**Title:** Violence and Obesogenic Behavior among Adolescents aged 12-15 years from 62 Countries: A Global Perspective

**Running title:** Violence and Obesogenic Behavior

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**CONFLICTS OF INTEREST**

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**ABSTRACT**

Exposure to violence may be associated with increased risk for obesogenic behavior among adolescents but studies providing a global perspective are lacking. The aim of this work was to assess the relationship between violence and obesogenic behaviors among young adolescents from 62 countries. Cross-sectional data from the Global School-based Student Health Survey 2009-2016 were analyzed. Information on violence (intentional injury, physical attack, physical fight) and obesogenic behavior (anxiety-induced sleep problems, low physical activity, sedentary behavior, fast-food consumption, carbonated soft-drink consumption) were self-reported. Associations were analyzed using meta-analysis based on country-wise multivariable logistic regression analyses. A total of 165,380 adolescents aged 12-15 years [mean (SD) age 13.8 (1.0) years; 50.9% boys] were included in the analysis. All types of violence were positively associated with higher odds for all types of obesogenic behavior with the exception of low physical activity. Associations were particularly pronounced for anxiety-induced insomnia. In contrast, intentional injury (OR=0.72; 95%CI=0.64-0.81) and physical fight (OR=0.90; 95%CI=0.86-0.95) were associated with lower odds for low physical activity. In this large global sample of adolescents, exposure to violence was associated with all obesogenic behaviors apart from low physical activity. Multidimensional government programs and policies addressing exposure to violence among young adolescents may lead to reduction in obesogenic behavior and hence curtail the global obesity epidemic.

**Keywords:** Violence, Obesity, Obesogenic behaviors, Adolescents, Global, Epidemiology

**1. INTRODUCTION**

Child and adolescent obesity is one of the leading global public health challenges of the 21st century. Approximately, 18% of children and adolescents aged 5-19 years were overweight or obese in 2016. This estimate has risen dramatically from just 4% in 1975.1 However, it should be noted that levels of overweight and obesity are not uniform across all countries. For example, one study carried out on middle school children from Karachi, Pakistan found that 6% of children were obese and 8% were overweight.2 Whereas a study in Urban Sharkia Governorate, Egypt found that the prevalence of overweight and obesity was 20% and 10.7% respectively, in children of a similar age.3 This is a major public health concern as obesity is negatively associated with many facets of adolescents’ health. For example, obesity increases the risk of developing type 2 diabetes, hypertension, sleep apnea and cardiovascular diseases.4,5 It also negatively influences adolescents’ quality of life and is possibly causally related to various emotional-behavioral problems (e.g., anxiety, depression, withdrawal, and somatic complaints).6-8 Importantly, about four in every five adolescents who become obese will continue to have weight problems as adults.6 In light of the high and increasing prevalence of obesity, the World Health Organization (WHO) developed the "Global Action Plan for the Prevention and Control of Non-communicable Diseases 2013-2020" which aims to halt the rise of global obesity to match the rates of 2010, amongst other aims.

There is a large body of literature to suggest that the following behaviors are associated with an increase in obesity in adolescents: sleep problems, 9 low levels of physical activity,10 sedentary behavior,11 fast-food consumption,12,13 and carbonated soft-drink consumption.14,15 There is also a relatively large body of literature identifying correlates of these obesogenic behaviors. However, one understudied correlate of such behaviors is that of physical violence, defined here as bodily harm suffered as a result of the application of immediate and unlawful physical force. The prevalence of youth violence is high. For example, globally the fourth leading cause of death in young people is homicide (10–29 years old).16 Moreover, through violence, many more young people are hospitalized owing to injuries.17

Violence may influence obesity risk by triggering obesogenic behaviors such as unhealthy food consumption, disordered eating, sleep problems, and inactivity.18,19 It is likely that exposure to violence leads to unhealthy diets via dysregulation in physiological systems that regulate responses to environmental stress. Stress increases levels of cortisol. Higher cortisol and/or chronic stress are each related to subsequent obesogenic food craving and consumption and are also found to predict future weight gain. Furthermore, chronic stress is found to increase obesogenic eating behaviors via epigenetic changes. Moreover, it is possible that adolescents growing up in violent neighborhoods are less likely to engage in physical activity, and more likely to engage in sedentary behaviors, owing to a lack of safe outdoor spaces to be physically active.20 Due to these potential pathways, it could be hypothesized that victimization is likely to be associated with obesogenic behaviors. However, it should also be noted that acting out violent acts is associated with higher levels of stress, and therefore, it is also plausible that carrying out violent acts may also lead to obesogenic behaviors. Indeed, it has been identified that young people who carry out violent acts have a poor ability to cope with stress, as well as low self-efficacy, poor relationship building skills and a lack of role models that may all lead to a greater likelihood of engaging in obesogenic behaviors.21 It should also be noted here that the relationship between violence and obesogenic behavior is complex in terms of causality and potentially bidirectional.

To our knowledge only one study exists on the relationship between exposure to violence and obesogenic behaviors.20 This study used Ecological Momentary Assessment techniques in two small cohorts of US adolescents (n=151 and n=395). The study found that exposure to violence is associated with same-day unhealthy dietary consumption among at-risk adolescents and next-day tiredness related to sleep quality among adolescents from both at-risk and normative populations. It is important to confirm the representativeness of such findings in larger global samples of adolescents.

To date, multinational studies exploring associations between violence and obesogenic behaviors in adolescents have not been undertaken. Multinational studies are important as they can shed light on whether associations are generalizable across countries, while between-country differences may provide hints on how factors such as culture and income levels may influence associations.

Given the above-mentioned gaps in the literature, the present study examined the relationship

of three domains of exposure to violence (intentional injury, physical attacks, physical fights) with five obesogenic behaviors (anxiety induced sleep-problems, low physical activity, sedentary behavior, fast-food consumption, carbonated soft-drink consumption) among 165,380 adolescents aged 12-15 years from 62 countries.

**2. METHODS**

**2.1 The Survey**

Publicly available data from the 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.22 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 that included the variables used in the current analysis (i.e., if they included data on any type of violence or obesogenic behavior). If there were more than two datasets from the same country, we chose the most recent dataset. A total of 62 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 2016.

**2.2. Violence**

**2.2.1. Intentional injury**

The students were first provided with information that an injury is serious when it makes one miss at least one full day of usual activities (such as school, sports, or a job) or requires treatment by a doctor or nurse. Subsequently, students were asked the major cause of the most serious injury that happened to them in the past 12 months. Those who answered “I was attacked or abused or was fighting with someone” were considered to have had intentional injury, and those with injuries with other causes and those who did not have a serious injury were considered to not have had intentional injury. It should be noted that this item captures both victimization (e.g., attacked abused) and potentially perpetrating violence (fighting with someone). Data on intentional injury were not available from Bangladesh, Guatemala, Guyana, Maldives, and Pakistan.

**2.2.2. Physical attack**

Students were first provided with the following explanation on physical attacks: “A physical attack occurs when one or more people hit or strike someone, or when one or more people hurt another person with a weapon (such as a stick, knife, or gun). It is not a physical attack when two students of about the same strength or power choose to fight each other. Subsequently, they were asked “During the past 12 months, how many times were you physically attacked?” with answer options 0, 1, 2-3, 4-5, 6-7, 8-9, 10-11, and ≥12 times. Physical attack was defined as having been attacked at least once.

**2.2.3. Physical fight**

Students were provided an explanation that a physical fight occurs when two or more students of about the same strength or power to choose to fight each other. Physical fight was assessed with the question “During the past 12 months, how many times were you in a physical fight?” with answer options 0, 1, 2-3, 4-5, 6-7, 8-9, 10-11, and ≥12 times. Physical fight was defined as having been in a physical fight at least once.

**2.3. Obesogenic behavior**

**2.3.1. 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.23 Data on anxiety-induced sleep problems were not available from Algeria, Chile, Egypt, Mauritius, Oman, and Vietnam.

**2.3.2. Low physical activity**

Levels of physical activity were assessed with The PACE+ (Patient-centered Assessment and Counseling for Exercise plus Nutrition) Adolescent Physical Activity Measure,24 and the student was 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 0-4 days (low physical activity; coded 1) and ≥5 days (coded 0) in accordance with a previous GSHS publication.25 Data on physical activity were not available from Jamaica, Maldives, and Swaziland.

**2.3.3. 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,26-28 the variable was dichotomized (≥3 hours/day or not). Data on sedentary behavior were not available from Dominica, Jamaica, Maldives, and Swaziland.

**2.3.4. 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 <3 days (coded 0) and ≥3 days (coded 1) as in a previous GSHS publication.29

**2.3.5. 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 ≥1 time per day or not.

**2.4. Control variables**

The control variables included sex, age, and food insecurity (as a proxy of socio-economic status). As in previous studies using the same dataset,28,30 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’.

**2.5. 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. The prevalence of different types of obesogenic behavior was calculated among those with and without intentional injury, and also by the frequency of physical attacks and fights in the past 12 months. Due to the small numbers in the extreme categories, variables on physical attack and physical fight were categorized as 0, 1, 2-3, and ≥4 times for this analysis.

The associations between each of the different types of violence (intentional injury, physical attack, physical fight; exposure variables) and obesogenic behavior (anxiety-induced insomnia, low physical activity, sedentary behavior, fast-food consumption, carbonated soft-drink consumption; outcome variables) were assessed by country-wise multivariable logistic regression analysis adjusting for age, sex, and food insecurity. 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. I2 values of 25%, 50%, and 75% are often considered low, moderate, and high level of heterogeneity, respectively.31 We also explored whether survey year is a potential source of heterogeneity through random effects meta-regression analysis.

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).

**3. RESULTS**

A total of 165,380 adolescents aged 12-15 years [mean (SD) age 13.8 (1.0) years; 50.9% boys] were included in the analysis. Overall, the prevalence of intentional injury, physical attack, and physical fight were 1.7%, 38.6%, and 32.4%, respectively. The overall prevalence of obesogenic behavior was: 7.2% (anxiety-induced sleep problems), 84.5% (low physical activity), 27.1% (sedentary behavior), 50.0% (fast-food consumption), and 44.3% (carbonated soft-drink consumption). There was a wide range in the prevalence of these figures between countries (**Table S1** of the supplementary material). The prevalence of all obesogenic behavior was higher among those who experienced an intentional injury with the exception of physical activity (**Figure 1**). The prevalence of anxiety-induced insomnia, fast-food consumption, and carbonated soft-drink consumption increased linearly with increasing number of physical attacks but the prevalence of low physical activity was lowest in those who had been physically attacked ≥4 times in the past 12 months (**Figure 2**). The dose-dependent increase in the prevalence of obesogenic behavior (i.e., anxiety-induced insomnia, sedentary behavior, fast-food, carbonated soft-drink consumption) was more pronounced for physical fights, and similarly to physical attacks, the highest frequency of physical fights had the lowest prevalence of low physical activity (**Figure 3**). The association between different types of violence (independent variables) and obesogenic behavior (dependent variables) estimated by meta-analysis based on country-wise estimates is shown in **Table 2**. All types of violence were positively associated with higher odds for anxiety-induced insomnia, sedentary behavior, fast-food consumption, and carbonated soft-drink consumption, with particularly high ORs observed for anxiety-induced insomnia (e.g., intentional injury OR=2.99; 95%CI=2.55-3.50). In contrast, intentional injury and physical fight were associated with lower odds for low physical activity. A relatively high level of between-country heterogeneity was observed for some associations [e.g., physical attack and fast-food consumption (*I2*=63.4%), physical fight and carbonated soft-drink consumption (*I2*=65.5%). For example, the OR (95%CI) for the association between physical fight and carbonated soft-drink consumption ranged from 0.86 (0.58-1.27) in Egypt to 2.03 (1.62-2.54) in Curaçao. The country-wise estimates on which the meta-analysis was based are shown in **Figure S1-S15** of the supplementary material. Results were fairly consistent across all regions. The results from the meta-regression showed that survey year does not explain the between-country heterogeneity observed for the associations between all types of violence and obesogenic behavior with the exception of the association between intentional injury and fast-food consumption. Specifically, more recent surveys showed weaker associations between intentional injury and fast-food consumption (**Figure S16** of the supplementary material).

**4. DISCUSSION**

In this large global sample of young adolescents, it was found that all types of violence were positively associated with higher odds for anxiety-induced insomnia, sedentary behavior, fast-food consumption, and carbonated soft-drink consumption, with highest ORs observed for anxiety-induced insomnia. Interestingly, receiving an intentional injury and being in a physical fight were associated with lower odds for low physical activity. Taken together these results suggest that exposure to violence is broadly and positively associated with obesogenic behaviors with the exception of low physical activity. These results provide important clues on how violence may increase the risk for obesity among adolescents as despite the fact that it is well documented that children exposed to violence are at increased risk for obesity,32 the underlying mechanisms are largely unknown.

The present findings support that of previous research that found in a small sample of US adolescents using ecological momentary assessment that exposure to violence is associated with same-day unhealthy dietary consumption among at-risk adolescents and next-day tiredness related to sleep quality among adolescents from both at-risk and normative populations.20 The present findings add to this literature by showing that such associations exist in a large global sample of adolescents. Moreover, the present study further adds to the knowledge base by showing that such an association also exists with sedentary behavior and carbonated soft-drink consumption.

There are several plausible pathways that may explain the observed associations. First, violence may trigger unhealthy food consumption or disordered eating by disrupting sleep.18,19 Adolescents who are exposed to violence are likely at an increased risk for negative affect and internalizing disorders,33,34 while literature suggests that such mental states may contribute to sleep problems35 and this may in turn lead to disordered eating behaviors, such as binge eating.36 The exact pathway of how sleep problems lead to disordered eating is not known but it is likely that the appetite hormones leptin and ghrelin are implicated.37 Moreover, stress may also be a common factor underlying both sleep problems and disordered eating.37 Indeed, binge eating has been associated with high-fat and/or high-sugar foods, which are typically the constitute of fast food.38 It is also possible that exposure to violence leads to unhealthy diets via dysregulation in physiological systems that regulate responses to environmental stress, such as the autonomic nervous system (ANS), the hypothalamic-pituitary-adrenal (HPA) axis39,40 or increased emotional reactivity41-43 that contributes to maladaptive behavioral patterns, including poor dietary choices, potentially increased fast-food and carbonated soft-drink consumption.44 Indeed, stress increases levels of cortisol. Higher cortisol and/or chronic stress are each related to subsequent obesogenic food craving and consumption and are also found to predict future weight gain.45,46 Moreover, chronic stress is found to increase obesogenic eating behaviors via epigenetic changes: increasing levels of dopamine receptor 2 (DR2) and mu-opioid receptor (MOR) gene expression in the nucleus accumbens - a central component of the food reward system.47 Second, literature has shown that sedentary time is associated with negative psychosocial health, including bullying victimization and aggression.48 It has been suggested that family background/circumstances might drive many of the associations seen in relation to sedentary behavior and psychosocial health in young people.48 Moreover, it may be that those exposed to violence prefer not to go out because they may have greater fear that they will be attacked and thus staying at home will likely increase sedentary behavior. Finally, the increased odds of sedentary behavior may be explained by the evidence that sedentary behavior, fast-food consumption, and carbonated soft-drink consumption tend to co-occur.49

Interestingly, the present study found that intentional injury and physical fighting were associated with lower odds for low physical activity. One plausible explanation is that those who are more physically active may be more likely to go outside where they may be more likely to be exposed to violence. However, this hypothesis remains untested and the exact reason for this association is not clear. Future research of a qualitative nature is required to understand this observed association.

It should be noted that a relatively high level of between-country heterogeneity was observed for the associations between physical attack and fast-food consumption, and between physical fight or physical attack and carbonated soft-drink consumption. This suggests that country-specific cultural factors influence some of the association between exposure to violence and obesogenic behaviors. This between-country heterogeneity may be related with factors such as differences in the availability of fast-food and soft-drinks or their contents. Future studies should aim to understand the factors underlying this between-country heterogeneity, and future interventions to reduce violence with the aim to reduce obesogenic behavior and ultimately obesity should consider such potential influences.

The large global sample of adolescents and the investigation of three domains of exposure to violence and several obesogenic behaviors are clear strengths of the present study. However, findings from the present study must be interpreted in light of its limitations. First, the study is of a cross-sectional nature and thus it is not known whether exposure to violence drives obesogenic behaviors or if obesogenic behaviors drive exposure to violence. The relationship is likely to be bi-directional. Indeed, it has been previously suggested that junk food consumption may increase the risk for psychiatric distress and violent behaviors in adolescents.50 However, since the association was almost unequivocally observed among all countries, this provides robustness to our findings. Second, the study was based on adolescents attending school. Thus, the study results may not be generalizable to adolescents who do not attend school. In particular, the percentage of children attending school varies by country, and therefore, the present data may be more representative for some countries in comparison to others. Third, exposure to violence and obesogenic behaviors were assessed using self-report measures, and this may have introduced reporting biases (e.g., social desirability bias, recall bias). Fourth, a measure of socioeconomic status *per se* was not available in the present dataset, and thus, a proxy measure (food insecurity) was used. This may have introduced some bias into the analyses but it is unlikely to have signiﬁcantly inﬂuenced the ﬁndings given the considerable overlap between food insecurity and levels of wealth. Relatedly, students of higher socioeconomic status may engage more in regular physical activity or sports in some countries, and this may increase their chances of being exposed to violence. Adjustment for this factor may have been incomplete as specific data on socioeconomic status were not available. Next, information on witnessing violence was not available, and therefore, the relationship between witnessing violence and obesogenic behaviors remains untested. In addition, those who were exposed to violence in our study could have been a perpetuator and/or a victim and it was not possible to clearly distinguish between the two. However, previous studies have shown that violence-related stress occurs in both the perpetuator and the victim 51 and that stress can lead to obesogenic behaviors.52 Nonetheless, future studies which clearly distinguish the two are warranted to assess whether their association with obesogenic behaviors differs. Furthermore, the time element between the obesogenic behaviors and incidents of intentional violence were beyond the scope of this particular data set. Finally, exposure to violence may be a non-specific risk factor for psychopathology, and that for instance depression may be causally related to obesity. However, we could not control for these possible confounding variables (e.g. depression).

In conclusion, in this large global sample of adolescents, exposure to violence was associated with obesogenic behaviors with the exception of low physical activity. Addressing obesity and obesogenic behaviors may also call for the evaluation of incidents of intentional injury.

**CONFLICTS OF INTEREST**

The authors declare no conflict of interest.

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| **Table 1** Survey characteristics | | | |
| Country | Year | Response rate (%) | Na |
|
| Afghanistan | 2014 | 79 | 1,493 |
| Algeria | 2011 | 98 | 3,484 |
| Antigua & Barbuda | 2009 | 67 | 1,235 |
| Argentina | 2012 | 71 | 21,528 |
| Bahamas | 2013 | 78 | 1,308 |
| Bangladesh | 2014 | 91 | 2,753 |
| Barbados | 2011 | 73 | 1,504 |
| Belize | 2011 | 88 | 1,600 |
| Benin | 2016 | 78 | 717 |
| Bolivia | 2012 | 88 | 2,804 |
| Brunei Darussalam | 2014 | 65 | 1,824 |
| Cambodia | 2013 | 85 | 1,812 |
| Chile | 2013 | 60 | 1,353 |
| Costa Rica | 2009 | 72 | 2,265 |
| Curaçao | 2015 | 83 | 1,498 |
| Dominica | 2009 | 84 | 1,310 |
| East Timor | 2015 | 79 | 1,631 |
| Egypt | 2011 | 85 | 2,364 |
| El Salvador | 2013 | 88 | 1,615 |
| Fiji | 2016 | 79 | 1,537 |
| French Polynesia | 2015 | 70 | 1,902 |
| Ghana | 2012 | 82 | 1,110 |
| Guatemala | 2015 | 82 | 3,611 |
| Guyana | 2010 | 76 | 1,973 |
| Honduras | 2012 | 79 | 1,486 |
| Indonesia | 2015 | 94 | 8,806 |
| Iraq | 2012 | 88 | 1,533 |
| Jamaica | 2010 | 72 | 1,204 |
| Kiribati | 2011 | 85 | 1,340 |
| Kuwait | 2015 | 78 | 2,034 |
| Laos | 2015 | 70 | 1,644 |
| Lebanon | 2011 | 87 | 1,982 |
| Malaysia | 2012 | 89 | 16,273 |
| Maldives | 2014 | 60 | 1,781 |
| Mauritania | 2010 | 70 | 1,285 |
| Mauritius | 2011 | 82 | 2,074 |
| Mongolia | 2013 | 88 | 3,707 |
| Morocco | 2010 | 92 | 2,405 |
| Mozambique | 2015 | 80 | 668 |
| Namibia | 2013 | 89 | 1,936 |
| Nepal | 2015 | 69 | 4,616 |
| Oman | 2010 | 89 | 1,000 |
| Pakistan | 2009 | 76 | 4,998 |
| Peru | 2010 | 85 | 2,359 |
| Philippines | 2015 | 79 | 6,162 |
| Qatar | 2011 | 87 | 1,781 |
| Samoa | 2011 | 79 | 2,200 |
| Seychelles | 2015 | 82 | 2,061 |
| Solomon Islands | 2011 | 85 | 925 |
| St. Kitts & Nevis | 2011 | 70 | 1,471 |
| Suriname | 2009 | 89 | 1,046 |
| Swaziland | 2013 | 97 | 1,318 |
| Tanzania | 2014 | 87 | 2,615 |
| Thailand | 2015 | 89 | 4,132 |
| Tonga | 2010 | 80 | 1,946 |
| Trinidad & Tobago | 2011 | 90 | 2,363 |
| Tuvalu | 2013 | 90 | 679 |
| United Arab Emirates | 2010 | 91 | 2,302 |
| Uruguay | 2012 | 77 | 2,869 |
| Vanuatu | 2011 | 72 | 852 |
| Vietnam | 2013 | 96 | 1,743 |
| Yemen | 2014 | 75 | 1,553 |

a Based on sample aged 12-15 years.

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| **Table 2** Adjusted association between different types of violence and obesogenic behavior estimated by meta-analysis with random effects based on country-wise estimates | | | |
| Outcome | Exposure | OR [95%CI] | *I2* |
| Anxiety-induced sleep problemsa | Intentional injuryb | 2.99 [2.55,3.50] | 32.0% |
|  | Physical attack | 1.99 [1.84,2.15] | 57.6% |
|  | Physical fight | 1.88 [1.76,2.02] | 43.8% |
| Low physical activityc | Intentional injuryb,d | 0.72 [0.64,0.81] | 4.6% |
|  | Physical attack | 1.02 [0.96,1.07] | 51.1% |
|  | Physical fight | 0.90 [0.86,0.95] | 49.4% |
| Sedentary behaviore | Intentional injuryb,f | 1.58 [1.43,1.74] | 0.0% |
|  | Physical attack | 1.19 [1.13,1.24] | 46.4% |
|  | Physical fight | 1.35 [1.28,1.42] | 60.9% |
| Fast-food consumption | Intentional injuryb,g | 1.78 [1.55,2.04] | 32.0% |
|  | Physical attack | 1.40 [1.31,1.50] | 63.4% |
|  | Physical fight | 1.56 [1.47,1.66] | 59.0% |
| Carbonated soft-drink consumption | Intentional injuryb | 1.38 [1.21,1.57] | 33.4% |
|  | Physical attack | 1.18 [1.12,1.24] | 64.8% |
|  | Physical fight | 1.36 [1.29,1.43] | 65.5% |

Abbreviation: OR Odds ratio; CI Confidence interval.

Country-wise estimates were adjusted for age, sex, and food insecurity.

a Algeria, Chile, Egypt, Mauritius, Oman, and Vietnam were not included due to lack of data.

b Bangladesh, Guatemala, Guyana, Maldives, and Pakistan were not included due to lack of data.

c Jamaica, Maldives, and Swaziland were not included due to lack of data.

d Cambodia and East Timor were not included because estimates could not be obtained due to small numbers.

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

f Laos was not included because estimates could not be obtained due to small numbers.

g Cambodia and Honduras were not included because estimates could not be obtained due to small numbers.

**TABLE AND FIGURE LEGENDS**

**Table 1** Survey characteristics

**Table 2** Adjusted association between different types of violence and obesogenic behavior estimated by meta-analysis with random effects based on country-wise estimates

**Figure 1** Prevalence of different types of obesogenic behavior by presence or absence of intentional injury in the past 12 months

**Figure 2** Prevalence of different types of obesogenic behavior by number of times physically attacked in past 12 months

**Figure 3** Prevalence of different types of obesogenic behavior by number of times in physical fight in past 12 months

**Table S1** Prevalence of different types of obesogenic behavior and violence by country

**Figure S1** Country-wise association between intentional injury (exposure) and anxiety-induced insomnia (outcome) estimated by multivariable logistic regression

**Figure S2** Country-wise association between physical attack (exposure) and anxiety-induced insomnia (outcome) estimated by multivariable logistic regression

**Figure S3** Country-wise association between physical fight (exposure) and anxiety-induced insomnia (outcome) estimated by multivariable logistic regression

**Figure S4** Country-wise association between intentional injury (exposure) and low physical activity (outcome) estimated by multivariable logistic regression

**Figure S5** Country-wise association between physical attack (exposure) and low physical activity (outcome) estimated by multivariable logistic regression

**Figure S6** Country-wise association between physical fight (exposure) and low physical activity (outcome) estimated by multivariable logistic regression

**Figure S7** Country-wise association between intentional injury (exposure) and sedentary behavior (outcome) estimated by multivariable logistic regression

**Figure S8** Country-wise association between physical attack (exposure) and sedentary behavior (outcome) estimated by multivariable logistic regression

**Figure S9** Country-wise association between physical fight (exposure) and sedentary behavior (outcome) estimated by multivariable logistic regression

**Figure S10** Country-wise association between intentional injury (exposure) and fast-food consumption (outcome) estimated by multivariable logistic regression

**Figure S11** Country-wise association between physical attack (exposure) and fast-food consumption (outcome) estimated by multivariable logistic regression

**Figure S12** Country-wise association between physical fight (exposure) and fast-food consumption (outcome) estimated by multivariable logistic regression

**Figure S13** Country-wise association between intentional injury (exposure) and carbonated soft-drink consumption (outcome) estimated by multivariable logistic regression

**Figure S14** Country-wise association between physical attack (exposure) and carbonated soft-drink consumption (outcome) estimated by multivariable logistic regression

**Figure S15** Country-wise association between physical fight (exposure) and carbonated soft-drink consumption (outcome) estimated by multivariable logistic regression

**Figure S16** Bubble plot with fitted meta-regression line of the log-odds of the association between intentional injury and fast food consumption, and survey year by country based on data from 57 countries