**Addictive Behaviors**

**Cannabis use and leisure-time sedentary behavior among 94,035 adolescents aged 12-15 years from 24 low- and middle-income countries**

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**ABSTRACT**

Adolescents spend a high proportion of their leisure time in sedentary behavior, which is associated with adverse physical and mental health outcomes. Exploring factors associated with leisure-time sedentary behavior (LTSB) is important for the development of targeted interventions. The aim of this study was to explore associations between cannabis use and LTSB in adolescents from 24 low- and middle-income countries. Data from the Global School-based Student Health Survey were analyzed. Data on past month cannabis use and LTSB during a typical day were collected. Multivariable logistic regressions were conducted to assess the associations. Among 94,035 adolescents aged 12-15 years [age=13.7±SD 0.9 years; 49.2% female], the prevalence of high LTSB (≥3 hours/day) was 26.6%, while 2.8% used cannabis at least once in the past 30 days. In adjusted analyses, compared to those who did not consume cannabis in the past 30 days, the OR (99%CI) for high LTSB among those who used cannabis 1-2 times, 3-9 times, 10-19 times, and ≥20 times were 0.89 (0.58-1.35), 1.96 (1.26-3.07), 1.97 (0.71-5.47), and 2.34 (0.95-5.78), respectively (test for trend p<0.01). Our data suggest that frequent cannabis use is associated with increased odds for being more sedentary in adolescence. Future longitudinal data are required to confirm/refute the findings to inform public health campaigns.

**Keywords:** cannabis; sitting; sedentary; physical activity; adolescents

1. **Introduction**

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)) is widespread and a growing health concern in adolescents, particularly in low- and middle-income countries (LMICs). Recent population-scale studies of young adolescents (aged 12-15) in LMICs have found that being sedentary for ≥3 hours/day outside school hours (i.e., leisure time sedentary behavior, LTSB), which was the case in 26.2% of the adolescents, is associated with higher odds of obesity (Ashdown‐Franks et al., 2019), fast-food consumption (Ashdown-Franks et al., 2019), loneliness (Vancampfort, Ashdown-Franks, et al., 2019) and suicide attempts (Vancampfort, Stubbs, et al., 2019). Recent evidence indeed indicates that sedentary behavior is associated with worse mental health. For example, there is strong consistent evidence for the relationship between both depressive symptomatology and psychological distress, and time spent using screens for leisure in adolescents, while moderate evidence supports the relationship between low self-esteem and screen use in this age group (Hoare, Milton, Foster, & Allender, 2016). Poorer mental health status is found in particular among adolescents using screen time more than 2 to 3 hours per day (Hoare et al., 2016). It has been suggested that the adverse relationship between sedentary behavior and some health outcomes may be independent of a person’s physical activity levels (Lee et al., 2012; Owen, Sparling, Healy, Dunstan, & Matthews, 2010).

Given the aforementioned deleterious outcomes, there has been an increasing emphasis on research aimed at reducing sedentary behavior among adolescents in recent years (Demetriou et al., 2019; Rodriguez-Ayllon et al., 2019). Whilst interventions focusing on sedentary behavior in adolescents may be promising (Babic et al., 2016; Penning et al., 2017), more high quality research is needed to determine if such interventions are sufficient to produce clinically meaningful and sustainable reductions in sedentary time. The first step in order to aid the development of effective interventions is a clear understanding and comprehensive examination of modifiable correlates of sedentary behavior in adolescents, as these can be targets for effective interventions. It is important to explore correlates of sedentary behavior in LMICs solely as there may be important differences in comparison to high-income countries. For example, while in adolescents living in high-income countries, the socio-economic status is inversely associated with sedentary behavior (ES=0.67; 95%CI=0.62-0.73), in LMICs there was a positive association between socio-economic status and sedentary behavior (ES=1.18; 95%CI=1.04-1.34) (Mielke, Brown, Nunes, Silva, & Hallal, 2017).

There is evidence, mainly from high-income countries, that frequent and large amounts of cannabis use might contribute to longer periods of LTSB by decreasing motivation for non-drug related engagements (De La Haye, D'Amico, Miles, Ewing, & Tucker, 2014; Leatherdale & Harvey, 2015; Lesjak & Stanojević-Jerković, 2015). Furthermore, a large body of evidence has suggested that cannabis use during adolescence may be particularly detrimental to brain development and to the emergence of psychopathology (Chadwick, Miller, & Hurd, 2013; Gobbi et al., 2019; Lubman, Cheetham, & Yucel, 2015; Renard, Rushlow, & Laviolette, 2018). Mental disorders such as depression, anxiety and psychosis are, in turn, associated with a more sedentary lifestyle in adolescents (Hoare et al., 2016). Vice versa, sedentary behavior may lead to depression (Edwards & Loprinzi, 2016a) and anxiety (Edwards & Loprinzi, 2016b) in adolescents, which are both risk factors for cannabis use (Stapinski, Montgomery & Araya, 2016).

However, to date, only a few epidemiological studies have explored the association between cannabis use and LTSB in LMICs. Exploring associations between cannabis use and LTSB with a focus on LMICs is also important given different sociocultural attitudes towards sedentary behavior (e.g., a sign of wealth), different access to devices (e.g., television, computers) and different environmental factors (e.g., safety, climate) in LMICs compared with high-income countries (Arat & Wong, 2017). The only multinational study to date in LMICs exploring the association between LTSB and substance use in adolescents from eight African countries explored the association with overall substance use including not only cannabis but also glue, benzene, cocaine and mandrax (Peltzer, 2010). Spending 3 to 4 hours sedentary outside school hours was associated with a 1.53 (95%CI=1.22–1.92) higher odds for illicit drugs use, while this increased to a 2.35 (95%CI=1.78–3.11) higher odds for those sedentary outside school hours for 5 or more hours (Peltzer, 2010). However, the association with cannabis use alone was not explored. This is of relevance as different illicit drugs might have different effects on a person’s LTSB (Brellenthin & Lee, 2018). If an association between cannabis use and LTSB can be observed, this might also partially explain previously observed associations between cannabis and health outcomes in adolescents (Gobbi et al., 2019). Therefore, an association will also justify a dual lifestyle intervention targeting both behaviors simultaneously in LMICs.

In order to fill the current gap in the literature, the aim of the current study was to assess the association between LTSB and cannabis use in adolescents using data from 24 LMICs from four World Health Organization regions (African Region, Region of the Americas, South-East Asia Region, and Western Pacific Region).

1. **Material and methods**
   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 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 (Brener, Collins, Kann, Warren, & Williams, 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. Data collection was performed during one regular class period. The survey questions were translated into the local language in each country and pilot tested for comprehension. The questionnaires were distributed by survey administrators 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 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. Benin was excluded as there were very few students who had consumed cannabis and stable estimates could not be obtained. Thus, a total of 24 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 2010 and 2016, and consisted of 4 low-income, 13 lower middle-income, and 7 upper middle-income countries based on the World Bank classification at the time of the survey.

* 1. ***Cannabis use (Independent variable)***

Past 30-day cannabis use was assessed with the question “During the past 30 days, how many times have you used marijuana?” Country-specific slang terms for marijuana were also included in the question. Answer options included 0, 1-2, 3-9, 10-19, and ≥20 times. In accordance with previous research (Carvalho et al., 2018), this variable was used as the original five-category variable or as a dichotomized variable (any cannabis use): ≥1 time (coded=1) or 0 times (coded=0).

* 1. ***Leisure-time sedentary behavior (LTSB) (Dependent variable)***

LTSB 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 six answer options: <1, 1-2, 3-4, 5-6, 7-8, and >8 hours/day. This excluded time at school and when doing homework. This question was based on the National Health and Nutrition Examination Survey (NHANES) questionnaire from 1999-2000, and modified for use in children. In accordance with previous studies using the same dataset, this variable was dichotomized as ≥3 hours/day (coded=1) and <3 hours/day (coded=0) (Guthold, Cowan, Autenrieth, Kann, & Riley, 2010). Throughout this manuscript, we refer to ≥3 hours/day of LTSB as high LTSB for the sake of brevity.

* 1. ***Control variables***

The selection of control variables was based on past literature (Vidot, Bispo, Hlaing, Prado, & Messiah, 2017) and included sex, age, food insecurity (hunger), body mass index (BMI), anxiety-induced insomnia, alcohol consumption, smoking, and physical activity. As in previous studies using the same dataset (Balogun, Koyanagi, Stickley, Gilmour, & Shibuya, 2014; Carvalho et al., 2018), food insecurity was used as a proxy for socioeconomic status as there were no variables on socioeconomic status in the GSHS. Also, anxiety-induced insomnia was considered a proxy of psychiatric disorders as there were no variables on psychiatric disorders including depression in the dataset (Carvalho et al., 2018). 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. BMI was calculated as weight in kilograms divided by height in meters squared. Obesity and overweight were defined as >2 SDs and >1 SD above the median for age and sex based on the 2007 WHO Child Growth reference, respectively, and adolescents who were below -2 SDs were considered to be underweight (Caleyachetty et al., 2018). All other subjects were considered to be normal weight. Anxiety-induced insomnia was defined as replying ‘most of the time’ or ‘always’ to the question “During the past 12 months, how often have you been so worried about something that you could not sleep at night?” Alcohol consumption was defined as having had one drink containing alcohol for at least one day in the past 30 days. Smoking was defined as having smoked at least on one day during the past 30 days. To assess levels of physical activity, questions that represented the PACE+ Adolescent Physical Activity Measure (Prochaska, Sallis, & Long, 2001) were asked. This measure has been tested for validity and reliability (Prochaska et al., 2001). The questions asked about the number of days with physical activity of at least 60 minutes during the past 7 days.

* 1. ***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 range and the exact age outside of this age range was not provided. Using the pooled sample, multivariable logistic regression analysis was conducted to estimate the association between cannabis use [five-category variable (0, 1-2, 3-9, 10-19, and ≥20 times in the past 30 days); independent variable] and LTSB (dependent variable). A test for trend was also conducted by including the five-category variable as a continuous variable in the model.

We also conducted country-wise analyses to assess whether there is between-country heterogeneity in the association between cannabis use and LTSB. The dichotomized variable on cannabis use (i.e., any cannabis use) was used for this analysis to obtain stable estimates, as the sample size in each country was small. We also calculated the Higgins’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 & Thompson, 2002). A pooled estimate was obtained by combining the estimates for each country into a random-effect meta-analysis.

The regression analyses were adjusted for sex, age, food insecurity, anxiety-induced insomnia, BMI, alcohol consumption, smoking, physical activity and country with the exception of the country-wise analysis, which was not adjusted for country. Adjustment for country was done by including each country as dummy variables as in previous GSHS studies (Carvalho et al., 2018; McKinnon, Gariepy, Sentenac, & Elgar, 2016). All covariates were included in the regression analysis as categorical variables with the exception of age and physical activity (continuous variable). Under 3.6% of the data were missing for all the variables used in the analysis with the exception of BMI (18.1%). For BMI, we included a missing category so as not to exclude a large number of observations from the regression analysis. Complete case analysis was done. Sensitivity analysis using the subset of data with the covariates of missingness yielded similar results, and this suggests that bias due to missing values was minimal. Sampling weights and the clustered sampling design (i.e., classrooms, schools) of the surveys were taken into account to obtain nationally representative estimates by the use of the Stata *svy* command, which uses the Taylor’s linearization method. Results from the logistic regression analyses are presented as odds ratios (ORs) with 99% confidence intervals (CIs). The level of statistical significance was set at p<0.01 as the sample size of our study was large.

1. **Results**

The final sample consisted of 94,035 adolescents aged 12-15 years with a mean (SD) age of 13.7 (0.9) years and 49.2% were females. The prevalence of high LTSB was 26.6% while 2.8% used cannabis at least once in the past 30 days (1-2 times 1.4%; 3-9 times 0.8%; 10-19 times 0.3%; ≥20 times 0.3%). The prevalence of any cannabis use and high LTSB ranged widely between countries with the former ranging from 0.6% (Laos) to Samoa (36.1%), and the latter 9.8% (Nepal) to 50.7% (Thailand) (Table 1). The prevalence of any cannabis use by different levels of sedentary behavior were: <1 hour/day 1.6%; 1-2 hours/day 2.8%; 3-4 hours/day 3.8%; 5-6 hours/day 5.9%; 7-8 hours/day 4.9%; ≥8 hours/day 4.1%.

The proportion of adolescents engaging in high LTSB increased with increasing times used cannabis in the past 30 days (**Figure 1**). For example, this prevalence was 26.1% among those who did not consume cannabis but increased to 56% among those who used cannabis more than 20 times. This was also shown in the adjusted analysis where compared to those who did not use cannabis in the past 30 days, the OR (99%CI) for high LTSB among those who used cannabis 1-2 times, 3-9 times, 10-19 times, and ≥20 times were 0.89 (0.58-1.35), 1.96 (1.26-3.07), 1.97 (0.71-5.47), and 2.34 (0.95-5.78), respectively (test for trend P<0.01) (**Figure 2**). The coefficients of the covariates used in this analysis are shown in **Table S1** of the Appendix.

The country-wise associations between any cannabis use (at least once in the past 30 days) and LTSB estimated by multivariable logistic regression are shown in **Figure 3**. Cannabis use was positively associated with high LTSB (OR>1) in 18 of the 24 countries, with the overall estimate based on a meta-analysis being 1.55 (99%CI=1.18-2.02). There was a moderate level of between-country heterogeneity (*I2*=43.6%).

1. **Discussion**
   1. ***General findings***

Our findings suggest that frequent cannabis use during the past 30 days is associated with a greater likelihood of being sedentary for ≥3 hours/day outside of school hours in most countries and regions examined. Our results are in accordance with a previous school-based report exploring associations between being sedentary and other illicit drug use (Peltzer, 2010). The present study also suggests that there was a linear increase in the prevalence of high LTSB with increasing cannabis use and this was evident after adjusting for sex, age, food insecurity (hunger), BMI, anxiety-induced insomnia, alcohol consumption, smoking, physical activity, and country. Country-wise analysis showed that any cannabis use was associated with LTSB of ≥3 hours/day (vs. <3 hours/day) in most parts of the world, although there was a moderate level of between-country heterogeneity. The overall estimate based on a meta-analysis was 1.55 (99%CI=1.18-2.02).

There might be several underlying mechanisms that could explain the associations between LTSB and cannabis use. First, it might be hypothesized that cannabis use is prospectively associated with LTSB. Previous research documented that cannabis use decreases motivation for active engagement in daily life activities (Volkow et al., 2016) and in turn, might decrease a person’s interest in interrupting sedentary time. Previous research has also documented that cannabis users exhibit reduced striatal dopamine synthesis capacity, with an inverse relationship to amotivation (Bloomfield et al., 2014; Volkow et al., 2016). As it is believed that dopamine signaling sustains motivation, impaired dopamine synthesis could underlie the amotivational state in cannabis users (Berridge & Robinson, 1998; Volkow et al., 2016). Some of the frequent cannabis users in our study might have been cannabis dependent (Coffey et al., 2002) (e.g., among those using cannabis 20+ times in a month). Imaging studies demonstrated decreased reactivity to dopamine stimulation in frequent cannabis users (Volkow et al., 2016; Volkow et al., 2014), but in particular in cannabis dependent users (Ernst & Luciana, 2015), and this was associated with negative emotionality, which can contribute to reduced engagement in daily life activities.

Second, it is also plausible that cannabis use is not prospectively associated with sedentary behavior but is rather clustered together in certain subgroups of the population (De La Haye et al., 2014; Neilson, Lin, & misuse, 2019). Longitudinal and intervention studies are however required to better disentangle the relationships observed.

Third, the presence of depression might be an underlying mechanism. It is known that cannabis use may be associated with the development of depressive disorders (Lev-Ran et al., 2014), which is known to be associated with high LTSB in adolescents in LMICs (Vancampfort et al., 2018). Vice versa, symptoms of depression, panic and generalized anxiety are associated with greater cannabis use following the onset of the mental health problems (Stapinski, Montgomery & Araya, 2016). We were however unable to assess the potential mediating effect of depression in the LTSB-cannabis use association due to lack of data in the GSHS dataset.

Finally, although information was obtained by anonymous self-completion questionnaires, it is also possible that the association between cannabis use and LTSB is partly driven by social desirability bias as lower levels of LTSB and cannabis use are both likely to be socially desirable in many countries, and the respondent may have responded in a socially desirable manner to both questions.

* 1. ***Limitations and strengths***

Our data should also be interpreted with caution due to other limitations. First of all, LTSB and cannabis use were assessed using single-item, self-reported data for which the validity is uncertain. The validity of the responses could also have been affected by factors such as recall and social desirability biases (Soundy, Roskell, Stubbs, & Vancampfort, 2014). For example, the low prevalence of cannabis use observed in some countries may be related with social desirability bias. However, intentional misreporting was probably minimized by the fact that study participants completed the questionnaires anonymously. Second, the question on cannabis use was based on a question that asked the student about how many times he/she used cannabis in the past 30 days and it is possible that the students interpreted this question differently (e.g., number of days, occasions). Third, 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 sensor-based measures of sedentary behavior. Fourth, although the percentage of missing values was overall low in this study, those missing values on either cannabis use or LTSB were more likely to be males, consume alcohol and smoke, and have anxiety-induced insomnia. Thus, it is possible that some level of bias may exist due to missing data. Fifth, in terms of the issue related to generalizability, since our study only included adolescents attending school, our study results may not be generalizable to adolescents who do not attend school. Nonetheless, the majority of 12–15 years old adolescents from most of the countries in our study do attend school (UNICEF, 2015). Also, since our study only included young adolescents aged 12-15 years, the results may not be generalizable to older adolescents. Sixth, we were not able to explore to what extent symptoms of cannabis dependence could be driving the association with LTSB, rather than cannabis use more generally. Finally, although at the time of the study, cannabis use and possession was not legalized nor decriminalized in any of the surveyed countries (United Nations Office on Drugs and Crime, 2019), we were not able to explore whether, for example, the severity of persecution for cannabis use and possession in the different national laws might have influenced the association between LTSB and cannabis use. Similarly, we were not able to explore whether national awareness and/or dissuasive school campaigns about cannabis use and/or a sedentary lifestyle targeting adolescents might have resulted in differences between countries. Despite these limitations, there are also some important strengths. This study included the largest sample size to date exploring this relationship among adolescents in LMICs. Data were collected in nationally representative samples of adolescents attending school. Second, to the best of our knowledge, this is the first multinational study on the association between sedentary behavior and cannabis use alone in adolescents living in LMICs.

* 1. ***Implications***

Given the findings of our study, but also the wider literature from longitudinal research consideringthe deleterious impact of LTSB on multiple mental health outcomes in adolescents (Hoare et al., 2016), it is essential that future research explores the efficacy and effectiveness of public health interventions that seek to limit both the time spent sedentary and the use of cannabis in this young population. Next to this, the current study potentially supports a dual lifestyle intervention, targeting high LTSB and cannabis misuse simultaneously in community treatment programs for a subgroup of adolescents who are cannabis-dependent. Finally, our findings also have implications for epidemiological research as they indicate that LTSB should be considered as a control variable in causal models relating cannabis use to mental and physical health outcomes.

1. **Conclusions**

The current study found that cannabis use is associated with LTSB, particularly among frequent users. Given this emerging evidence, the association between cannabis use and excessive sedentary time should be given consideration in public health campaigns. Schools, in addition to primary care settings should be cognizant of the importance of assessing cannabis use in adolescents who are sedentary. Similarly, sedentary behavior may be a precursor of cannabis use. Future longitudinal studies are needed to provide more insight into causality and the potential mediators (e.g., lack of motivation, depression) that are involved in the sedentary behavior - cannabis use relationship. Additionally, future research should assess if interventions which tackle sedentary time (e.g., sports programs) can also reduce the frequency or incidence of cannabis use among young people. Finally, the link between cannabis use and higher odds of adverse health behaviors (such as sedentary time) should be considered in policy maker’s debate around legalization of cannabis.

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| --- | --- | --- | --- | --- | --- | --- |
| **Table 1** Survey characteristics of each country | | | | | | |
|  |  |  | Response |  | Cannabisa | High LTSBb |
| Country incomec | Country | Year | rate (%)d | Ne | use (%) | (%) |
| Low | Cambodia | 2013 | 85 | 1812 | 1.2 | 10.2 |
|  | Mozambique | 2015 | 80 | 668 | 1.3 | 41.0 |
|  | Nepal | 2015 | 69 | 4616 | 2.5 | 9.8 |
|  | Tanzania | 2014 | 87 | 2615 | 2.4 | 20.1 |
| Low middle | Bangladesh | 2014 | 91 | 2753 | 1.6 | 14.9 |
|  | Bolivia | 2012 | 88 | 2804 | 2.6 | 24.3 |
|  | East Timor | 2015 | 79 | 1,631 | 5.8 | 15.6 |
|  | Ghana | 2012 | 82 | 1110 | 7.4 | 18.4 |
|  | Indonesia | 2015 | 94 | 8806 | 1.2 | 24.5 |
|  | Kiribati | 2011 | 85 | 1340 | 4.6 | 14.4 |
|  | Laos | 2015 | 70 | 1644 | 0.6 | 19.2 |
|  | Mongolia | 2013 | 88 | 3707 | 1.1 | 39.6 |
|  | Philippines | 2015 | 79 | 6162 | 5.3 | 30.7 |
|  | Samoa | 2011 | 79 | 2200 | 36.1 | 38.1 |
|  | Solomon Islands | 2011 | 85 | 925 | 13.3 | 26.4 |
|  | Tonga | 2010 | 80 | 1946 | 5.9 | 29.2 |
|  | Vanuatu | 2011 | 72 | 852 | 2.7 | 19.0 |
| Upper middle | Argentina | 2012 | 71 | 21528 | 5.9 | 49.9 |
|  | Fiji | 2016 | 79 | 1537 | 5.1 | 28.9 |
|  | Malaysia | 2012 | 89 | 16273 | 1.0 | 42.7 |
|  | Namibia | 2013 | 89 | 1936 | 4.6 | 37.2 |
|  | Peru | 2010 | 85 | 2359 | 2.9 | 28.6 |
|  | Thailand | 2015 | 89 | 4132 | 5.3 | 50.7 |
|  | Tuvalu | 2013 | 90 | 679 | 3.7 | 15.3 |

Abbreviation: LTSB Leisure-time sedentary behavior.

a Past 30-day cannabis use of any frequency.

b High leisure-time sedentary behavior referred to ≥3 hours/day of leisure-time sedentary behavior.

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

d Response rate was calculated as school response rate multiplied by student response rate.

e Based on sample aged 12-15 years.

**Figure 1** Prevalence of high leisure-time sedentary behavior by times used cannabis in past 30 days

High leisure-time sedentary behavior referred to ≥3 hours/day of leisure-time sedentary behavior.



**Figure 2** Association between times used cannabis in past 30 days and high leisure-time sedentary behavior estimated by multivariable logistic regression

Abbreviation: OR Odds ratio; CI Confidence interval

High leisure-time sedentary behavior referred to ≥3 hours/day of leisure-time sedentary behavior.

Reference category is 0 days.

Model is adjusted for sex, age, food insecurity, anxiety-induced insomnia, body mass index, alcohol consumption, smoking, physical activity, and country.

Significant test for trend (P<0.01).



**Figure 3** Country-wise associations between any cannabis use and high leisure-time sedentary behavior estimated by multivariable logistic regression

Abbreviation: OR Odds ratio; CI Confidence interval

High leisure-time sedentary behavior referred to ≥3 hours/day of leisure-time sedentary behavior.

Models are adjusted for sex, age, food insecurity, anxiety-induced insomnia, body mass index, alcohol consumption, smoking, and physical activity.

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