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Research paper

Leisure-time sedentary behavior and suicide attempt among 126,392 adolescents in 43 countries

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ABSTRACT

Background: Adolescent suicide is a major global mental health problem. Exploring variables associated with suicide attempts is important for the development of targeted interventions. The aim of the current study was to explore associations between leisure-time sedentary behavior and suicide attempts.

Methods: Data from the Global School-based Student Health Survey were analyzed. Data on past 12-month suicide attempts and self-reported leisure-time sedentary time were collected. Multivariable logistic regression and meta-analysis were conducted to assess the associations.

Results: Among 126,392 students from 43 countries (mean age 13.8 ± 0.96 years; 48.9% female), 10.6% had attempted suicide. The prevalence of suicide attempts increased with increasing sedentary leisure-time per day (from 9% at <1 h/day to 16.8% at >8 h/day). Compared to those engaging in <1 h/day sedentary during leisure-time, there was a dose-dependent increase in odds ratios (ORs) for suicide attempts, with the OR for >8 h/day being 1.45 (95% confidence interval = 1.19–1.77).

Limitations: The study is cross-sectional, therefore the directionality of the relationships cannot be deduced.

Conclusions: Our data suggest that leisure-time sedentary behavior is associated with increased odds for suicide attempt in adolescence. Future longitudinal data are required to confirm/refute the findings to inform public prevention campaigns.

1. Introduction

Adolescent suicide is a major global public health issue. Although in the past two decades, the suicide rate per 100,000 in boys aged 10–14 years in 81 countries has shown a minor decline (from 1.61 to 1.52), in girls, it increased (from 0.85 to 0.94) in the same period (Kolves and De Leo, 2014). Among 15–29 year olds, suicide is nowadays the second leading cause of death globally (World Health Organization, 2014). Thus, there is an urgent need to identify risk factors for suicidality among adolescents to implement effective and evidence-based interventions at population and individual levels. Previously reported risk factors for adolescent suicide are diverse. Mental health factors include sleep disturbances, psychiatric diagnoses, panic attacks, a history of aggression, impulsivity, severe anger, and pathologic internet use

Abbreviations: AMR, Region of the Americas; AFR, African Region; CDC, US Centers for Disease Control and Prevention; CI, Confidence interval; EMR, Eastern Mediterranean Region; GSHS, Global school-based Student Health Survey; NHANES, National Health And Nutrition Examination Survey; OR, odds ratio; SEAR, South-East Asia Region; YRBS, Youth Risk Behavior Survey; WHO, World Health Organization; WPR, Western Pacific Region

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Table 1
Survey year, sample size, response rate, and prevalence of sedentary behavior and suicide attempt by country.

WHO region	Country	Year	Income level[a]	Response rate (%)[b]	N[c]	Sedentary behavior% (95%CI)[d,e]	Suicide attempt% (95%CI)[d]
AFR	Benin	2009	L	90	1170	18.4 (15.3–22.0)	27.6 (23.7–31.7)
	Ghana	2012	LM	82	1110	18.3 (14.9–22.3)	26.6 (20.8–33.4)
	Mauritania	2010	LM	70	1285	39.2 (33.9–44.8)	16.6 (9.6–27.2)
	Mozambique	2015	L	80	668	40.7 (33.6–48.2)	16.5 (11.9–22.5)
	Namibia	2013	UM	89	1936	37.0 (33.6–40.5)	25.4 (21.3–30.0)
	Seychelles	2015	H	82	2061	50.2 (47.4–52.9)	20.5 (17.6–23.8)
	Tanzania	2014	L	87	2615	20.3 (17.3–23.7)	10.8 (8.5–13.6)
AMR	Antigua and Barbuda	2009	UM	67	1235	53.8 (49.9–57.7)	11.8 (9.6–14.5)
	Argentina	2012	UM	71	21,528	49.1 (47.3–50.9)	15.2 (13.8–16.7)
	Bahamas	2013	H	78	1308	56.1 (52.4–59.7)	14.1 (11.3–17.5)
	Belize	2011	LM	88	1600	36.2 (31.9–40.8)	12.3 (10.3–14.6)
	Bolivia	2012	LM	88	2804	24.2 (21.0–27.8)	19.9 (17.7–22.2)
	Costa Rica	2009	UM	72	2265	43.2 (39.7–46.7)	8.5 (6.9–10.4)
	Curaçao	2015	H	83	1498	57.2 (54.0–60.3)	12.0 (10.2–14.2)
	El Salvador	2013	LM	88	1615	33.7 (29.2–38.5)	11.8 (9.8–14.1)
	Guatemala	2015	LM	82	3611	22.5 (17.4–28.6)	17.3 (14.0–21.1)
	Honduras	2012	LM	79	1486	30.4 (27.8–33.2)	16.5 (13.7–19.7)
	Peru	2010	UM	85	2359	27.4 (24.0–31.1)	17.3 (15.2–19.7)
	St. Kitts and Nevis	2011	H	70	1471	57.2 (53.0–61.4)	15.2 (12.1–18.9)
	Suriname	2009	UM	89	1046	39.1 (34.7–43.7)	7.1 (5.5–9.2)
	Trinidad and Tobago	2011	H	90	2363	45.1 (40.8–49.3)	13.5 (11.7–15.5)
	Uruguay	2012	H	77	2869	59.8 (56.1–63.4)	7.7 (6.3–9.5)
EMR	Afghanistan	2014	L	79	1493	22.9 (17.2–29.7)	12.5 (9.6–16.2)
	Iraq	2012	UM	88	1533	25.6 (21.7–30.0)	14.0 (11.7–16.7)
	Kuwait	2015	H	78	2034	62.3 (56.1–68.1)	15.8 (13.2–18.8)
	Lebanon	2011	UM	87	1982	47.0 (42.6–51.5)	13.2 (11.6–15.0)
	Morocco	2010	LM	92	2405	25.9 (23.0–29.1)	13.2 (10.8–15.9)
	United Arab Emirates	2010	H	91	2302	49.1 (45.5–52.7)	12.2 (10.1–14.6)
SEAR	Bangladesh	2014	LM	91	2753	14.1 (10.8–18.3)	6.6 (4.9–8.8)
	East Timor	2015	LM	79	1631	15.2 (12.6–18.3)	9.3 (6.6–12.8)
	Indonesia	2015	LM	94	8806	25.7 (23.8–27.7)	3.9 (3.2–4.8)
	Thailand	2015	UM	89	4132	51.0 (48.1–54.0)	14.0 (10.9–17.7)
WPR	Brunei Darussalam	2014	H	65	1824	52.9 (50.2–55.5)	5.1 (4.1–6.3)
	Cambodia	2013	L	85	1812	9.9 (7.6–12.6)	6.5 (5.1–8.2)
	Kiribati	2011	LM	85	1340	14.9 (13.0–17.0)	30.7 (27.1–34.6)
	Laos	2015	LM	70	1644	17.3 (14.9–20.1)	4.7 (3.7–6.1)
	Malaysia	2012	UM	89	16,273	42.7 (40.5–45.0)	7.1 (6.1–8.2)
	Mongolia	2013	LM	88	3707	39.9 (36.1–43.8)	9.3 (8.2–10.5)
	Philippines	2015	LM	79	6162	30.5 (26.8–34.5)	15.8 (12.9–19.4)
	Samoa	2011	LM	79	2200	37.4 (34.3–40.7)	62.3 (55.2–69)
	Solomon Islands	2011	LM	85	925	27.7 (21.9–34.2)	29.6 (21.1–39.8)
	Tuvalu	2013	UM	90	679	15.4 (12.6–18.7)	9.4 (7.3–12.0)
	Vanuatu	2011	LM	72	852	20.0 (15.5–25.5)	23.6 (17.9–30.6)

Abbreviation: AFR African Region; AMR Region of the Americas; EMR Eastern Mediterranean Region; SEAR South-East Asia Region; WPR Western Pacific Region; L low income; LM lower middle income; UM upper middle income; H high income; CI Confidence interval.

[a] Country income level was based on the World Bank classification at the year of the survey in the respective countries.

[b] Response rate was calculated as school response rate multiplied by student response rate.

[c] Based on sample aged 12–15 years.

[d] Estimates are sex- and age-adjusted.

[e] ≥ 3 h of sedentary behavior per day.

(Shain, 2016). Psychosocial risk factors include family conflict, physical and sexual childhood abuse, isolation, socioeconomic disadvantage, discrimination and acculturation and low self-esteem (Abraham and Sher, 2017). Protective factors are family cohesion and strong interpersonal relationships, as well as increased access to care (Abraham and Sher, 2017).

Currently, there is growing evidence that healthy lifestyles including participation in light, moderate and vigorous physical activity (Cho, 2014; Rodelli et al., 2018; Taliaferro et al., 2008; **2009**), a healthy diet (Rodelli et al., 2018), and sufficient sleep duration (Guo et al., 2017; Rodelli et al., 2018) might also be protective factors against suicidal behaviors. Conversely, unhealthy lifestyle behaviors such as substance abuse, including cannabis, tobacco and alcohol use (Borges et al., 2017; Sampasa-Kanyinga et al., 2017; Sharma et al., 2015), and excessive energy drink intake and junk food consumption (Park et al., 2016) have been associated with adolescent suicide attempts. However, there are currently very few studies on sedentary behavior (i.e., any behavior during waking hours with energy expenditure less than or equal to 1.5 metabolic equivalents while in a sitting or reclining posture (Cart, 2012)) and suicidality among adolescents. Sedentary behavior may, independently from physical activity participation, increase risk for depressive symptomatology, psychological distress and low self-esteem (Hoare et al., 2016), all of which are risk factors for a suicide attempt. The few previous studies on suicidality and sedentary behavior in adolescents have only focused on suicidal ideation, yielding mixed results (Arat and Wong, 2017; Casiano et al., 2012; Do et al., 2013; Fang et al., 2014; Messias et al., 2011), and there are no studies on suicide attempts, despite the fact that suicide attempts represent a much more serious risk than suicidal ideation alone. For instance, a prior suicide attempt has been identified as the single most important risk factor for suicides in the general population (World Health Organization, 2014), but the vast majority of ideators actually do not go on and make a suicide attempt (Nock et al., 2013). Furthermore, while non-fatal, suicide attempts can have a profound psychological effect on the individual and family, and it can also result in economic burden for the individual and society in large for health care to treat injuries and

the associated long-term disabilities in some cases (Kerkhof, 2012).

Given the lack of studies on sedentary behavior and suicide attempts, the aim of the current study was to assess this association of sedentary behavior during leisure-time and suicide attempts by using data from 43 countries from five World Health Organization (WHO) regions [African Region (AFR), Region of the Americas (AMR), Eastern Mediterranean Region (EMR), South-East Asia Region (SEAR), Western Pacific Region (WPR)] to provide a global understanding on this topic.

2. Methods

2.1. The survey

Publicly available data from the Global school-based Student 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 World Health Organization (WHO) and the US Centers for Disease Control and Prevention (CDC), and other United Nations 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 (Brener et al., 1995). 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. Thus, data were also collected from those who were not aged 13–15 years. 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 pertaining to our analysis. If there were more than two datasets from the same country, we chose the most recent dataset. A total of 43 countries were included in the current study. The characteristics of each country including the survey year, country income level, response rate, and sample size are provided in Table 1. For the included countries, the survey was conducted between 2009 and 2015, and consisted of 9 high-income, 29 middle-income, and 5 low-income countries.

2.2. Suicide attempt (dependent variable)

Suicide attempt was assessed by the question “During the past 12 months, how many times did you actually attempt suicide?” and was defined as at least one suicide attempt in the past 12 months.

2.3. Leisure-time sedentary behavior (independent variable)

Leisure-time 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 h/day. This excluded time at school and when doing homework. This variable was used as a six-category variable or a dichotomized variable (≥3 h/day or not) (Guthold et al., 2010). This question was based on the National Health And Nutrition Examination Survey (NHANES) questionnaire from 1999–2000 (https://wwwn.cdc.gov/Nchs/Nhanes/1999–2000) and modified for use in children.

2.4. Control variables

Sex, age, food insecurity (i.e., proxy for socioeconomic status), physical activity, presence of close friends, anxiety-induced insomnia, obesity, fruit and vegetable intake, fast food consumption, and alcohol consumption were used as control variables in the analysis. Food insecurity was used as a proxy for socioeconomic status as in a previous GSHS study (Balogun et al., 2014) as there were no variables on socioeconomic status in the GSHS. Specifically, this 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’ (McKinnon et al., 2016). To assess levels of physical activity, questions that represented the PACE+ Adolescent Physical Activity Measure (Prochaska et al., 2001) were asked. This measure showed reliability and validity (Prochaska et al., 2001). The questions asked about the number of days with physical activity of at least 60 min during the past 7 days. This did not include physical activity during physical education or gym classes. A separate question asked about physical education classes. Specifically, the student was asked to indicate how many days he/she went to physical education class each week during this school year with answer options 0, 1, 2, 3, 4, and 5 or more days. Presence of close friend was defined as having at least one close friend. 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’. Those who answered ‘most of the time’ or ‘always’ were considered to have anxiety-induced insomnia (Sharma et al., 2017). Trained survey staff conducted measurement of weight and height. Body mass index (BMI) 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 (Caleyachetty et al., 2015). Low fruit and vegetable intake was defined as intake of fruit and vegetables less than five times per day (< 400 g of fruits and vegetables/day) during the past 30 days (Caleyachetty et al., 2015). 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. Alcohol consumption was defined as having had at least one drink containing alcohol in the past 30 days. Data on alcohol consumption were not collected in Afghanistan, Iraq, Kuwait, Mauritania, Morocco, St. Kitts and Nevis, and United Arab Emirates.

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. Age- and sex- adjusted prevalence estimates of leisure-time sedentary behavior (i.e., ≥3 h/day) and suicide attempts were obtained by using the overall proportion of age and sex obtained from this current dataset as the standard population. We used logistic regression analysis to estimate the association between sedentary behavior (independent variable) and suicide attempts (dependent variable). The exposure variable was the six-category sedentary behavior variable when the overall sample was used. However, for country-wise analyses, we used the dichotomized sedentary behavior variable to obtain stable estimates, as the sample size in each country was small. In order to assess between-country heterogeneity in the association between sedentary behavior and suicide attempts, we calculated the Higgin's I^2 which represents the degree of heterogeneity that is not explained by sampling error with a value of <40% often considered as negligible and

40–60% as moderate heterogeneity (Higgins and Thompson, 2002). Heterogeneity between regions was tested by Cochran's Q tests. A pooled estimate was obtained by combining the estimates for each country into a fixed effect meta-analysis as the level of heterogeneity was low. This analysis was done using the overall sample and region-wise samples. The regression analyses were adjusted for age, sex, food insecurity (proxy of socioeconomic status), physical activity (including days attended physical education class), presence of close friends, anxiety-induced insomnia, obesity, fruit and vegetable intake, fast food consumption, alcohol consumption, and country with the exception of the country-wise analyses which were not adjusted for country. Afghanistan, Iraq, Kuwait, Mauritania, Morocco, St. Kitts and Nevis, and United Arab Emirates were not included in the overall analysis as information on alcohol consumption was not collected. The country-wise estimates for these countries were not adjusted for alcohol consumption. Adjustment for country was done using fixed effects models as in a previous GSHS study (McKinnon et al., 2016). We also tested for interaction by sex by including the product term 'sedentary time X sex' into the model using the overall sample.

All variables were included in the regression analysis as categorical variables with the exception of age, physical activity (including days attended physical education class) and days consumed fast food (continuous variables). Under 3.8% of the data were missing for all the variables used in the analysis with the exception of obesity (17.4%). In order to avoid the omission of a large number of participants from the analysis, we included a missing category only for obesity. Sampling weights and the clustered sampling design of the surveys were taken into account to obtain nationally representative estimates. 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 final sample consisted of 126,392 students aged 12–15 years with a mean (SD) age of 13.8 (0.96) and 48.9% were females. The overall prevalence of leisure-time sedentary behavior in each category were: 39.4% (<1 h/day), 32.7% (1–2 h/day), 15.8% (3–4 h/day), 5.9% (5–6 h/day), and 2.2% (7–8 h/day), and 4.0% (≥8 h/day). Overall, 10.6% of the students reported a suicide attempt in the past 12 months. There was a wide variation in the prevalence of ≥3 h/day of sedentary behavior [range 9.9% (Cambodia) to 62.3% (Kuwait)] (Table 1).

The prevalence of suicide attempts increased with increasing leisure-time spent sedentary per day (<1 h/day 9.0% to >8 h 16.8%) (Fig. 1).

This was also illustrated in the adjusted model, where compared to those who engage in leisure-time sedentary behavior for <1 h/day, there was a dose-dependent increase in the ORs with the OR (95%CI) for >8 h/day being 1.45 (1.19–1.77) (Fig. 2). No significant interaction by sex was observed.

The pooled OR (95%CI) for the association between ≥3 h/day of leisure-time sedentary behavior and suicide attempts were: 1.09 (0.94–1.26) for African countries, 1.16 (1.06–1.26) for the Americas, 1.25 (1.08–1.45) for Eastern Mediterranean countries, 1.46 (1.17–1.81) for South-East Asian countries, and 1.22 (1.11–1.33) for Western Pacific countries (Fig. 3). There was no significant between-region heterogeneity in the association between sedentary behavior and suicide attempts ($P = 0.447$). The country-wise association between leisure-time sedentary behavior per day (continuous variable) and suicide attempts estimated by multivariable logistic regression is presented in Supplementary Fig. 1.

The overall estimate including all countries was 1.20 (95%CI = 1.14–1.26). The overall level of between-country heterogeneity was low ($I^2 = 0.0\%$). The pooled estimate after the exclusion of countries for which adjustment for alcohol consumption could not be conducted (Afghanistan, Iraq, Kuwait, Mauritania, Morocco, St. Kitts and Nevis, United Arab Emirates) were similar (OR = 1.18; 95%CI = 1.12–1.25; $I^2 = 0.0\%$) (data shown only in text).

4. Discussion

4.1. General findings

The overall prevalence of suicide attempts (10.6%) and leisure-time sedentary behavior of ≥3 h per day (27.9%) were similar to those reported in surveys among adolescents with the same questions from different settings (Guthold et al., 2010). Furthermore, the present study showed that there was a linear increase in the prevalence of suicide attempts with increasing sedentary leisure-time and this was irrespective of age, sex, socioeconomic status (food insecurity), physical activity levels, presence of close friends, anxiety-induced insomnia, obesity, fruit and vegetable intake, fast food consumption, alcohol consumption, and country. Country-wise analysis showed that sedentary behavior of ≥3 h/day (vs. <3 h/day) was associated with a higher risk for suicide attempts in most parts of the world and only a low level of between-country heterogeneity was observed with the overall estimate based on a meta-analysis being 1.20 (95%CI = 1.14–1.26).

4.2. Interpretation of the findings

This study is the first to examine the relationship between leisure-time sedentary behavior and suicide attempts in adolescents. The results show that more leisure-time spent sedentary is associated with increased odds of suicide attempts, which is in line with several other adolescent studies showing that sedentary behavior is associated with suicidal ideation (Do et al., 2013; Messias et al., 2011). Specifically, Messias and colleagues (Messias et al., 2011) found that after accounting for age, gender, smoking and self-reported two-week sadness, adolescents reporting five hours or more of video game/ internet use per day are more likely to have experienced suicidal ideation compared to adolescents reporting no video game or internet use. An examination of internet use among a large ($n = 136,589$) South Korean adolescent sample (Do et al., 2013) revealed lower odds of suicide ideation in those using less than two hours per day of internet use, while those reporting more than two hours experience an increased likelihood of suicidal ideation.

Future research should explore the directionality of the relationships we observed and potential underlying mechanisms clarifying the relation between leisure-time sedentary behavior and suicide attempt. There is evidence to believe that suicidal thoughts are induced by feelings of depression (Shaffer et al., 1996), which also results in more sedentary behavior (Hoare et al., 2016). Vice versa, previous research has suggested a causal pathway from sedentary behavior to adverse mental health outcomes. Specifically, data from randomized controlled trials in Western samples have already demonstrated the independent deleterious impact of increasing sedentary behavior on mood and in particular symptoms of anxiety in active youth (Edwards and Loprinzi, 2016), both of which are risk factors for suicide attempt, and this being possibly through changes in inflammation (Endrighi et al., 2015). Sedentary behavior has been shown to be associated with higher c-reactive protein and interleukin-6 levels (Henson et al., 2013). Both inflammatory biomarkers are also associated with suicidal behavior (Black and Miller, 2015). There is some provisional evidence in adults to suggest that standing and breaking up prolonged periods of sedentary behavior can improve inflammatory biomarkers profiles (Healy et al., 2011), while in adolescents, metabolic benefits were observed (Fletcher et al., 2018). In addition, adolescents may be more vulnerable to physiological responses from arousal of the central nervous system and associated negative effects on sleep patterns with high rates of screen viewing (Hume et al., 2010). Previous research did show that sleep problems are an important risk factor for suicide attempt (Koyawala et al., 2015), and in particular in adolescents with internet

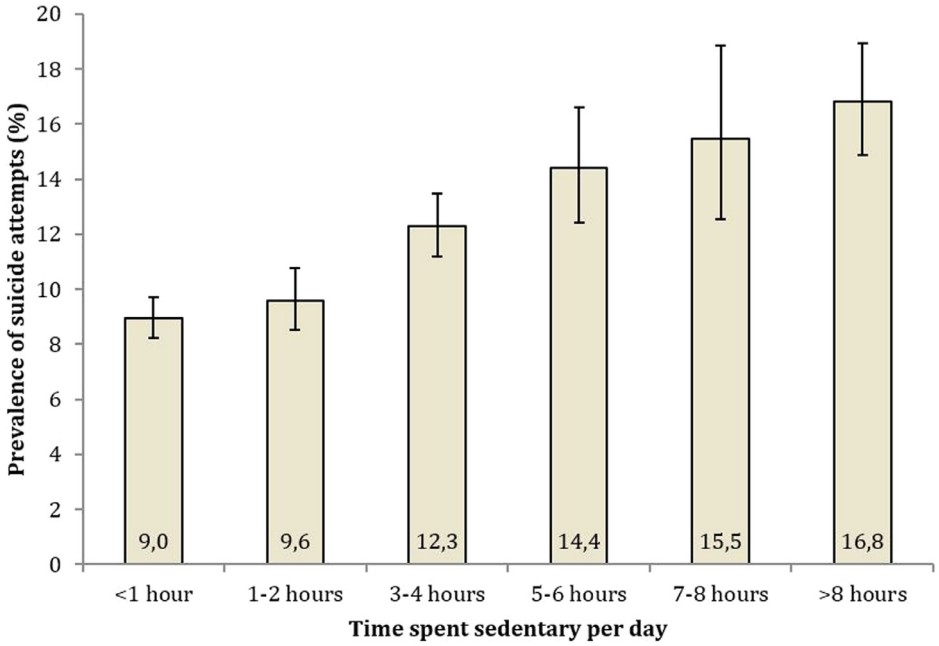


Fig. 1. Prevalence of suicide attempts by time spent sedentary per day upper and lower bars denote 95% confidence interval.

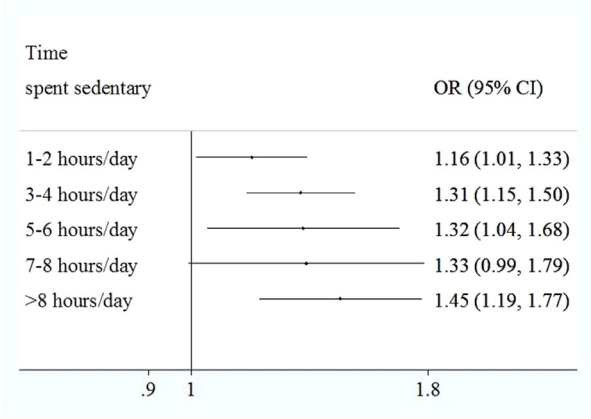


Fig. 2. Association between time spent sedentary per day and suicide attempts estimated by multivariable logistic regression.
Abbreviation: OR odds ratio; CI confidence interval
Reference category is <1 h/day.
Model is adjusted for age, sex, hunger due to lack of food at home (proxy of socioeconomic status), physical activity, presence of close friend, anxiety-induced insomnia, obesity, fruit and vegetable intake, fast food consumption, alcohol consumption, and country.
Data from Afghanistan, Iraq, Kuwait, Mauritania, Morocco, St. Kitts and Nevis, and United Arab Emirates were not included due to lack of data on alcohol consumption.

addiction (Kim et al., 2017). Finally, more time spent sedentary is also associated with a higher risk for functional somatic symptoms in adolescents (Janssens et al., 2014), which on its turn are a risk factor for poor mental health and a higher risk for suicidal behaviour (Junker et al., 2017).

4.3. Limitations and future research

Our findings should be interpreted in light of several potential limitations. First of all, the study is cross-sectional, therefore the directionality of the relationships cannot be deduced. Longitudinal studies are required to better disentangle the relationships observed. Second, the study relied on self-reported data, which could have been affected by factors such as recall and social desirability biases (Soundy et al., 2014). For example, although our overall estimate of suicide attempts was similar to the figure reported in the Youth Risk Behavior Surveillance System (YRBSS) 2013, which reported a past 12-month suicide attempt prevalence figure of 8% (Kann et al., 2014), the exceptionally high prevalence of suicide attempts in countries such as Samoa point to the possibility that some of the variation in the prevalence across countries may also be attributable to different cultural understandings of the questions, as the interpretation of suicide may differ across cultures and languages. Additionally, self-reported time spent sedentary excluded time at school and when doing homework and therefore is an underestimate of the real time spent sedentary during the entire day. Future research should utilize objective measures of sedentary behavior. Accelerometers-inclinometers are available that allow for valid and reliable assessment of sedentary behavior. However, the association between sedentary behavior and suicide attempt may be dependent on the domain/type of sedentary behavior (e.g., cognitively active sedentary behavior, such as reading and internet use, versus cognitively passive TV viewing), an aspect that is not reliably measured with accelerometers. It has been suggested as well that increasing time spent using the internet may represent an increased dependency on social media platforms which are used to stay in touch with friends, make plans, get to know people better, and present oneself to others (Shapiro and Margolin, 2014), all of which might have protective benefits. Similarly, it has been suggested that access to internet may offer increased access to health information, including mental health support (Horgan and Sweeney, 2010). Therefore, in order to better understand the relationship between time spent sedentary during leisure and suicide risk, a combination of both objective and subjective assessment of sedentary behavior is warranted. Third, varying degrees of bias may have been introduced by interviewing only schoolchildren, especially in countries where schooling attendance rates are low. Nonetheless, the majority of 12–15 years old adolescents from most of the countries in our study do attend school (UNICEF, 2015). Fourth, it is also important to note that our results may be an underestimate for having adjusted for anxiety-induced insomnia, as previous studies have shown that excessive amounts of sedentary behaviour may also cause anxiety (Edwards and Loprinzi, 2016). Fifth, we were unable to assess the potential mediating effect of depression in time spent sedentary - suicide attempt association due to lack of data on this construct.

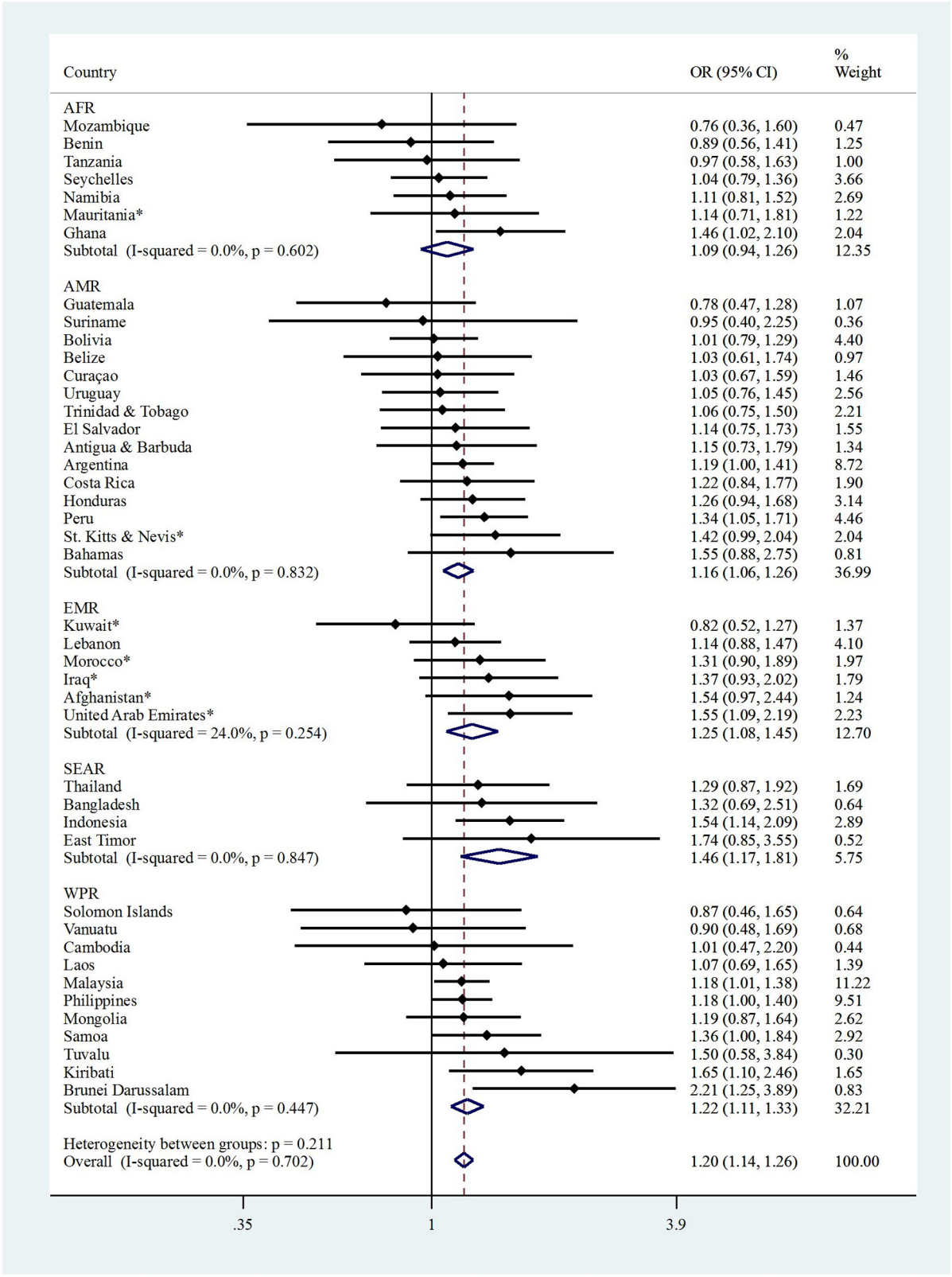


Fig. 3. Country-wise association between three hours or more of sedentary behavior per day and suicide attempts estimated by multivariable logistic regression.
Abbreviation: OR odds ratio; CI confidence interval; AFR African Region; AMR Region of the Americas; EMR Eastern Mediterranean Region; SEAR South-East Asia Region; WPR Western Pacific Region
Models are adjusted for age, sex, hunger due to lack of food at home (proxy of socioeconomic status), physical activity, presence of close friend, anxiety-induced insomnia, obesity, fruit and vegetable intake, fast food consumption, and alcohol consumption for all countries with the exception of Afghanistan, Iraq, Kuwait, Mauritania, Morocco, St. Kitts and Nevis, and United Arab Emirates which were not adjusted for alcohol consumption due to lack of data (*).
Subtotal and overall estimates were obtained by meta-analysis with fixed effects.

Nonetheless, the strengths of the study include the largest sample size and the inclusion of nationally representative samples of adolescents attending school. Furthermore, to the best of our knowledge, this is the first study on sedentary behavior and suicide attempts. Finally, given the findings of our study, but also the wider literature from longitudinal research considering the deleterious impact of sedentary behavior on multiple mental health outcomes in adolescents (Hoare et al., 2016), it is essential that future research explores the efficacy and effectiveness of public mental health interventions that seek to limit the time spent sedentary in this young population. Such campaigns and interventions should, next to promoting physical activity in general, also include messages on reducing sedentary time during leisure.

5. Conclusions

The current study found that leisure-time sedentary behavior and suicide attempts are both highly prevalent among school children globally, and that those who were sedentary for 8 or more hours had a nearly 1.5 times higher odds for suicide attempts compared to those who were sedentary for <1 h/day. This builds upon previous findings of sedentary time being linked to higher levels of depression and suicidal ideation in young people. Given this emerging evidence, avoiding excessive time spent sedentary during leisure, especially 8 or more hours per day, should be given consideration in suicide prevention strategies. Mental health practitioners should be cognizant of the fact that sedentary behavior may be a precursor of suicide attempts, while it is also important to assess suicidality in adolescents who are sedentary. Future longitudinal studies are needed to provide more insight into causality and the potential mediators (e.g., depression) that are involved in the sedentary behavior-suicide attempt association for the establishment of effective interventions to counteract this global mental health problem.

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Contributors

Dr. Davy Vancampfort—participated in the conception and design of the study, assisted in the analysis and wrote the manuscript. Dr. Ai Koyanagi—participated in the design of the study, analyzed the data and wrote the manuscript. Dr. Brendon Stubbs—participated in the conception and design of the study, and wrote the manuscript. All other co-authors—revised the different versions of article critically for important intellectual content based on their expert background and approved the final manuscript.

Conflicts of interest

The authors have no conflicts of interest to report.

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Supplementary materials

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