaziland.

2.3. Control variables

The control variables included sex, age, food insecurity (as a proxy of socio-economic status), and obesity. As in previous studies using the same dataset,^{22,24} food insecurity was used as a proxy for socioeconomic status as there were no variables on socioeconomic status in the GSHS. Food insecurity was assessed by the question “During the past 30 days, how often did you go hungry because there was not enough food in your home?” Answer options were categorized as ‘never’, ‘rarely/sometimes’, and ‘most of the time/always’. Trained survey staff conducted measurement of weight and height. Body mass index was calculated as weight in kilograms divided by height in meters squared. Obesity was defined as >2 SDs above the median for age and sex based on the 2007 WHO Child Growth reference.²⁵

2.4. Statistical analysis

Statistical analyses were performed with Stata 14.1 (Stata Corp LP, College station, Texas). The analysis was restricted to those aged 12-15 years as most students were within this age group while information on the exact age outside of this age range was not available. Age- and sex-adjusted prevalence of obesogenic behaviors and bullying victimization by country were calculated using the proportions derived from the overall sample as the standard population. The association between bullying victimization (vs. no bullying victimization) and the different types of obesogenic behavior (anxiety-induced insomnia, fast-food consumption, carbonated soft-drink consumption, no physical activity, sedentary behavior) were assessed by country-wise multivariable logistic regression analysis adjusting for age, sex, food insecurity, and obesity with obesogenic behaviors being the outcome. Pooled

estimates were obtained by meta-analysis with random effects based on country-wise estimates. In order to assess the level of between-country heterogeneity in the association between different types of violence and obesogenic behavior, we also calculated the Higgins's I^2 which represents the degree of heterogeneity that is not explained by sampling error. I^2 values of 25%, 50%, and 75% are often considered low, moderate, and high level of heterogeneity, respectively.²⁶ Analyses stratified by sex adjusting for age, food insecurity, and obesity were also conducted. Sampling weights and the clustered sampling design of the surveys were taken into account. Results from the logistic regression analyses are presented as odds ratios (ORs) with 95% confidence intervals (CIs). The level of statistical significance was set at $p < 0.05$.

3. RESULTS

The sample consisted of 153,929 students aged 12-15 years [mean (SD) age 13.8 (1.0) years; 49.3% girls]. Overall, the prevalence of bullying victimization was 35.9%, while the prevalence of obesogenic behaviors were: 7.1% (anxiety-induced insomnia); 50.5% (fast-food consumption); 76.1% (carbonated soft-drink consumption); 31.4% (no physical activity); 26.4% (≥ 3 hours/day sedentary behavior). A large variety in the prevalence of bullying victimization and obesogenic behavior was observed between countries (Table 1, supplementary Table S1). The prevalence of all types of obesogenic behavior was higher among those who were bullied with the exception of low physical activity (**Figure 1**).

The adjusted association between bullying victimization and obesogenic behaviors based on meta-analyses are shown in **Table 2**. Overall, bullying victimization (vs. no bullying victimization) was significantly associated with greater odds for all types of obesogenic

behavior with the exception of physical activity, which showed an inverse association. Specifically, the ORs (95% CIs) were: anxiety-induced sleep problems 2.65 (2.43-2.88); fast-food consumption 1.36 (1.27-1.44); carbonated soft-drink consumption 1.14 (1.08-1.21); no physical activity 0.84 (0.79-0.89); and sedentary behavior 1.34 (1.25-1.43). The strength of the association was similar among boys and girls for all types of obesogenic behavior. The country-wise estimates on which the meta-analysis was based are shown in Figure S1-S15 of the supplementary material. A moderate level of between-country heterogeneity was observed for most associations.

4. DISCUSSION

The present analysis utilized a sample of 153,929 students aged 12-15 years from 54 LMICs. The analyses show a high prevalence of bullying victimization and obesogenic behaviors among the studied countries. Overall, bullying victimization was significantly associated with greater odds for all types of obesogenic behavior with the exception of physical activity, which showed an inverse association, although a moderate level of between-country heterogeneity was observed for almost all associations. The results of our study support previous research in HICs carried out in smaller samples^{10,11,12} and using overweight/obesity as an outcome.⁵⁻⁷ The present study adds to this research by showing that bullying victimization is associated with various types of obesogenic behavior in LMICs in a large representative sample of adolescents.

Although the mechanisms underlying the link between bullying victimization and obesogenic behavior are largely unknown, several hypotheses may be proposed. First bullying victimization has been found to be associated with higher levels of perceived stress²⁷ and

stress per se is associated with obesogenic behaviors such as consumption of energy-dense foods and potentially carbonated soft drinks, as well as anxiety-induced insomnia.^{28,29} Indeed, research has suggested that stress can lead to eating as a coping mechanism for bullying victimization.³⁰ Moreover, in adolescents, one study found that stress not only increased food consumption in certain individuals but also shifted their food choices from lower fat to higher fat foods.³¹ In the case of anxiety induced insomnia, literature has shown that bullying victimization leads to both anxiety³² and insomnia.³³ Although, no other research exists on the relationship between bullying victimization and sedentary behavior, the relationship can be plausibly explained. It is possible that those who are bullied are more likely to stay at home (and engage in activities such as computer use and TV viewing) to avoid contact with peers. Alternatively, those who experience bullying victimization may develop mental health complications³⁴ and these conditions have been shown to be associated with higher levels of sedentary behavior.³⁵ Future research of a qualitative nature is required to further explain the relationship between bullying victimization and sedentary behavior.

The finding that bullying victimization was inversely associated with lower levels of physical activity in our study should be noted. This contrasts with the results from previous studies carried out in HICs, which have shown that bullying victimization is positively associated with lower levels of PA.^{13,36,37} Although the reasons for the discrepant results between our study and previous studies from HICs can only be speculated, it is possible that physical activity increases the chances of meeting offenders by being out of home more often in our study setting. The difference may thus be related to where physical activity and bullying occur (e.g., in school or out of school). For example, the proportion of physical activity that originates from commuting to school or through physical education may differ between HICs and LMICs and the risk of being exposed to bullying when engaging in different types of

physical activity may differ between settings. Further research to investigate the differences in associations between bullying victimization and physical activity between LMICs and HICs is warranted.

In our study, a moderate level of between-country heterogeneity was observed for most associations between bullying victimization and obesogenic behaviors. Although the reasons for this between-country heterogeneity are unclear, some hypotheses may be proposed. First, given the potentially central role of perceived stress in the association between bullying victimization and obesogenic behavior, it is possible that the severity of bullying or the type of bullying may differ by countries, giving rise to different magnitude in strength of the association between bullying victimization and obesogenic behaviors. For example, previous studies have shown that physical victimization may be particularly stressful³⁸ and it is possible that this type of bullying is more prevalent in some settings compared to others. Relatedly, if the obesogenic behaviors are coping strategies for stress, the tendency for individuals to resort to a certain type of coping strategy may differ by country or culture. For example, although not on obesogenic behaviors per se, a cross-country comparison on coping strategies in relation to bullying victimization between English and Japanese school children found important between-countries differences specifically relating to help-seeking, and found the difference was predominantly owing to differences in fear of social exclusion.³⁹ Alternatively, if those who engage in obesogenic behavior are more likely to be bullied not only for the behavior themselves but for the image it carries (e.g., laziness), it is possible that these behaviors or images may be more subject to bullying in some settings than others.

If our study results are corroborated in future longitudinal studies from LMICs, addressing bullying victimization at school may potentially reduce the risk for weight gain and obesity

among adolescents via the reduction in obesogenic behaviors in this setting. In a recent systematic review on school-based interventions to address bullying, 44 evaluations were identified. The review concluded that school-based anti-bullying programs are effective. Moreover, more intensive programs were more effective, as were programs including parent meetings, firm disciplinary methods, and improved playground supervision.⁴⁰ Despite the fact that causality cannot be established in our study due to the cross-sectional nature, the finding that bullying victimization and obesogenic behaviors (i.e., anxiety-induced insomnia, fast-food and soft-drink consumption, sedentary behavior) tend to co-exist among adolescents in LMICs is alarming given that bullying victimization and these obesogenic behavior are both associated with a myriad of adverse health outcomes (e.g., depression, anxiety disorder, suicidality, and lower quality of life) in adolescence and adulthood.⁴¹⁻⁴³

The findings from the present study must be interpreted in light of its limitations. First, the study relied on self-reported data for bullying victimization, physical activity, sedentary behavior, and fast-food and soft-drink consumption. Thus, some degree of bias may exist (e.g., recall bias and social desirability bias). Second, it is possible that some countries included in our study do not have a proper translation for the word “bullying.” However, the survey provided a clear definition of bullying prior to asking the questions on bullying. Thus, this is likely to have minimized misinterpretation. Relatedly, the bullying item used in this study was a general bullying item which was not specific to obesity or obesogenic behaviors (e.g., physical appearance, laziness). Thus, it is possible that the results may differ if the variable on bullying referred to these specific types of bullying. Next, our study only included adolescents who attend school, and the results may therefore not be generalizable to all adolescents in the respective countries especially in countries where school attendance rates are low. Finally, given the cross-sectional nature of the study, causality or temporal

associations cannot be established. For example, it may be that participating in obesogenic behaviors per se may illicit negative perceptions that may result in a greater risk of being bullied.

In conclusion, in this large representative sample of adolescents from LMICs, bullying victimization was found to be associated with several, but not all obesogenic behaviors. Future studies with the aim of understanding the adverse consequence of these obesogenic behaviors among victims of bullying in adolescence should be conducted. Interventions that address bullying in school may also have positive effects in terms of reducing overweight or obesity and this is an area for future research.

CONFLICTS OF INTEREST

None.

ACKNOWLEDGEMENT

This research was based on data from the Global School-Based Student Health Survey, which was made available for use by the Chronic Diseases and Health Promotion Department of the WHO and the U.S. Centers for Disease Control and Prevention.

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

REFERENCES

1. Gladden RM, Vivolo-Kantor AM, Hamburger ME, Lumpkin CD. Bullying surveillance among youths: Uniform definitions for public health and recommended data elements. 2014. <https://www.cdc.gov/violenceprevention/pdf/bullying-definitions-final-a.pdf> Accessed April 14, 2020.
2. Smith PK, Cowie H, Olafsson RF, Liefoghe AP. Definitions of bullying: A comparison of terms used, and age and gender differences, in a Fourteen-Country international comparison. *Child Dev.* 2002;73(4):1119-33.
3. Modecki KL, Minchin J, Harbaugh AG, Guerra NG, Runions KC. Bullying prevalence across contexts: A meta-analysis measuring cyber and traditional bullying. *J Adolesc Health.* 2014;55(5):602-11.
4. Van Geel M, Vedder P, Tanilon J. Are overweight and obese youths more often bullied by their peers? A meta-analysis on the relation between weight status and bullying. *Int J Obes.* 2014;38(10):1263-7.
5. Koyanagi A, Veronese N, Vancampfort D, et al. Association of bullying victimization with overweight and obesity among adolescents from 41 low-and middle-income countries. *Pediatr. Obes.* 2020;15(1):e12571.
6. Nabors L, Odar Stough C, Garr K, Merianos A. Predictors of victimization among youth who are overweight in a national sample. *Pediatr. Obes.* 2019;14(7):e12516.
7. Puhl RM, Himmelstein MS, Watson RJ. Weight - based victimization among sexual and gender minority adolescents: Findings from a diverse national sample. *Pediatr. Obes.* 2019;14(7):e12514.
8. Puhl RM, Heuer CA. The stigma of obesity: a review and update. *Obes.* 2009;17(5):941-64.
9. Schag K, Schönleber J, Teufel M, Zipfel S, Giel KE. Food-related impulsivity in obesity and Binge Eating Disorder—a systematic review. *Obes Rev.* 2013;14(6):477-95.
10. Albaladejo-Blázquez N, Ferrer-Cascales R, Ruiz-Robledillo N, Sánchez-Sansegundo M, Clement-Carbonell V, Zaragoza-Martí A. Poor dietary habits in bullied adolescents: The moderating effects of diet on depression. *Int. J. Environ. Res. Public Health.* 2018;15(8):1569.
11. Donoghue C, Meltzer LJ. Sleep it off: Bullying and sleep disturbances in adolescents. *J. Adolesc.* 2018;68:87-93.
12. Hargens TA, Kaleth AS, Edwards ES, Butner KL. Association between sleep disorders, obesity, and exercise: a review. *Nat Sci Sleep.* 2013;5:27-35.
13. Roman CG, Taylor CJ. A multilevel assessment of school climate, bullying victimization, and physical activity. *J Sch Health.* 2013;83(6):400-7.
14. Demissie Z, Lowry R, Eaton DK, Hertz MF, Lee SM. Associations of school violence with physical activity among US high school students. *J Phys Act Health.* 2014;11(4):705-11.
15. United Nations. World population prospects: the 2017 revision, key findings and advance tables. 2017. <https://www.un.org/development/desa/publications/world-population-prospects-the-2017-revision.html> Accessed April 14, 2020.
16. De Onis M, Blössner M, Borghi E. Global prevalence and trends of overweight and obesity among preschool children. *Am J Clin Nutr.* 2010;92(5):1257-64.
17. Brener ND, Collins JL, Kann L, Warren CW, Williams BI. Reliability of the Youth Risk Behavior Survey Questionnaire. *Am J Epidemiol.* 1995;141(6):575-580.

18. Koyanagi A, Oh H, Carvalho AF. Bullying victimization and suicide attempt among adolescents aged 12-15 years from 48 countries. *Am Acad Child Adolesc Psychiatry*. 2019;58(9):907-918.
19. Sharma B, Lee TH, Nam EW. Loneliness, Insomnia and Suicidal Behavior among School-Going Adolescents in Western Pacific Island Countries: Role of Violence and Injury. *Int. J. Environ. Res. Public Health*. 2017;14(7):791.
20. Prochaska JJ, Sallis JF, Long B. A physical activity screening measure for use with adolescents in primary care. *Arch Pediatr Adolesc Med*. 2001;155(5):554-9.
21. Guthold R, Cowan MJ, Autenrieth CS, Kann L, Riley LM. Physical activity and sedentary behavior among schoolchildren: a 34-country comparison. *J Pediatr*. 2010;157(1):43-9.
22. Ashdown-Franks, G., Vancampfort D., Firth J., et al. Leisure-Time Sedentary Behavior and Obesity Among 116,762 Adolescents Aged 12-15 Years from 41 Low- and Middle-Income Countries. *Obes*. 2019;27(5):830-6.
23. Vancampfort D, Stubbs B, Firth J, Van Damme T, Koyanagi A. Sedentary behavior and depressive symptoms among 67,077 adolescents aged 12-15 years from 30 low- and middle-income countries. *Int J Behav Nutr Phys Act*. 2018;15(1):73.
24. Carvalho AF, Stubbs B, Vancampfort D, et al. Cannabis use and suicide attempts among 86,254 adolescents aged 12-15 years from 21 low- and middle-income countries. *Eur Psychiatry*. 2018;56:8-13.
25. Caleyachetty R, Thomas GN, Kengne AP, et al. The double burden of malnutrition among adolescents: analysis of data from the Global School-Based Student Health and Health Behavior in School-Aged Children surveys in 57 low- and middle-income countries. *Am J Clin Nutr* 2018;108(2):414-24.
26. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ*. 2003;327(7414):557-60.
27. Arseneault L, Bowes L, Shakoor S. Bullying victimization in youths and mental health problems: 'Much ado about nothing'?. *Psychol. Med*. 2010;40(5):717-29.
28. Mikolajczyk RT, El Ansari W, Maxwell AE. Food consumption frequency and perceived stress and depressive symptoms among students in three European countries. *Nutr. J*. 2009;8(1):31.
29. Kim K, Uchiyama M, Okawa M, Liu X, Ogihara R. An epidemiological study of insomnia among the Japanese general population. *Sleep*. 2000;23(1):41-7.
30. Jenkins S, Horner SD. Barriers that influence eating behaviors in adolescents. *J Pediatr Nurs* 2005;20(4):258-67.
31. Zellner DA, Loaiza S, Gonzalez Z, et al. Food selection changes under stress. *Physiol Behav* 2006;87(4):789-93.
32. Swearer SM, Song SY, Cary PT, Eagle JW, Mickelson WT. Psychosocial correlates in bullying and victimization: The relationship between depression, anxiety, and bully/victim status. *J Emot Abuse* 2001;2(2-3):95-121.
33. Van Geel M, Goemans A, Vedder PH. The relation between peer victimization and sleeping problems: A meta-analysis. *Sleep Med. Rev*. 2016;27:89-95.
34. Arseneault L. The long-term impact of bullying victimization on mental health. *World psychiatry*. 2017;16(1):27-28.
35. Zhai L, Zhang Y, Zhang D. Sedentary behaviour and the risk of depression: a meta-analysis. *Br J Sports Med*. 2015;49(11):705-9.
36. Case KR, Perez A, Saxton DL, Hoelscher DM, Springer AE. Bullied status and physical activity in Texas adolescents. *Health Educ Behav*. 2016;43(3):313-20.

37. Henriksen PW, Rayce SB, Melkevik O, Due P, Holstein BE. Social background, bullying, and physical inactivity: National study of 11-to 15-year-olds. *Scand. J. Med. Sci. Sports.* 2016;26(10):1249-55.
38. Sullivan TN, Farrell AD, Kliewer W. Peer victimization in early adolescence: Association between physical and relational victimization and drug use, aggression, and delinquent behaviors among urban middle school students. *Dev Psychopathol.* 2006;18(1):119-37.
39. Kanetsuna T, Smith PK, Morita Y. Coping with bullying at school: children's recommended strategies and attitudes to school - based interventions in England and Japan. *Aggress. Behav.* 2006;32(6):570-80.
40. Ttofi MM, Farrington DP. Effectiveness of school-based programs to reduce bullying: A systematic and meta-analytic review. *J. Exp. Criminol.* 2011;7(1):27-56.
41. Takizawa R, Maughan B, Arseneault L. Adult health outcomes of childhood bullying victimization: evidence from a five-decade longitudinal British birth cohort. *Am. J. Psychiatry* 2014;171(7):777-84.
42. Roane BM, Taylor DJ. Adolescent insomnia as a risk factor for early adult depression and substance abuse. *Sleep* 2008;31(10):1351-6.
43. Sánchez-Villegas A, Toledo E, De Irala J, et al. Fast-food and commercial baked goods consumption and the risk of depression. *Public health nutr.* 2012;15(3):424-32.

Tables and Figures

Table 1 Survey characteristics and age- and sex-adjusted prevalence of different types of obesogenic behavior and bullying victimization by country

Country	Year	Response rate (%)	N ^a	Anxiety-induced sleep problems (%)	Fast-food consumption (%)	Carbonated soft-drink consumption (%)	No physical activity (%)	Sedentary behavior (%)	Bullying victimization (%)
Afghanistan	2014	79	2579	21.7	64.1	71.2	31.5	22.8	41.8
Algeria	2011	98	4532	NA	53.1	93.0	11.5	27.1	51.0
Antigua & Barbuda	2009	67	1266	13.9	55.3	85.7	28.9	53.7	25.8
Argentina	2012	71	28368	7.8	32.1	90.0	14.4	49.1	24.3
Bangladesh	2014	91	2989	4.5	53.6	83.6	27.8	14.1	23.1
Belize	2011	88	2112	11.7	65.6	88.4	32.7	36.1	30.6
Benin	2016	78	2536	13.1	45.7	74.2	9.2	25.3	48.5
Bolivia	2012	88	3696	7.1	57.0	87.9	21.7	24.2	30.4
Cambodia	2013	85	3806	3.8	26.7	84.2	41.0	9.9	21.6
Costa Rica	2009	72	2679	4.0	53.4	86.9	17.0	43.1	19.3
Dominica	2009	84	1642	8.9	46.6	83.8	35.8	NA	28.0
Dominican Republic	2016	63	1481	7.6	49.8	91.3	34.8	41.9	22.6
East Timor	2015	79	3704	7.7	67.7	88.3	30.9	15.2	32.4
Egypt	2011	85	2568	NA	49.6	81.8	29.8	27.6	69.7
El Salvador	2013	88	1915	6.1	56.2	90.1	32.7	33.6	22.3
Fiji	2016	79	3705	13.3	67.5	91.4	30.1	24.4	28.8
Ghana	2012	82	1648	11.9	70.0	71.8	39.0	18.3	62.7
Guatemala	2015	82	4374	6.5	56.9	88.2	31.6	22.5	23.5
Guyana	2010	76	2392	14.6	55.5	90.4	40.4	35.9	39.3
Honduras	2012	79	1779	5.9	47.5	92.1	28.9	30.4	31.9
Indonesia	2015	94	11142	4.4	54.3	62.3	32.2	25.7	21.1
Iraq	2012	88	2038	11.2	55.3	87.0	38.1	25.6	28.0
Jamaica	2017	60	1667	13.2	55.8	86.4	28.4	45.0	29.9
Kiribati	2011	85	1582	8.2	45.1	48.4	29.9	14.9	37.7
Laos	2015	70	3683	2.2	40.3	90.5	24.4	17.4	14.5
Lebanon	2017	82	5708	12.0	77.8	81.6	22.5	41.4	17.8
Liberia	2017	71	2744	15.4	43.0	75.4	42.7	22.1	48.5
Malawi	2009	94	2359	13.9	NA	NA	NA	NA	43.9
Malaysia	2012	89	25507	4.4	48.5	73.2	20.4	42.6	21.9
Maldives	2014	60	3493	13.0	40.4	76.8	NA	NA	33.6
Mauritania	2010	70	2063	10.9	63.8	76.8	41.3	39.2	46.8
Mauritius	2017	84	3012	7.6	54.3	81.6	23.6	36.2	26.3
Mongolia	2013	88	5393	5.1	55.0	73.3	13.9	39.8	31.4
Morocco	2016	91	6745	14.2	61.8	65.2	23.7	26.8	37.5

Mozambique	2015	80	1918	8.7	66.1	88.1	25.6	40.6	46.7
Myanmar	2016	86	2838	3.6	NA	79.7	29.6	16.4	49.5
Namibia	2013	89	4531	12.3	54.8	75.1	46.9	36.9	44.0
Nepal	2015	69	6529	3.6	75.0	75.9	51.3	9.9	50.7
Pakistan	2009	76	5192	7.8	22.1	62.0	50.0	7.6	40.2
Paraguay	2017	87	3149	6.9	54.4	91.3	22.6	32.7	17.0
Peru	2010	85	2882	9.1	49.9	87.0	18.9	27.4	46.4
Philippines	2015	79	8761	10.2	52.4	87.7	45.2	30.5	51.8
Samoa	2011	79	2418	26.8	78.4	81.3	28.4	37.5	73.9
Solomon Islands	2011	85	1421	13.4	63.9	75.1	22.1	27.8	64.1
Sri Lanka	2016	89	3262	4.1	42.4	61.6	15.0	35.6	40.4
Suriname	2016	83	2126	11.2	63.7	95.1	34.1	44.0	24.9
Swaziland	2013	97	3680	6.1	42.0	72.4	NA	NA	32.7
Tanzania	2014	87	3793	6.2	35.0	63.2	27.3	20.4	26.5
Thailand	2015	89	5894	8.3	79.8	88.0	23.0	51.0	32.7
Tonga	2017	90	3333	13.6	69.1	87.5	23.9	20.4	40.3
Tuvalu	2013	90	943	7.0	42.2	70.4	48.2	15.4	29.4
Vanuatu	2016	57	2159	7.9	57.7	72.0	42.7	20.7	53.4
Vietnam	2013	96	3331	NA	31.5	74.2	29.1	33.6	17.0
Yemen	2014	75	2655	12.6	33.9	66.0	40.0	19.4	41.2

^a Based on sample aged 12-15 years.

Table 2 Association between bullying victimization and obesogenic behaviors estimated by meta-analysis with random effects based on country-wise estimates

Outcome		Unweighted N	OR [95%CI]	I ²
Anxiety-induced sleep problems ^a	Overall	134155	2.65 [2.43,2.88]	55.3
	Boys	63114	2.63 [2.38,2.91]	21.1
	Girls	71041	2.63 [2.38,2.91]	47.7
Fast-food consumption ^b	Overall	137495	1.36 [1.27,1.44]	68.2
	Boys	64702	1.43 [1.34,1.53]	49.3
	Girls	72793	1.29 [1.20,1.39]	58.2
Carbonated soft-drink consumption ^c	Overall	139496	1.14 [1.08,1.21]	50.2
	Boys	65579	1.17 [1.09,1.25]	31.6
	Girls	73917	1.15 [1.07,1.24]	37.3
Low physical activity ^d	Overall	134876	0.84 [0.79,0.89]	60.5
	Boys	633601	0.85 [0.78,0.92]	47.8
	Girls	71275	0.84 [0.78,0.90]	42.0
Sedentary behavior ^e	Overall	133221	1.34 [1.25,1.43]	66.8
	Boys	62779	1.36 [1.27,1.47]	45.3
	Girls	70422	1.30 [1.19,1.42]	66.3

Abbreviation: OR Odds ratio; CI Confidence interval

Country-wise estimates were adjusted for age, sex, food insecurity, and obesity with the exception of the sex-stratified analysis which was not adjusted for sex.

^a Algeria, Egypt, and Vietnam were not included due to lack of data.

^b Malawi and Myanmar were not included due to lack of data.

^c Malawi was not included due to lack of data.

^d Malawi, Maldives, and Swaziland were not included due to lack of data.

^e Dominica, Malawi, Maldives, and Swaziland were not included due to lack of data.

All estimates for statistically significant (i.e., P<0.05).

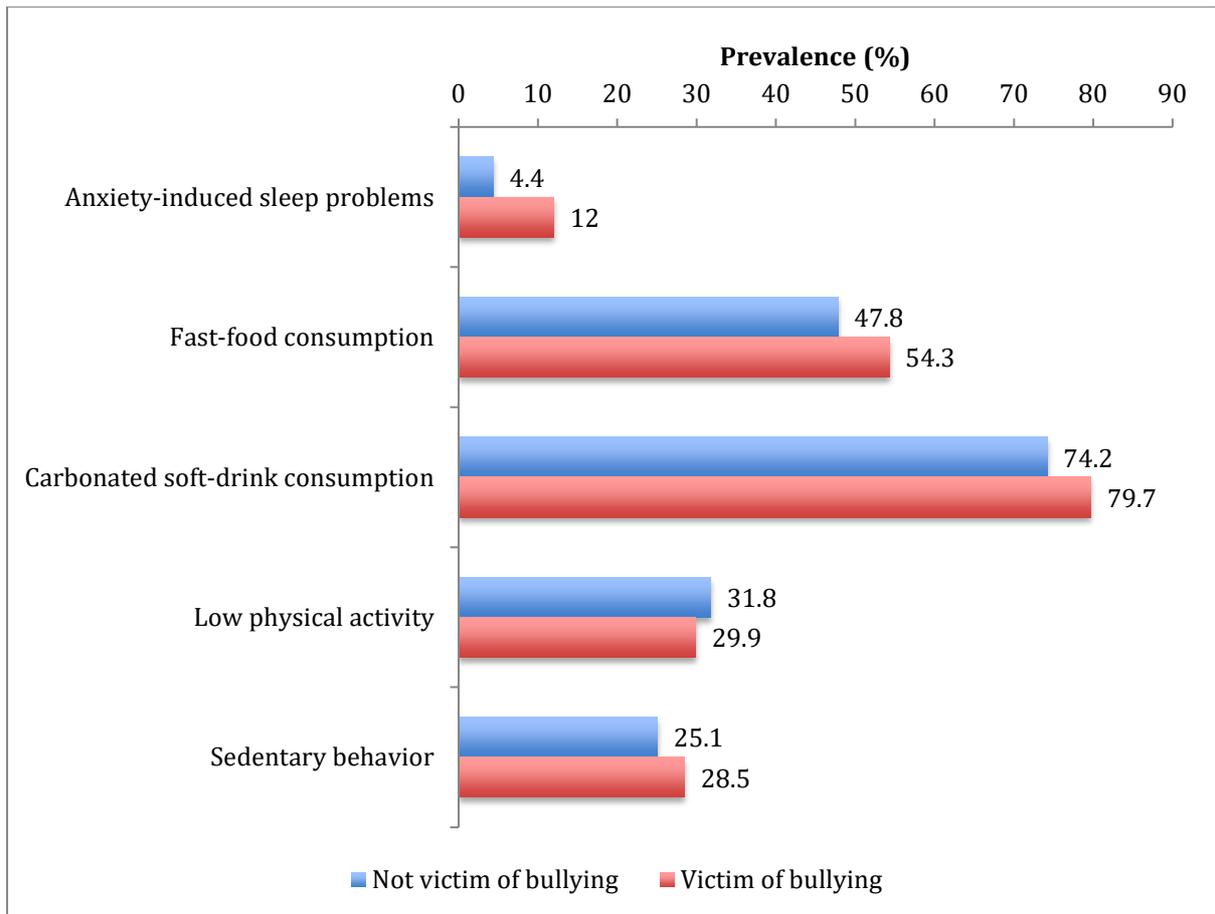


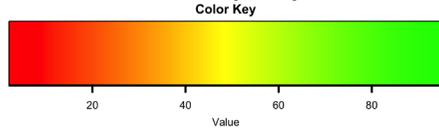
Figure 1 Prevalence of different types of obesogenic behavior by presence or absence of bullying victimization

The prevalence is based on weighted estimates.

The unweighted n/N for each obesogenic behavior were: anxiety-induced sleep problems (not victim of bullying 5207/93441; victim of bullying 6065/42734); fast-food consumption (44954/94693; 24700/44778); carbonated soft-drink consumption (75647/95663; 8730/37015); low physical activity (24670/92559; 11759/44309); sedentary behavior (29273/91412; 14715/43733).

APPENDIX

Table S1 Heat map of prevalence of obesogenic behavior and bullying victimization by country



21.7	64.1	71.2	31.5	22.8	41.8	Alghanistan
13.9	53.1	93	11.5	27.1	51	Algeria
7.8	55.3	85.7	28.9	53.7	25.8	Antigua & Barbuda
4.6	32.1	30	14.4	49.1	24.3	Argentina
11.7	53.6	83.6	27.8	14.1	23.1	Bangladesh
13.1	65.6	88.4	32.7	36.1	30.6	Belize
7.1	45.7	74.2	9.2	25.3	48.5	Benin
3.8	57	87.9	21.7	24.2	30.4	Bolivia
4	28.7	84.2	41	9.8	21.5	Cambodia
8.9	53.4	86.9	17	43.1	19.3	Costa Rica
7.8	46.6	83.8	35.8		28	Dominica
7.7	49.8	91.3	34.8	41.9	22.6	Dominican Republic
	67.7	88.3	30.9	15.2	32.4	East Timor
	45.6	81.8	29.8	27.6	69.7	Egypt
	56.2	90.1	32.7	33.6	22.3	El Salvador
6.1	67.5	91.4	30.1	24.4	28.8	Fiji
13.3	70	71.8	39	18.3	62.7	Ghana
11.9	56.9	88.2	31.6	22.5	23.5	Guatemala
6.5	55.5	90.4	40.4	35.9	39.3	Guyana
14.6	47.5	82.1	28.9	30.4	31.9	Honduras
5.9	54.3	62.3	32.2	25.7	21.1	Indonesia
4.4	55.3	87	38.1	25.6	28	Iraq
11.2	55.8	86.4	28.4	45	29.9	Jamaica
13.2	45.1	48.4	29.9	14.9	37.7	Kiribati
8.2	40.3	90.5	24.4	17.4	14.5	Laos
2.2	77.8	81.6	22.5	41.4	17.8	Lebanon
12	43	75.4	42.7	22.1	48.5	Liberia
15.4					43.9	Malawi
13.9					21.9	Malaysia
4.4	48.5	73.2	20.4	42.6	33.6	Maldives
15	40.4	76.8			46.8	Mauritania
10.9	63.8	76.8	41.3	39.2	26.3	Mauritius
7.6	54.3	61.6	23.6	36.2	31.4	Mongolia
5.1	55	73.3	13.9	39.8	37.5	Morocco
14.2	61.8	65.2	23.7	26.8	46.7	Mozambique
8.7	66.1	88.1	25.6	40.6	49.5	Myanmar
3.6					44	Namibia
12.3	54.8	79.7	29.6	36.9	50.7	Nepal
3.6	75	75.9	51.3	9.9	40.2	Pakistan
7.8	22.1	62	50	7.6	17	Paraguay
6.9	54.4	91.3	22.6	32.7	46.4	Peru
9.1	49.9	87	18.9	27.4	51.8	Philippines
10.2	52.4	87.7	45.2	30.5	73.9	Samoa
26.8	78.4	81.3	28.4	37.5	64.1	Solomon Islands
13.4	63.9	75.1	22.1	27.8	40.4	Sri Lanka
4.1	42.4	61.6	15	35.6	24.9	Suriname
11.2	63.7	95.1	34.1	44	32.7	Swaziland
6.1	42	72.4			26.5	Tanzania
6.2	35	63.2			32.7	Thailand
8.3	79.8	88	27.3	20.4	40.3	Tonga
13.6	69.1	87.5	23	51	29.4	Tuvalu
7	42.2	70.4	23.9	20.4	53.4	Vanuatu
7.9	57.7	72	48.2	20.7	33.6	Vietnam
	31.5	74.2	29.1	33.6	19.4	Yemen
12.6	33.9	66	40	19.4		

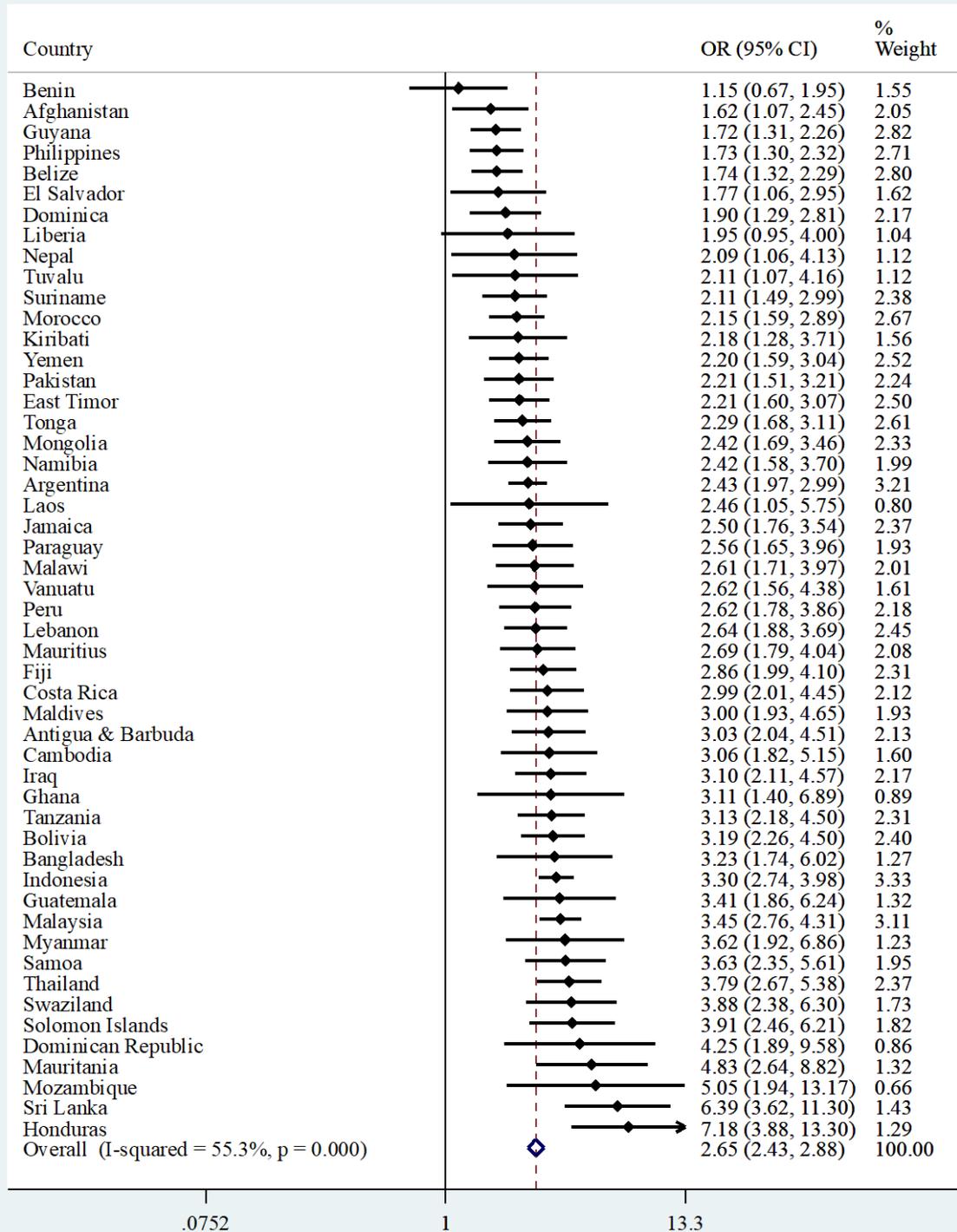


Figure S1 Country-wise association between bullying victimization (exposure) and anxiety-induced insomnia (outcome) estimated by multivariable logistic regression (overall)

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, food insecurity, and obesity.

Overall estimate was obtained by meta-analysis with random effects.

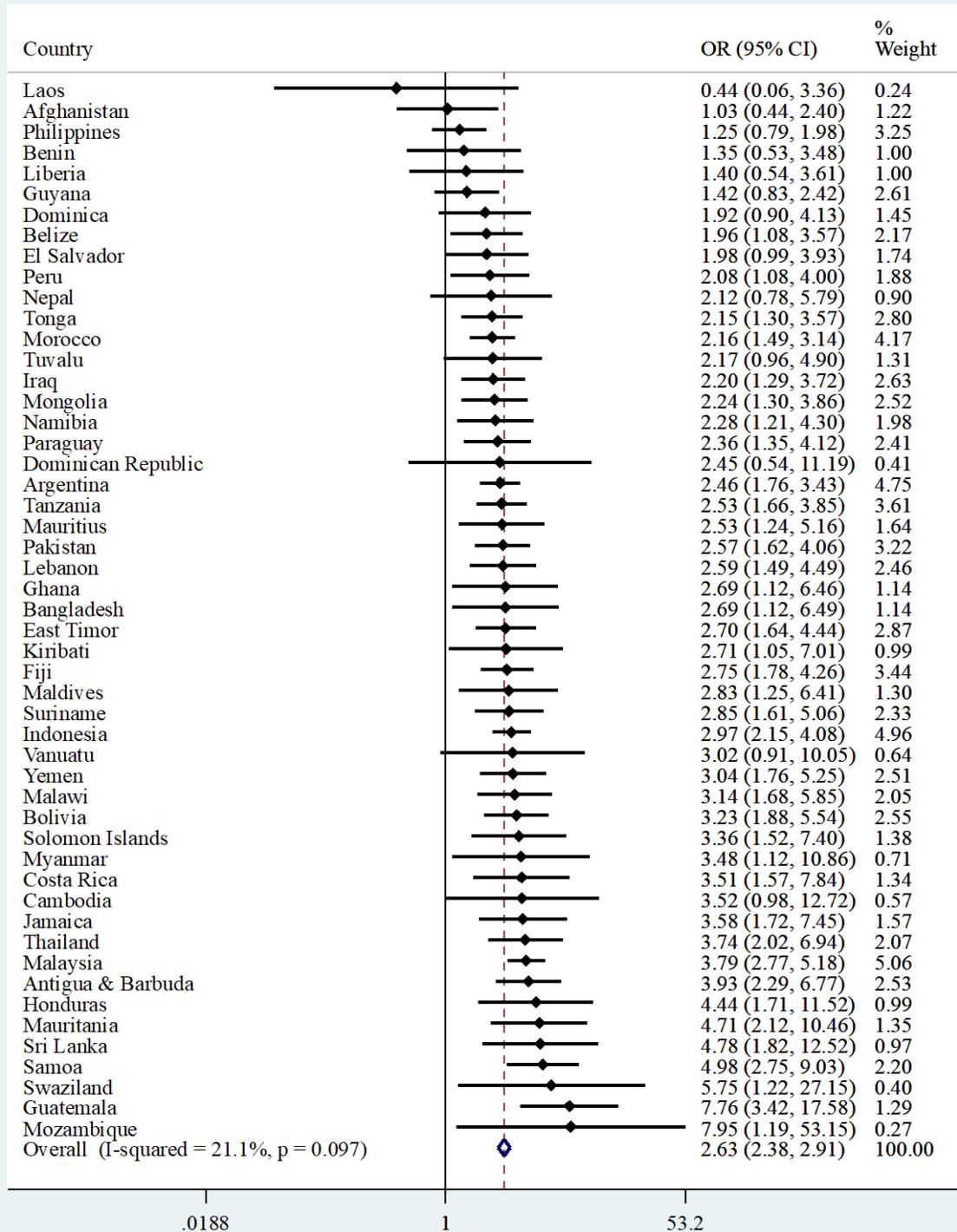


Figure S2 Country-wise association between bullying victimization (exposure) and anxiety-induced insomnia (outcome) estimated by multivariable logistic regression (boys)

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, food insecurity, and obesity.

Overall estimate was obtained by meta-analysis with random effects.

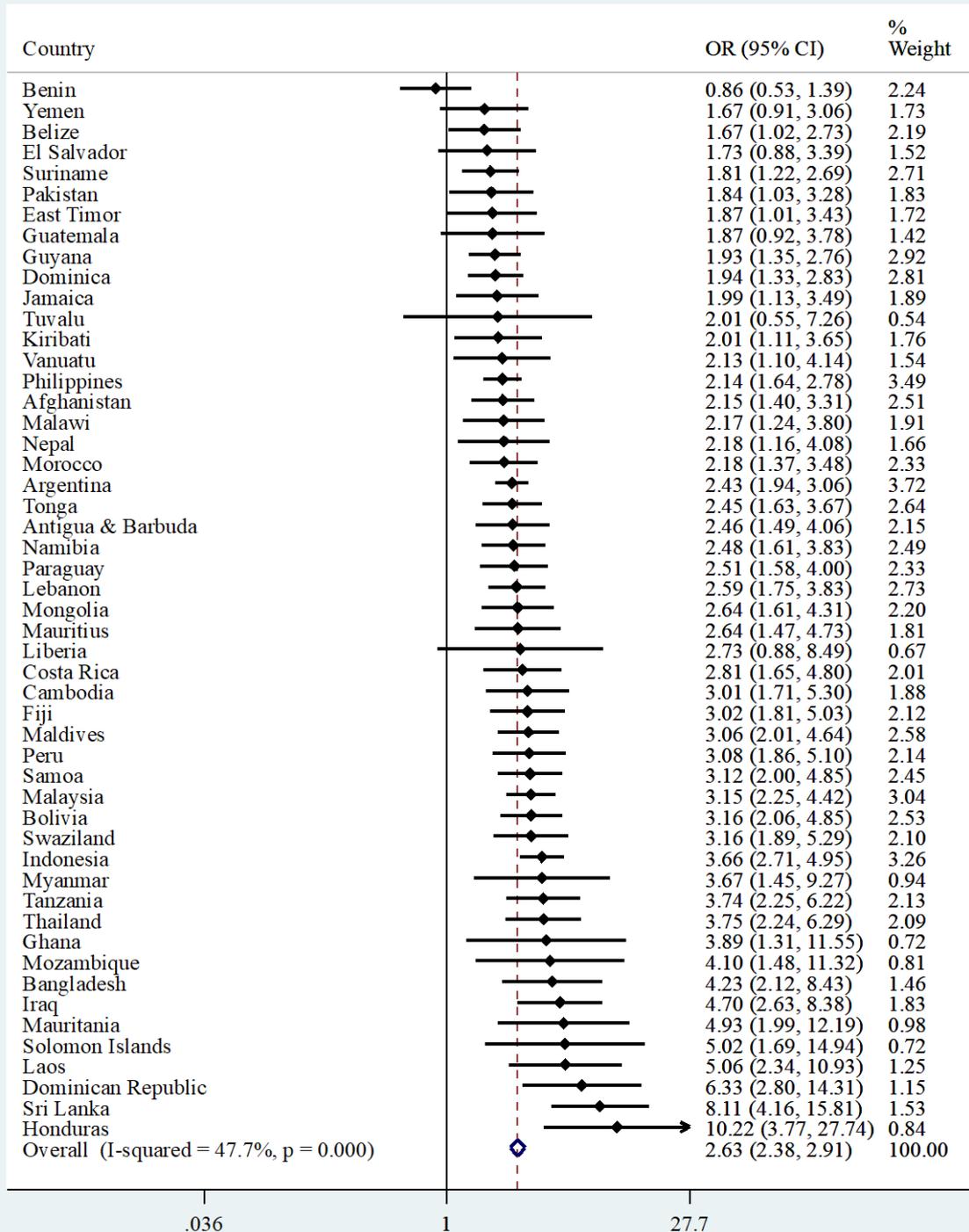


Figure S3 Country-wise association between bullying victimization (exposure) and anxiety-induced insomnia (outcome) estimated by multivariable logistic regression (girls)

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, food insecurity, and obesity.

Overall estimate was obtained by meta-analysis with random effects.

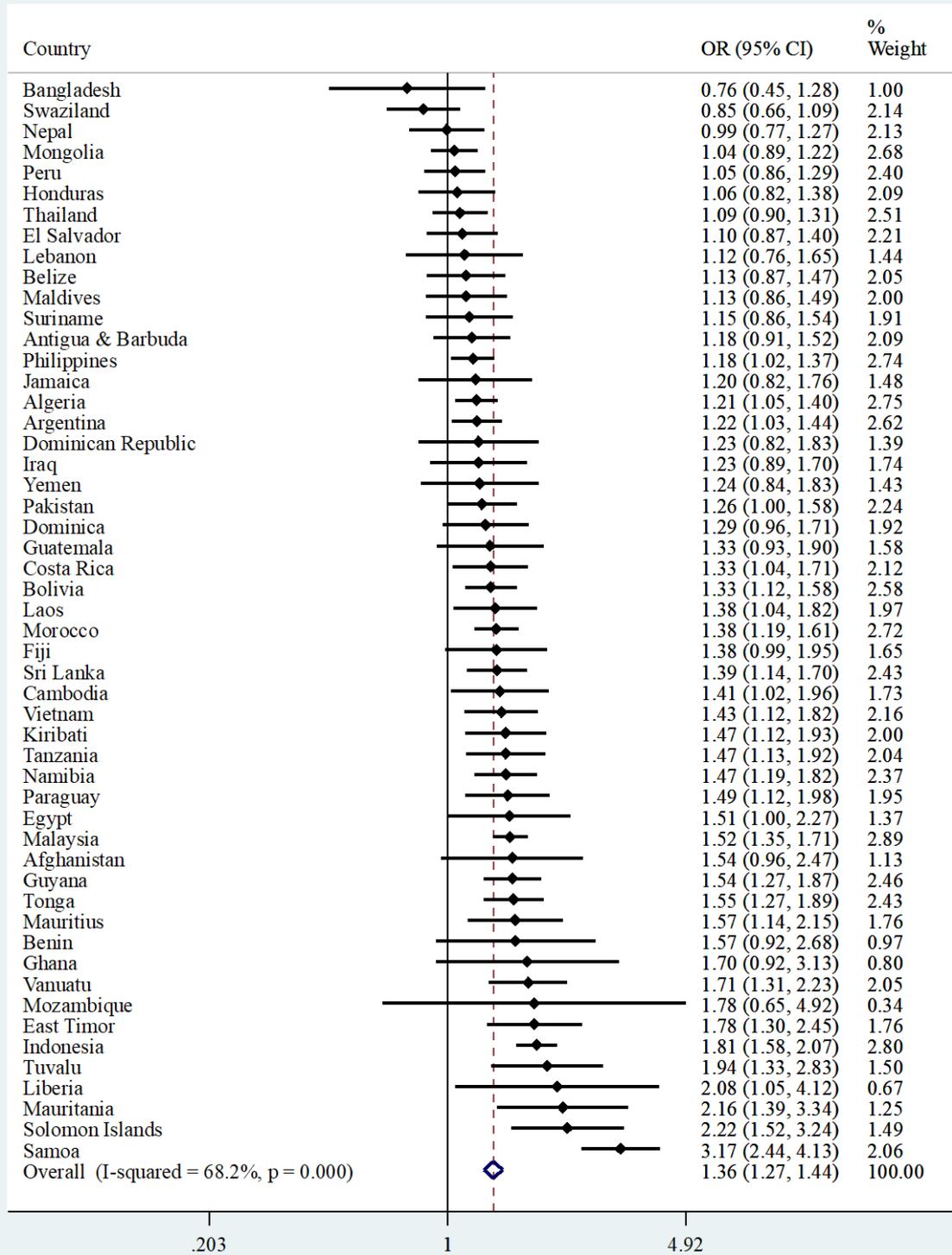


Figure S4 Country-wise association between bullying victimization (exposure) and fast-food consumption (outcome) estimated by multivariable logistic regression (overall)

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, food insecurity, and obesity.

Overall estimate was obtained by meta-analysis with random effects.

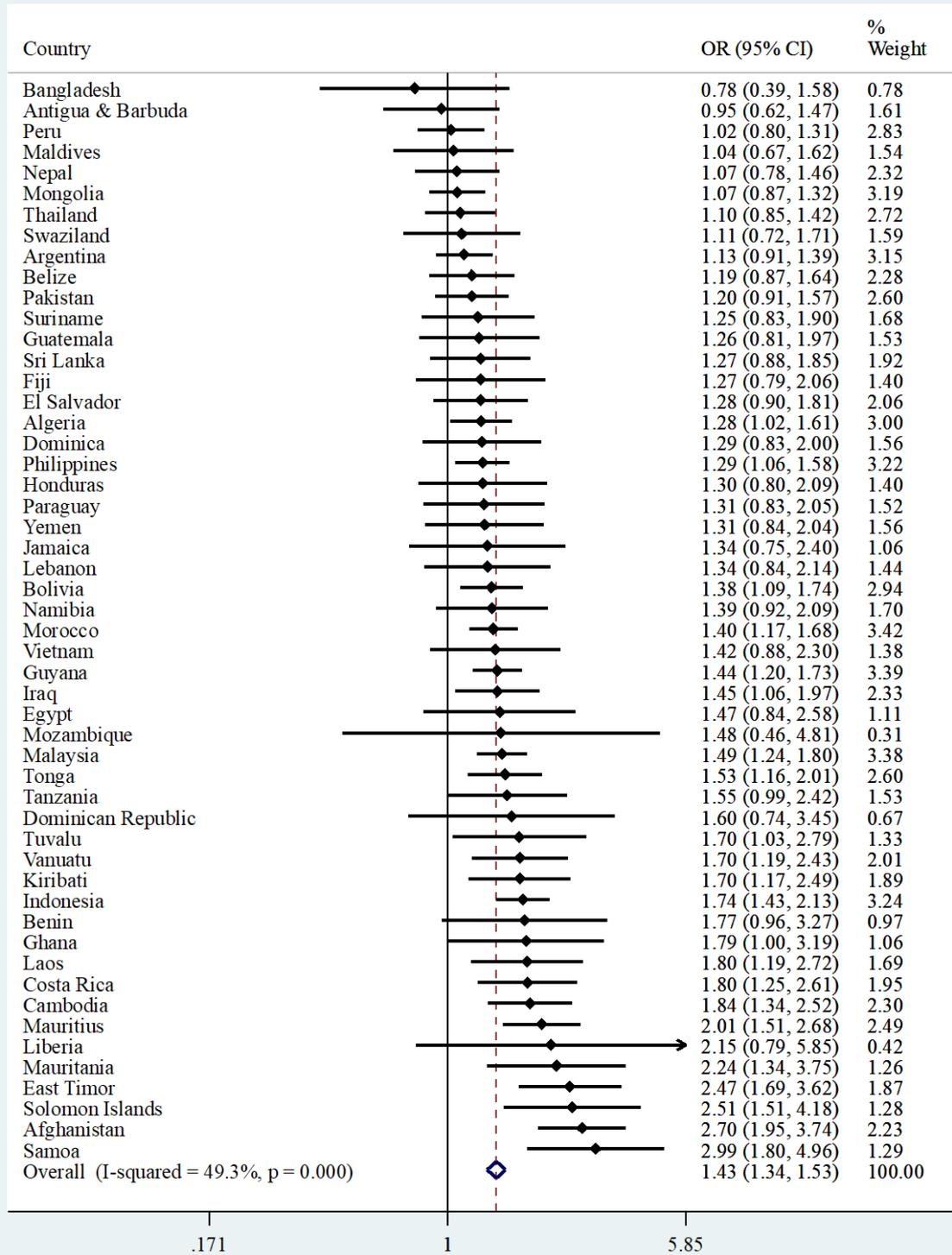


Figure S5 Country-wise association between bullying victimization (exposure) and fast-food consumption (outcome) estimated by multivariable logistic regression (boys)

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, food insecurity, and obesity.

Overall estimate was obtained by meta-analysis with random effects.

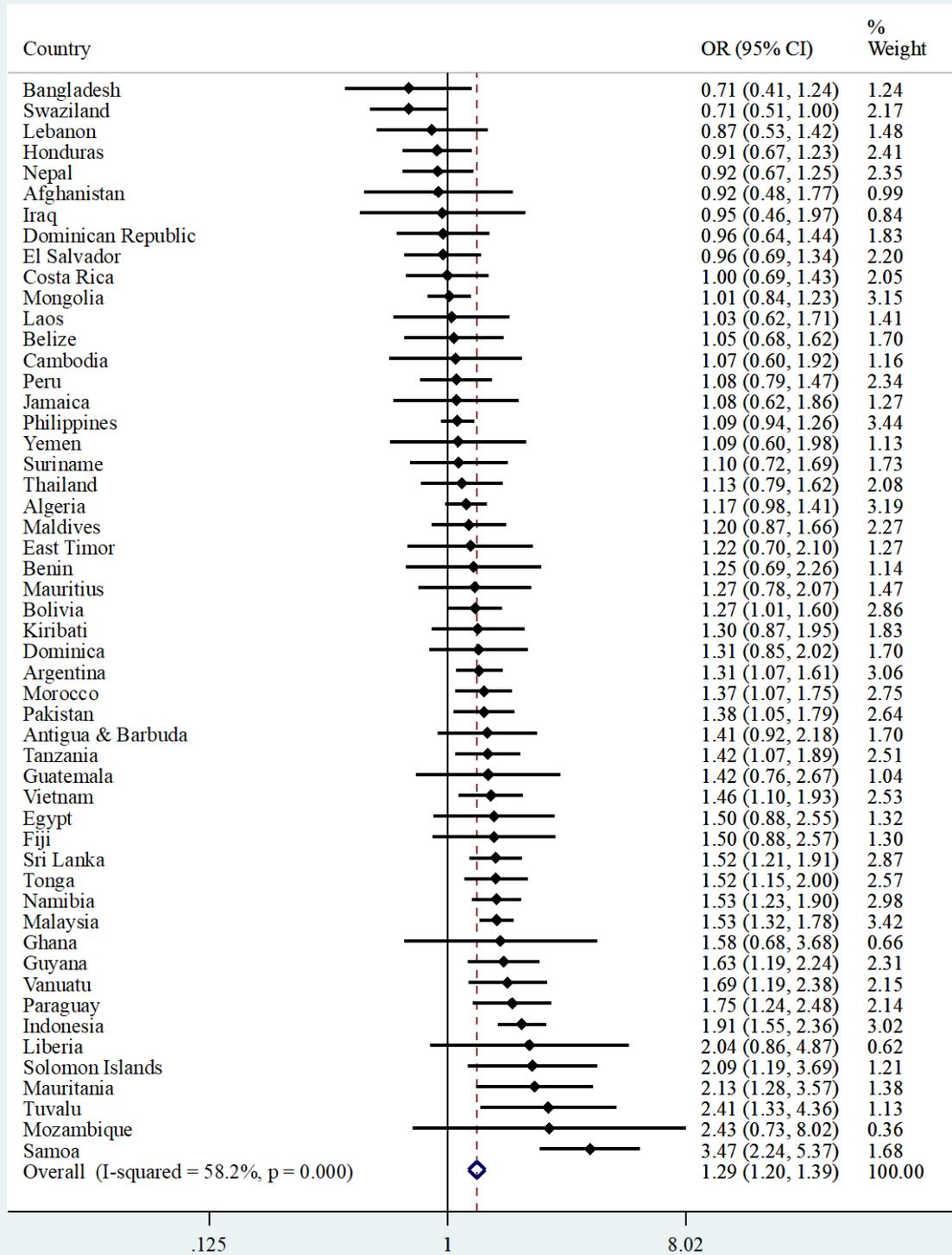


Figure S6 Country-wise association between bullying victimization (exposure) and fast-food consumption (outcome) estimated by multivariable logistic regression (girls)

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, food insecurity, and obesity.

Overall estimate was obtained by meta-analysis with random effects.

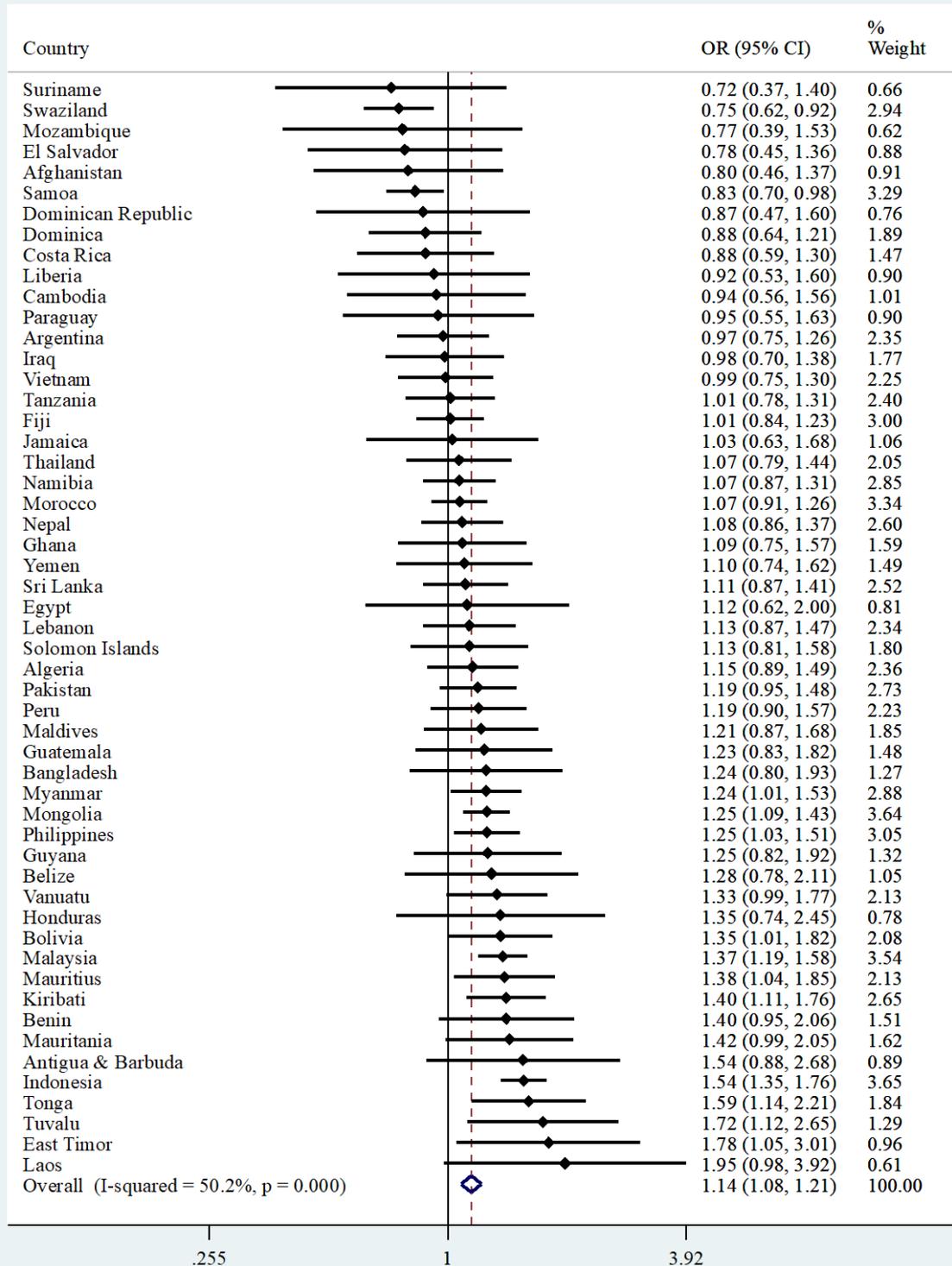


Figure S7 Country-wise association between bullying victimization (exposure) and carbonated soft-drink consumption (outcome) estimated by multivariable logistic regression (overall)

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, food insecurity, and obesity.

Overall estimate was obtained by meta-analysis with random effects.

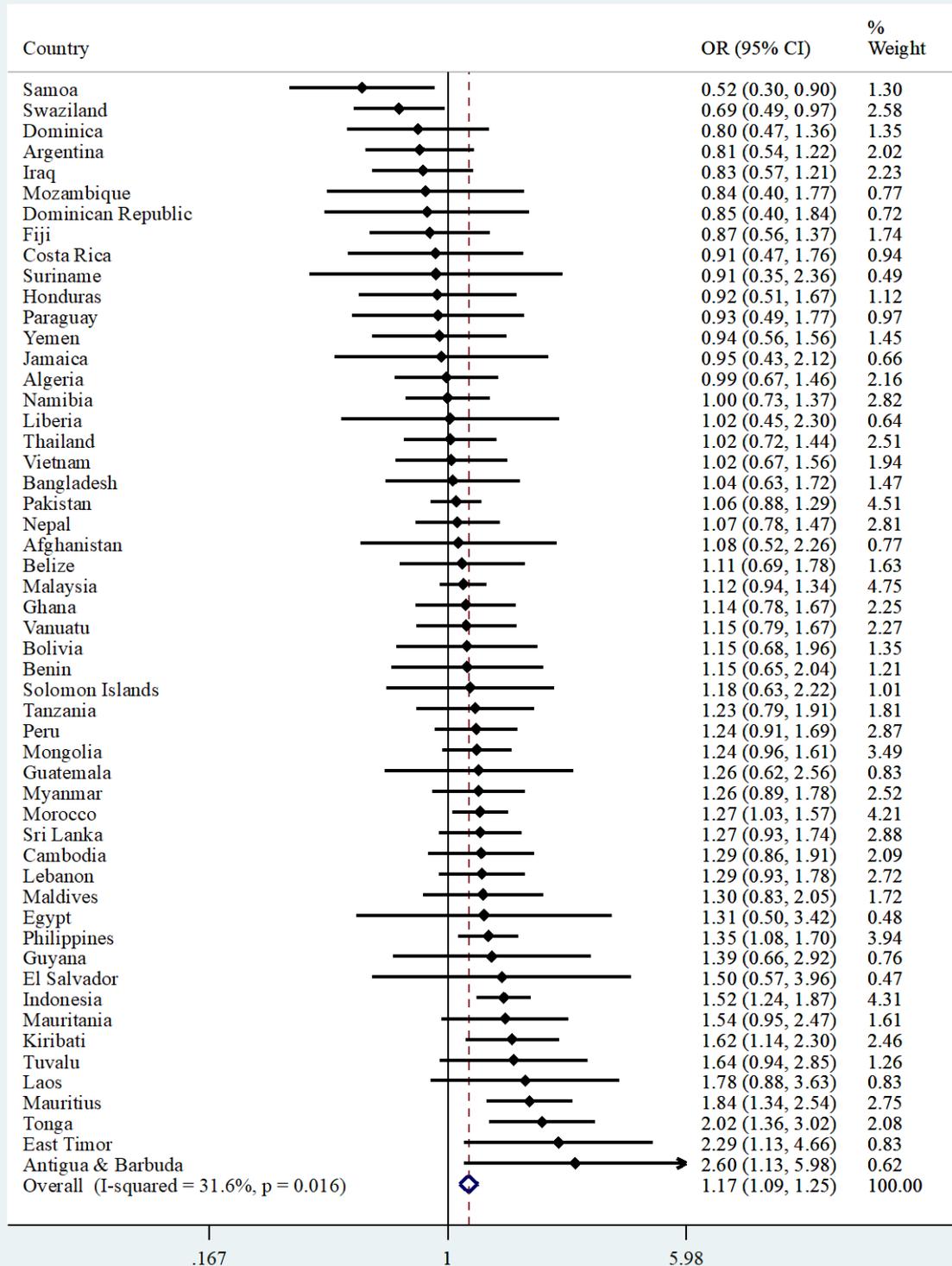


Figure S8 Country-wise association between bullying victimization (exposure) and carbonated soft-drink consumption (outcome) estimated by multivariable logistic regression (boys)

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, food insecurity, and obesity.

Overall estimate was obtained by meta-analysis with random effects.

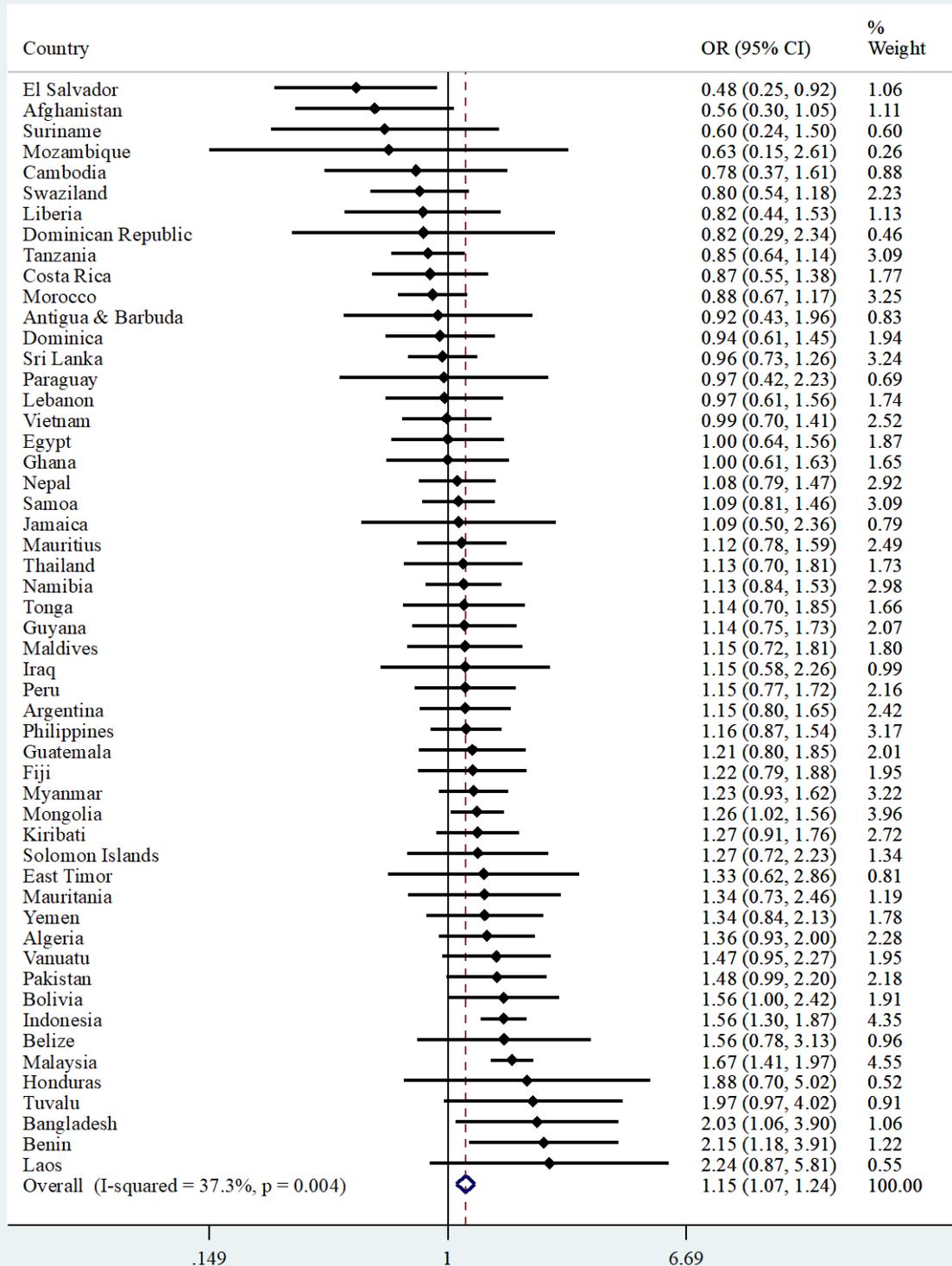


Figure S9 Country-wise association between bullying victimization (exposure) and carbonated soft-drink consumption (outcome) estimated by multivariable logistic regression (girls)

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, food insecurity, and obesity.

Overall estimate was obtained by meta-analysis with random effects.

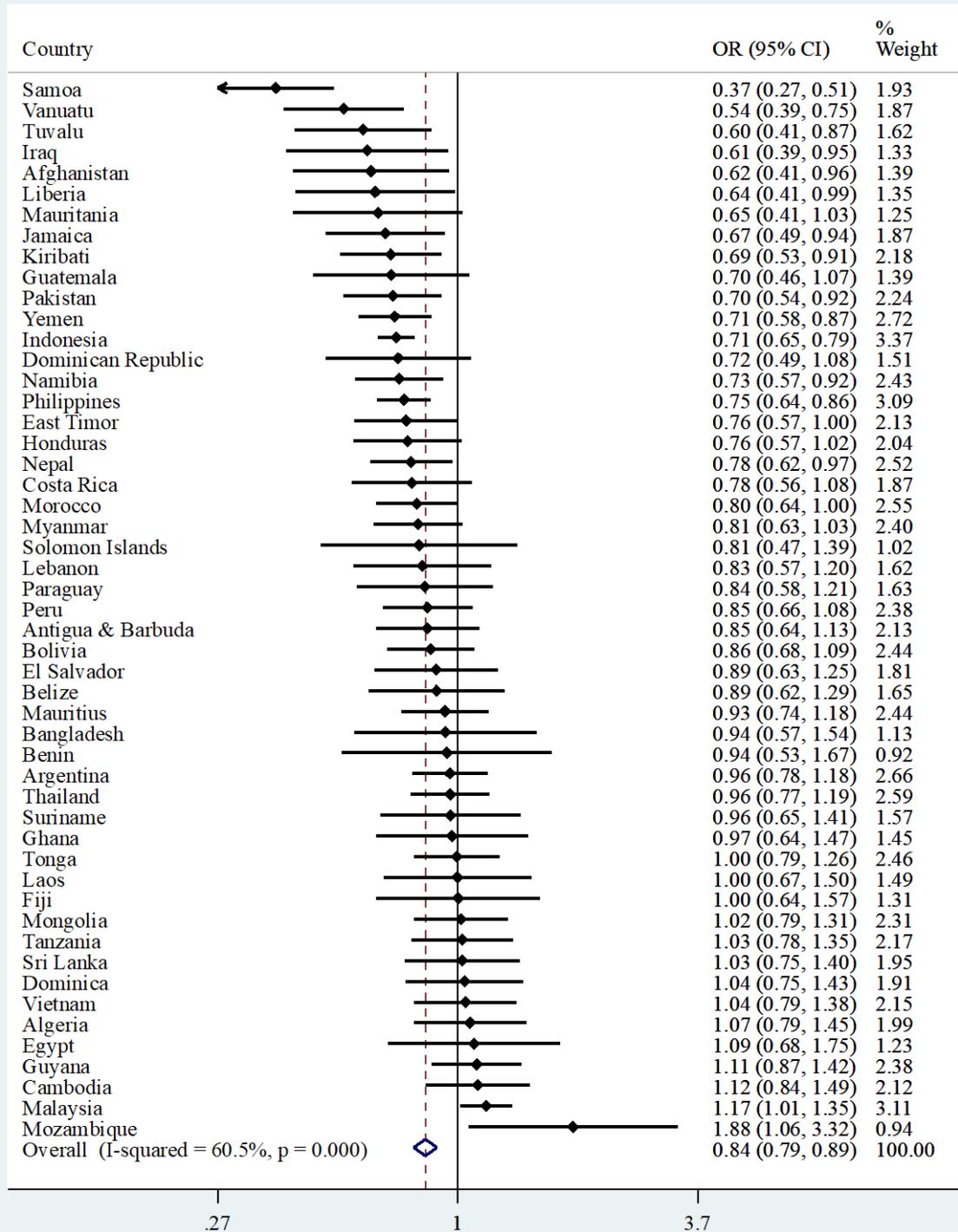


Figure S10 Country-wise association between bullying victimization (exposure) and low physical activity (outcome) estimated by multivariable logistic regression (overall)

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, food insecurity, and obesity.

Overall estimate was obtained by meta-analysis with random effects.

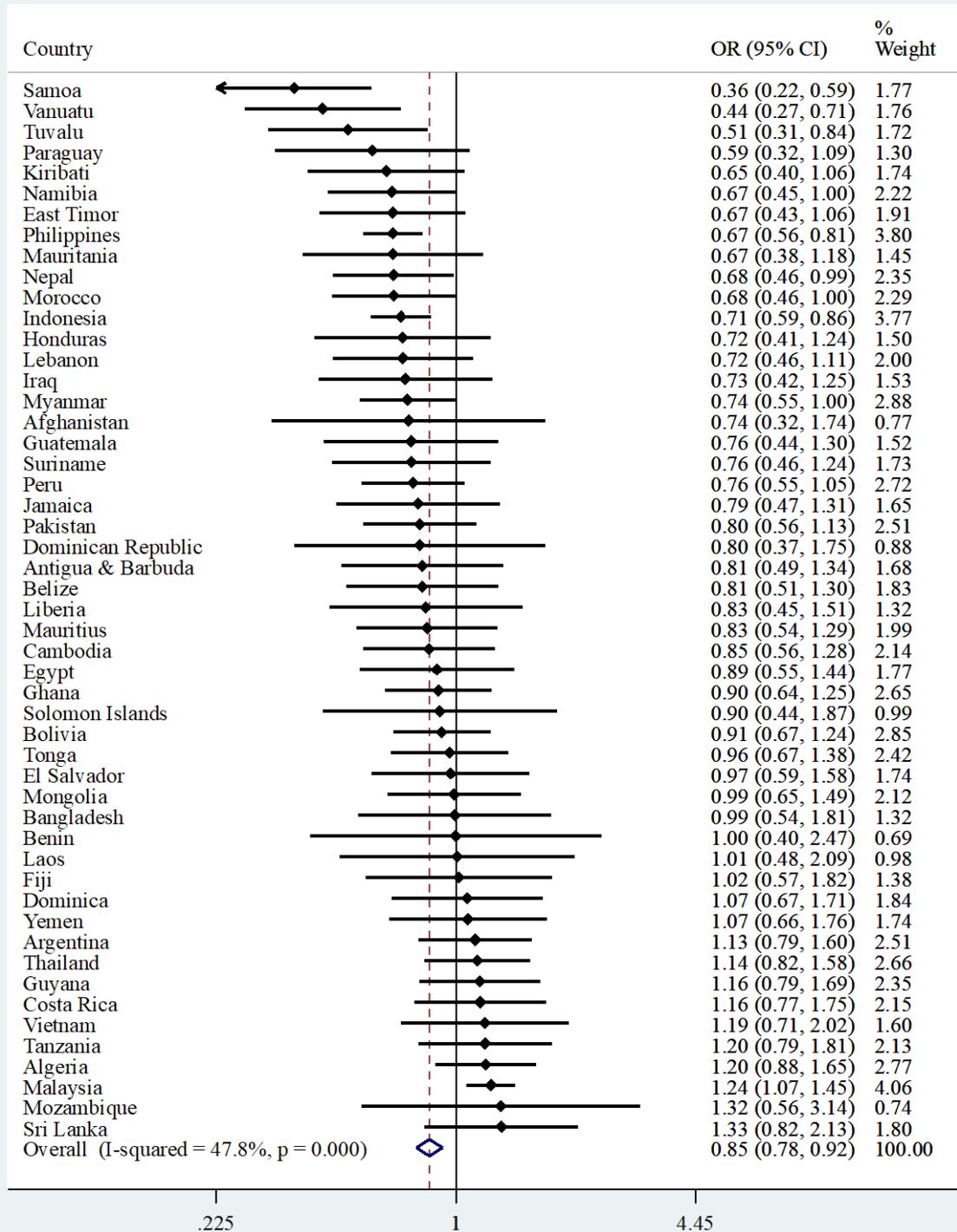


Figure S11 Country-wise association between bullying victimization (exposure) and low physical activity (outcome) estimated by multivariable logistic regression (boys)

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, food insecurity, and obesity.

Overall estimate was obtained by meta-analysis with random effects.

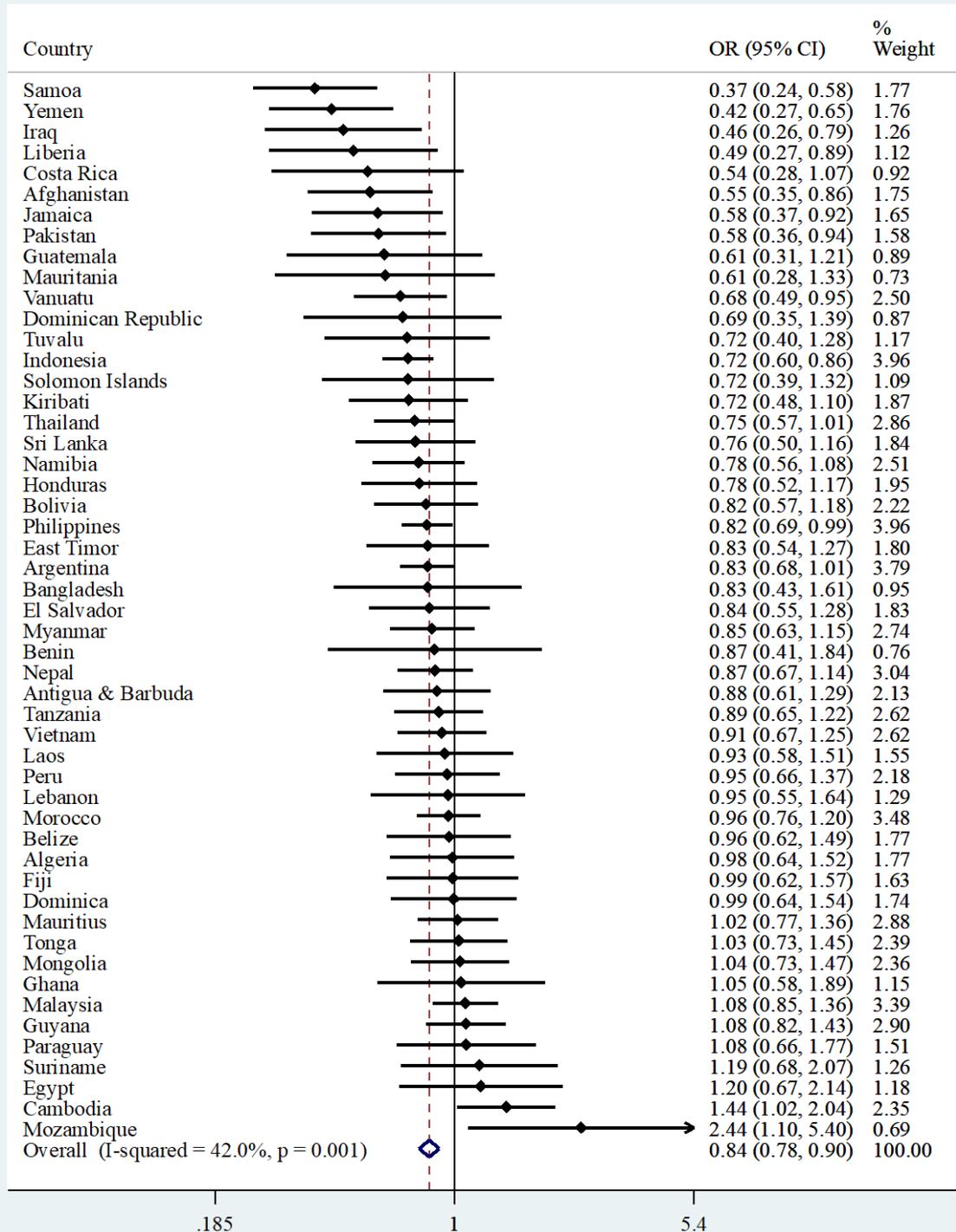


Figure S12 Country-wise association between bullying victimization (exposure) and low physical activity (outcome) estimated by multivariable logistic regression (girls)

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, food insecurity, and obesity.

Overall estimate was obtained by meta-analysis with random effects.

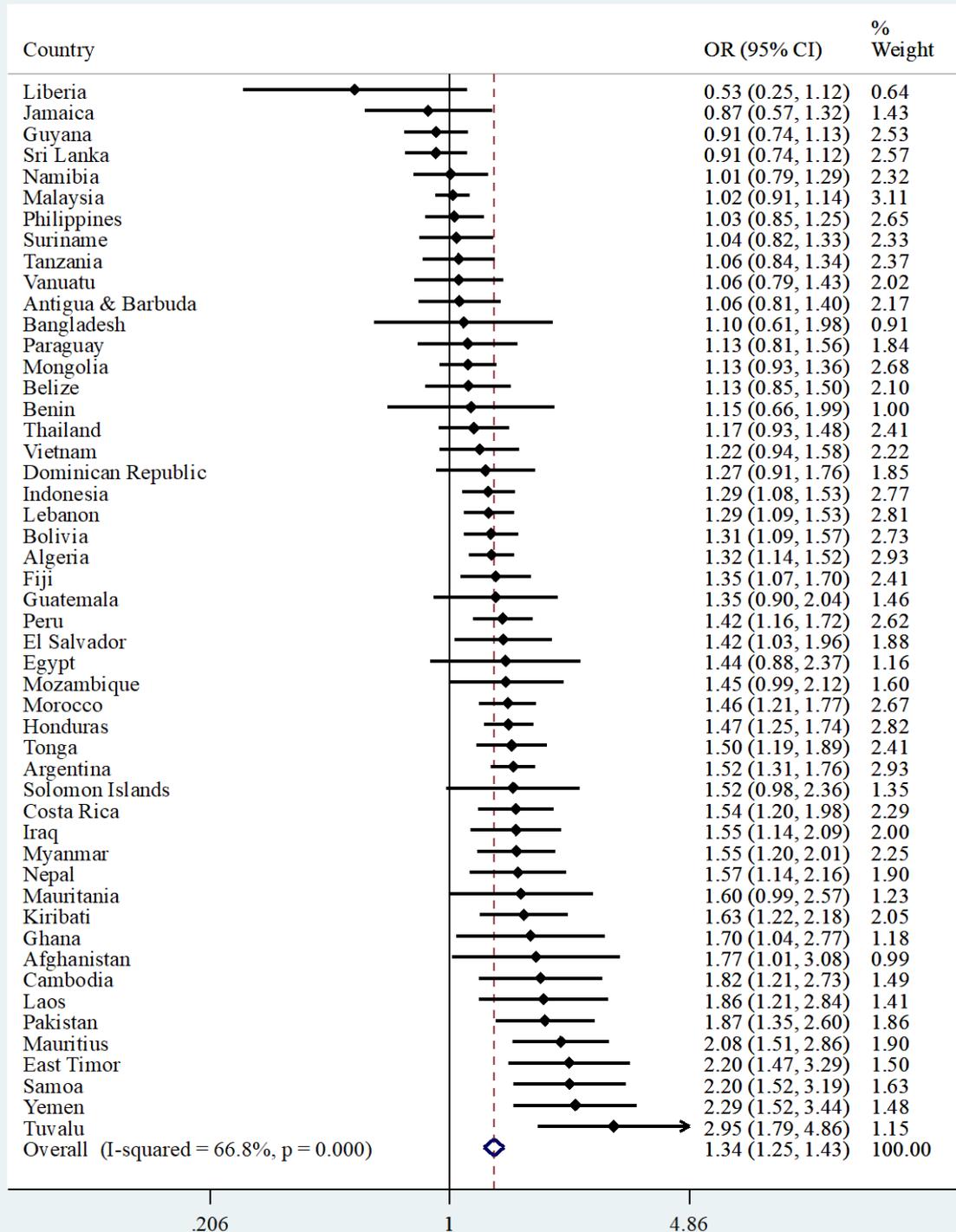


Figure S13 Country-wise association between bullying victimization (exposure) and sedentary behavior (outcome) estimated by multivariable logistic regression (overall)
 Abbreviation: OR Odds ratio; CI Confidence interval
 Models are adjusted for age, sex, food insecurity, and obesity.
 Overall estimate was obtained by meta-analysis with random effects.

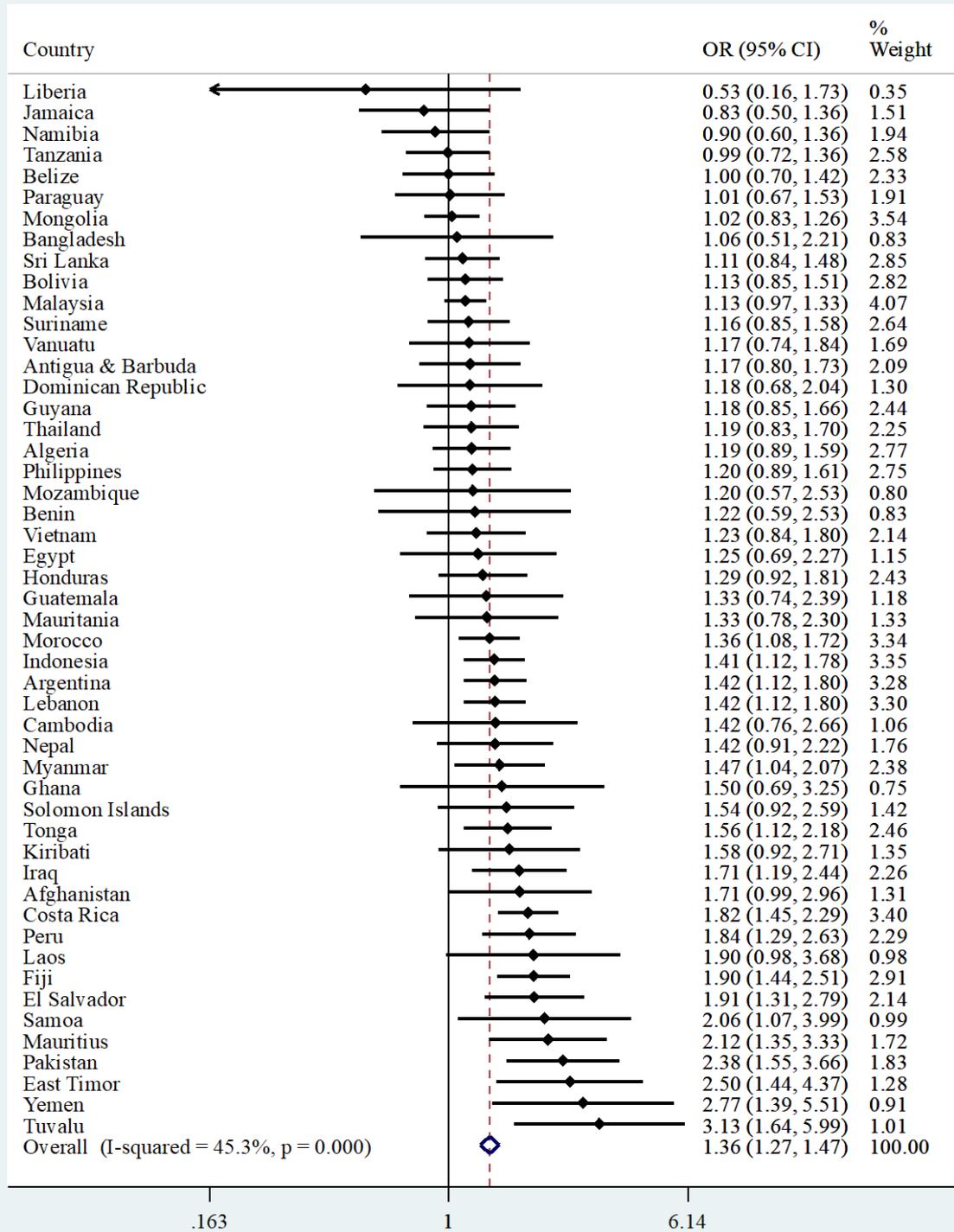


Figure S14 Country-wise association between bullying victimization (exposure) and sedentary behavior (outcome) estimated by multivariable logistic regression (boys)

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, food insecurity, and obesity.

Overall estimate was obtained by meta-analysis with random effects.

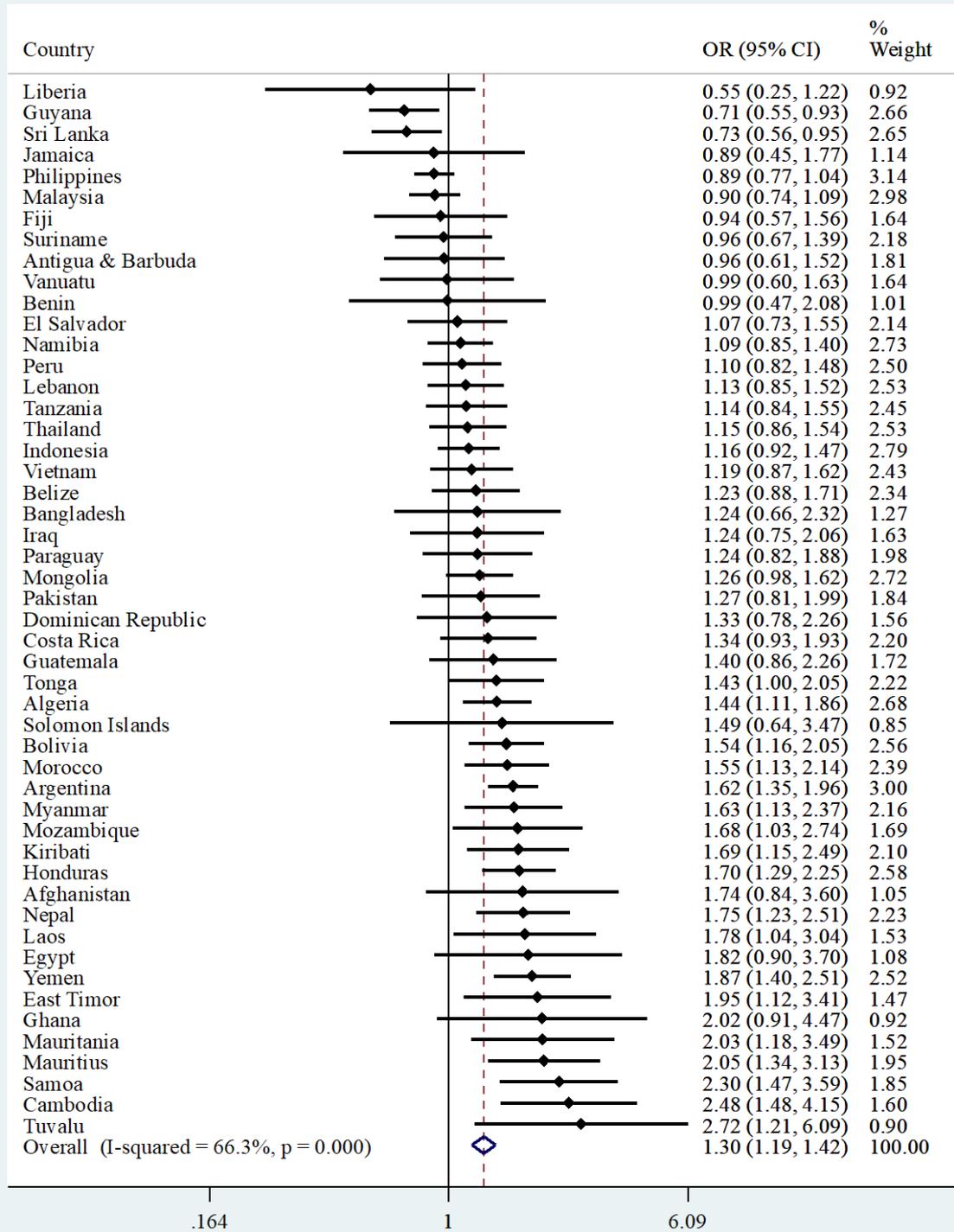


Figure S15 Country-wise association between bullying victimization (exposure) and sedentary behavior (outcome) estimated by multivariable logistic regression (girls)

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, food insecurity, and obesity.

Overall estimate was obtained by meta-analysis with random effects.