BMC Pediatrics

RESEARCH

Open Access

Association of physical activity and sitting time with tobacco and alcohol use in 222,495 adolescents from 66 countries

Eduardo Rossato de Victo[1*], Gerson Ferrari[2,3], Clemens Drenowatz[4] and Dirceu Solé[1]

Abstract

Background The prevalence of tobacco and alcohol use among adolescents is alarming, and these substances are among the leading risk factors for current and future health among adolescents. Physical activity has the potential to help prevent substance use among adolescents. The objective of this study was to evaluate the association between physical activity, modes of transportation to or from school, and sitting time with tobacco and alcohol use among 222,495 adolescents.

Methods This cross-sectional study used data from national surveys conducted in 66 countries, obtained through the Global School-based Student Health Survey, and included adolescents aged 11 to 17 years. Information on physical activity, transportation to or from school, sitting time, and tobacco and alcohol use was collected through self-report questionnaires. Generalized linear models were employed to estimate the associations between these variables.

Results The analysis, adjusted for sex, age, and region, revealed that being physically active was associated with lower odds of smoking (OR: 0.86, 95%CI: 0.83–0.89), alcohol use (OR: 0.74, 95%CI: 0.72–0.76), binge drinking (OR: 0.66, 95%CI: 0.62–0.69), and drunkenness (OR: 0.85, 95%CI: 0.83–0.88) compared to inactivity. Insufficiently active participants also had lower odds of tobacco use (OR: 0.83, 95%CI: 0.80–0.85), alcohol use (OR: 0.77, 95%CI: 0.75–0.79), binge drinking (OR: 0.91, 95%CI: 0.87–0.96), and drunkenness (OR: 0.88, 95%CI: 0.85–0.90) compared to inactive participants. Additionally, active transportation to or from school was associated with lower odds of tobacco use (OR: 0.97, 95%CI: 0.95–0.99), alcohol use (OR: 0.94, 95%CI: 0.92–0.96), and binge drinking (OR: 0.78, 95%CI: 0.75–0.81) compared to those using passive transportation. Participants with acceptable sitting time, however, were more likely to use tobacco (OR: 1.48, 95%CI: 1.45–1.52), use alcohol (OR: 1.68, 95%CI: 1.64–1.72), binge drink (OR: 1.68, 95%CI: 1.62–1.75), and experience drunkenness (OR: 1.66, 95%CI: 1.62–1.69) compared to those with excessive sitting time.

Conclusion Being physically active, even at insufficient levels, may have beneficial effects on tobacco and alcohol use in adolescents. Acceptable sedentary time, on the other hand, was positively associated with tobacco and alcohol use.

Keywords Physical exercise, Use of tobacco, Alcohol drinking, Binge drinking, Adolescent, Global School Based Student Health Survey, Global Youth Tobacco Survey

*Correspondence:
Eduardo Rossato de Victo
eduardo.rossato@unifesp.br
Full list of author information is available at the end of the article

© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by-nc-nd/4.0/.

Introduction

According to the World Health Organization (WHO), adolescence is defined as the second decade of life, ranging from 10 to 19 years of age. This period is characterized by a complex process of growth and biopsychosocial development, involving anatomical, physiological, psychological, and social changes [1]. Due to the sensitivity of this stage, adolescents are at an increased risk for health problems that are related to the experimentation and use of psychoactive substances such as tobacco, alcohol, and other drugs [2–4].

The prevalence of tobacco and alcohol use among adolescents is alarming. Data from the Global School-based Student Health Survey (GSHS) indicate that 13.6% of adolescents reported using tobacco, and 1 in 4 drank alcohol in the month prior to the survey [5, 6]. According to the Global Burden of Diseases, Injuries, and Risk Factors data, tobacco and alcohol use rank among the leading risk factors for global health [7]. The public health impact of these substances could be reduced with greater efforts to prevent their use during adolescence, as use typically begins in this period and is linked to various chronic non-communicable diseases in adulthood [8]. Accordingly there is growing concern of public authorities and experts on the subject who are increasingly warning about the dangers of using these substances, especially during adolescence [9, 10].

One strategy to prevent the use of substances like tobacco and alcohol is promoting physical activity (PA). PA is defined as any voluntary movement produced by muscles that results in energy expenditure above resting levels [11]. The WHO recommends that children and adolescents engage in at least 60 min of moderate to vigorous PA per day due to its numerous health benefits. The organization also emphasizes that any amount of PA is better than none [12]. PA can be accumulated across various domains, such as playing sports during leisure time or through active transportation to and from school [12]. Specifically, PA can help counteract the use of tobacco, alcohol, and other drugs through psychological mechanisms by reducing cravings and impulses, as well as by controlling behaviors that may lead to substance use [13, 14]. Additionally, involvement in PA may be limiting the exposure to these substances and increase interactions with individuals who are more interested in maintaining healthy habits [13–15].

Physical inactivity, which is characterized by the complete absence of moderate to vigorous PA, on the other hand, poses a serious threat to public health as it contributes to numerous health problems [16]. Accordingly, extensive periods of sedentary behavior, which refers to any waking activity with low energy expenditure, such as sitting [17], has been shown to be a risk marker for alcohol use in adults but there remains a need for research exploring these associations in adolescents [17].

Despite the increasing volume of data on this topic, the quality of evidence remains limited, and the literature lacks sufficient data to either support or refute the preventive role of PA in combating tobacco and alcohol use [13–15]. There is a pressing need for studies with larger sample sizes that include children and adolescents, particularly those conducted in countries outside the major global economies [13–15].

To address this gap, the present study aimed to evaluate the association between PA (including leisure sports and exercising with friends), transportation to or from school, and sitting time (excluding time spent sitting at school or doing homework) with tobacco and alcohol use among adolescents from different regions of the world.

Methods

Study design and sample

The study was conducted using national survey data obtained from the GSHS. Full details of the GSHS design and sampling methods are reported elsewhere [18]. The GSHS is a collaborative surveillance project designed to help countries measure and assess behavioral risk factors and protective factors across 10 key areas among adolescents between 11 and 17 years of age. This relatively low-cost, school-based survey uses a self-administered questionnaire to gather data on youth health behaviors and protective factors related to the leading causes of morbidity and mortality among children and adults worldwide [19, 20]. Questionnaires are completed during regular school hours using a computer-scanned, self-report form, and are translated into the corresponding language of each country. To obtain a nationally representative sample of adolescents, the study employed a two-stage sampling method. First, schools were randomly selected based on probability proportional to size. Then, within those selected schools, classes were randomly chosen to participate, with all students in the selected classes invited to participate [20].

The GSHS began in 2003 and continues to this day. Countries participated in different years, so the data available varies by country and survey edition. It is recommended that countries participate periodically, which is why some countries have participated in the survey more than once. The data collection period for this study included the years available on the GSHS website up until June 2020, encompassing 102 countries. For five countries (Zimbabwe, Chile, China, Ecuador, and Occupied Palestinian Territory), only regional or city data were available; all other estimates were nationally representative [21]. For countries that participated more than once, only data from the most recent collection period

were considered [22]. This resulted in an initial sample size of 388,381 adolescents. However, some countries did not have data on one or more of the variables considered in this study, and missing data on one or more variables of interest were used as exclusion criteria. After excluding participants with missing data, the final sample for this study consisted of 222,495 participants from 66 countries.

Ethical considerations

The GSHS adhered to human subjects' protection standards. Each participating country approved the research project through their local government administrations. Additionally, all studies received approval from ethics committees in their respective countries and followed the standards established by the WHO. Data from this study and detailed methods used in the GSHS are described online on the WHO website (https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/global-school-based-student-health-survey/methodology) and in other publications [20, 22, 23]. Participation was voluntary; adolescents provided their assent, and informed consent was obtained from their parents or guardians [20, 21]. All methods were performed in accordance with the Helsinki Declaration and guidelines.

Physical activity, transportation to or from school and sitting time

Total PA was assessed using the following question: "During the last 7 days, on how many days did you engage in PA for a total of at least 60 minutes per day?" (Add up all the time you spent in any kind of PA each day). Responses ranged from 0 to 7 days. PA was defined as any activity that increases the heart rate or leaves the student out of breath. This includes leisure sports, exercising with friends, or active transportation to or from school [24]. Based on their responses, adolescents were classified as physically inactive (0 days), insufficiently active (1 to 4 days), or physically active (5 or more days) [25].

Transportation to or from school refers to how adolescents travel between home and school. This was assessed with the question, "In the last 7 days, on how many days did you walk or ride a bicycle to or from school?" Possible answers ranged from 0 to 7 days. Adolescents who walked or cycled to or from school at least 3 days a week were considered to be engaging in active transportation, as 3 days represent the majority of school days in a week [26].

Time spent sitting was evaluated with the question, "How much time do you spend on a typical day sitting and watching television, playing on the computer, talking with friends, or doing other activities while seated, such as surfing the internet?" (Excluding time spent sitting at school or for homework) [24]. Response options included "less than 1 hour/day," "1 to 2 hours/day," "3 to 4 hours/day," "5 to 6 hours/day," "7 to 8 hours/day," or "more than 8 hours/day." A cut-off of 3 or more hours/day was used to define excessive sedentary time, based on previous associations with adverse health outcomes [27].

Tobacco and alcohol use

Tobacco use was assessed with the question, "In the last 30 days, on how many days did you smoke?" The response options were: "0 days," "1 to 2 days," "3 to 5 days," "6 to 9 days," "10 to 19 days," "20 to 29 days," or "every day." Alcohol use was measured by asking, "During the last 30 days, on how many days did you have at least one drink containing alcohol?" with the response options being "0 days," "1 to 2 days," "3 to 5 days," "6 to 9 days," "10 to 19 days," "20 to 29 days," or "every day." Both variables were categorized as not used (0 days) or used (1 or more days) [28].

Binge drinking was identified based on the frequency of drinks used in the last 30 days, using the question, "On the days when you drank alcohol in the last 30 days, how many drinks did you consume per day?" Possible answers were: "Didn't drink in the last 30 days", "less than 1 drink", "1 drink", "2 drinks", "3 drinks", "4 drinks", "5 or more drinks". According to the questionnaire, drinking alcohol does not include taking a few sips of wine for religious purposes. A 'drink' is defined as a glass of wine, a bottle of beer, a small glass of liquor, or a mixed drink. Those who consumed 5 or more drinks on the same day were classified as binge drinkers [29].

The number of times participants had been drunk was assessed with the question, "How many times have you been drunk in your life?" Response options were: "None," "1 to 2 times," "3 to 9 times," or "10 or more times." This variable was categorized as no (never) or yes (one or more times) [30].

Demographic data

Data on age and sex were collected through the questionnaire. Information about the countries and geographic regions of the participants was extracted from the respective country databases available on the WHO website (https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/global-school-based-student-health-survey/methodology) [20].

Statistical analysis

Descriptive statistics are presented as frequencies and percentages for tobacco use, alcohol use, binge drinking, and drunkenness.

Generalized linear models with a binomial link function were used to estimate the associations between

independent (i.e., PA, transportation to or from school and sitting time) and dependent variables (i.e., tobacco use, alcohol use, binge drinking, and drunkenness) due to their dichotomous nature. Binomial logistic regression analyses were conducted, and odds ratios (OR) with 95% confidence intervals (95% CI) were reported. Associations were adjusted using the following models: (i) model 1, mutually adjusted for independent variables with the level of PA categorized into three categories (i.e., inactive vs. insufficiently active vs. active); (ii) model 2, included model 1 plus sex, age, and region.

The Wald test and the likelihood ratio test were primarily used to assess the significance of the models' beta coefficients. Multicollinearity among the independent variables was examined using Variance Inflation Factor (VIF) values (acceptable: <10) and tolerance levels (acceptable: >0.25). All analyses incorporated the expansion technique and sample weights to ensure adherence to the selection process and population representativeness as outlined by the GSHS. The significance level was set at 5%. Analyses were conducted using R software, version 4.2.3.

Results

The sample consisted of 222,495 adolescents, 53.6% of whom were female. Among the participants, 26.0% were inactive, 58.6% used passive transportation to or from school and 37.6% had excessive sitting time (>3 h/day). Additionally, 12.6% used tobacco and 24.8% used alcohol at least once in the 30 days prior to data collection. Binge drinking was reported by 4.9% of the sample, and 18.7% had experienced at least one episode of drunkenness in their lives (Table 1). Results by country are detailed in the supplementary material (Tables S1 and S2).

Table 2 presents the results of the logistic regression analysis, adjusted for sex, age, and geographic region. Being active was associated with a lower likelihood of tobacco use (OR: 0.86, 95%CI: 0.83–0.89), alcohol use (OR: 0.74, 95%CI: 0.72–0.76), binge drinking (OR: 0.66, 95%CI: 0.62–0.69), and drunkenness (OR: 0.85, 95%CI: 0.83–0.88). Participants with insufficient PA were also less likely to use tobacco (OR: 0.83, 95%CI: 0.80–0.85), use alcohol (OR: 0.77, 95%CI: 0.75–0.79), report binge drinking (OR: 0.91, 95%CI: 0.87–0.96), and experience drunkenness (OR: 0.88, 95%CI: 0.85–0.90) compared to inactive participants. Those who used active transportation were less likely to use tobacco (OR: 0.97, 95%CI: 0.95–0.99), use alcohol (OR: 0.94, 95%CI: 0.92–0.96), and report binge drinking (OR: 0.78, 95%CI: 0.75–0.81), compared to those using passive transportation. Conversely, the group with acceptable sitting time was more likely to use tobacco, use alcohol, and report binge drinking and drunkenness compared to the group with excessive sitting time ($OR_{tobacco}$: 1.48, 95%CI: 1.45–1.52; $OR_{alcohol}$: 1.68, 95%CI: 1.64–1.72; $OR_{bingedrinking}$: 1.68, 95%CI: 1.62–1.75; $OR_{drunkenness}$: 1.66, 95%CI: 1.62–1.69).

Table 3 presents the results of multiple logistic regression analyses, examining the independent variables simultaneously in two models. Model 1 indicates that insufficiently active participants had lower odds of tobacco use and smoking compared to inactive participants ($OR_{tobacco}$: 0.79, 95% CI: 0.76–0.81; $OR_{alcohol}$: 0.74, 95%CI: 0.72–0.76; $OR_{bingedrinking}$: 0.86, 95%CI: 0.81–0.91; $OR_{drunkenness}$: 0.84, 95%CI: 0.82–0.86). These results remained essentially unchanged after adjusting for sex, age, and region (Model 2), except for binge drinking, which was no longer significant. Physically active participants were less likely to use tobacco or alcohol compared to inactive participants, even after adjustment for sex, age, and region ($OR_{tobacco}$: 0.88, 95%CI: 0.85–0.92; $OR_{alcohol}$: 0.77, 95%CI: 0.74–0.79; $OR_{bingedrinking}$: 0.70, 95%CI: 0.67–0.75; $OR_{drunkenness}$: 0.88, 95%CI: 0.85–0.90). Compared to those using passive transportation, individuals using active transportation were less likely to use alcohol and engage in binge drinking; however, after adjustment, only binge drinking remained significant (OR: 0.82, CI95%: 0.79–0.86). Those with acceptable sitting time were more likely to exhibit all of the aforementioned outcomes, even after adjustments ($OR_{tobacco}$: 1.47, 95%CI: 1.43–1.51; $OR_{alcohol}$: 1.66, 95%CI: 1.63–1.70; $OR_{bingedrinking}$: 1.67, 95%CI: 1.60–1.74; $OR_{drunkenness}$: 1.65, 95%CI: 1.61–0.69).

Discussion

This study investigated the association between PA, active transportation, and sedentary time with tobacco and alcohol use among adolescents. The results indicated that being active, even below PA recommendations, was beneficially associated with substance use, independent of sex, age, and region. This underscores the principle that "some PA is better than none" and that "additional benefits occur with more PA" [31, 32]. Thus, accumulating PA, even if it falls short of recommended levels, can serve as an important correlate of reduced tobacco and alcohol use.

A systematic review of longitudinal studies that examined the relationship between participation in sports and the use of alcohol and illicit drugs during late adolescence, on the other hand, showed a positive association between alcohol consumption and sports participation [33]. It was, however, noted that sports participation acted as a protective factor against illicit drug use. Similarly, cross-sectional studies have shown a negative association between sports and drug use while results on the association between sports participation and alcohol consumption have been equivocal

Table 1 Description [n(%)] of the demographic, lifestyle and behavioral characteristics of the adolescents

	Total 222,495	Tobacco use		Alcohol use		Binge drinking		Drunkenness	
		Yes 27,946 (12.6)	No 194,549 (87.4)	Yes 55,072 (24.8)	No 167,423 (75.2)	Yes 10,797 (4.9)	No 211,698 (95.1)	Yes 41,608 (18.7)	No 180,887 (81.3)
Sex									
Male	103,185 (46.4)	17,454 (16.9)	85,731 (83.1)	28,048 (27.2)	75,137 (72.8)	5628 (5.5)	97,557 (94.5)	22,833 (22.1)	80,352 (77.9)
Female	119,310 (53.6)	10,492 (8.8)	108,818 (91.2)	27,024 (22.7)	92,286 (77.3)	5169 (4.3)	114,141 (95.7)	18,775 (15.7)	100,535 (84.3)
Age (years)									
11	2390 (1.1)	210 (8.8)	2180 (91.2)	338 (14.1)	2052 (85.9)	37 (1.5)	2353 (98.5)	233 (9.7)	2157 (90.3)
12	13,598 (6.1)	743 (5.5)	12,855 (94.5)	1674 (12.3)	11,924 (87.7)	143 (1.1)	13,455 (98.9)	1117 (8.2)	12,481 (91.8)
13	39,786 (17.9)	3080 (7.7)	36,706 (92.3)	6843 (17.2)	32,943 (82.8)	927 (2.3)	38,859 (97.7)	4225 (10.6)	35,561 (89.4)
14	50,483 (22.7)	5574 (11.0)	44,909 (89.0)	11,857 (23.5)	38,626 (76.5)	2130 (4.2)	48,353 (95.8)	7850 (15.5)	42,633 (84.5)
15	49,485 (22.2)	6810 (13.8)	42,675 (86.2)	13,856 (28.0)	35,629 (72.0)	3021 (6.1)	46,464 (93.9)	10,282 (20.8)	39,203 (79.2)
≥16	66,753 (30.0)	11,529 (17.3)	55,224 (82.7)	20,504 (30.7)	46,249 (69.3)	4539 (6.8)	62,214 (93.2)	17,901 (26.8)	48,852 (73.2)
Region									
Africa	33,709 (15.2)	2604 (7.7)	31,105 (92.3)	6804 (20.2)	26,905 (79.8)	569 (1.7)	33,140 (98.3)	5889 (17.5)	27,820 (82.5)
Europe	1649 (0.7)	266 (16.1)	1383 (83.9)	712 (43.2)	937 (56.8)	55 (3.3)	1594 (96.7)	459 (27.8)	1190 (72.2)
America	73,046 (32.8)	11,656 (16.0)	61,390 (84.0)	31,477 (43.1)	41,569 (56.9)	7595 (10.4)	65,451 (89.6)	20,720 (28.4)	52,326 (71.6)
Eastern Mediterranean	4819 (2.2)	566 (11.7)	4253 (88.3)	647 (13.4)	4172 (86.6)	69 (1.4)	4750 (98.6)	501 (10.4)	4318 (89.6)
Western pacific	75,355 (33.9)	8580 (11.4)	66,775 (88.6)	11,524 (15.3)	63,831 (84.7)	2143 (2.8)	73,212 (97.2)	10,259 (13.6)	65,096 (86.4)
Southeast Asia	33,917 (15.2)	4274 (12.6)	29,643 (87.4)	3908 (11.5)	30,009 (88.5)	366 (1.1)	33,551 (98.9)	3780 (11.1)	30,137 (88.9)
Physical activity									
Inactive (0 days/week)	58,011 (26.0)	5974 (10.3)	52,037 (89.7)	11,488 (19.8)	46,523 (80.2)	2133 (3.7)	55,878 (96.3)	9242 (15.9)	48,769 (84.1)
Insufficiently active (1–4 days/week)	110,032 (49.5)	14,455 (13.1)	95,577 (86.9)	28,555 (26.0)	81,477 (74.0)	5092 (4.6)	104,940 (95.4)	21,105 (19.2)	88,927 (80.8)
Active (≥5 days/week)	54,452 (24.5)	7517 (13.8)	46,935 (86.2)	15,029 (27.6)	39,423 (72.4)	3572 (6.6)	50,880 (93.4)	11,261 (20.7)	43,191 (79.3)
Transportation to or from school									
Passive	130,337 (58.6)	15,947 (12.2)	114,390 (87.8)	30,960 (23.8)	99,377 (76.2)	5419 (4.2)	124,918 (95.8)	23,740 (18.2)	106,597 (81.8)
Active	92,158 (41.4)	11,999 (13.0)	80,159 (87.0)	24,112 (26.2)	68,046 (73.8)	5378 (5.8)	86,780 (94.2)	17,868 (19.4)	74,290 (80.6)
Sitting time									
Excess (≥3 h/day)	83,731 (37.6)	13,310 (15.9)	70,421 (84.1)	27,727 (33.1)	56,004 (66.9)	6087 (7.3)	77,644 (92.7)	20,943 (25.0)	62,788 (75.0)
Acceptable (< 3 h/day)	138,764 (62.4)	14,636 (10.5)	124,128 (89.5)	27,345 (19.7)	111,419 (80.3)	4710 (3.4)	134,054 (96.6)	20,665 (14.9)	118,099 (85.1)

[33]. Another study that explored the relationship between PA, physical education classes, and sports participation with substance use among adolescents also identified PA as an important protective factor against tobacco and drug use, while it was not found to be protective against alcohol use [34].

A notable aspect of the literature on this topic, however, is the frequent use of the term "sports participation" rather than "PA" when investigating the relationship with substance use. Although these terms have some similarities, they are distinctly different. "Sports participation" is more closely associated with organized sports and is

Table 2 Multivariate logistic regression estimating the probability of association of each independent variable

	Tobacco use OR (95% CI)	Alcohol use OR (95% CI)	Binge drinking OR (95% CI)	Drunkenness OR (95% CI)
Physical activity				
Inactive (0 days/week)	1	1	1	
Insufficiently active (1–4 days/week)	0.83 (0.80–0.85)	0.77 (0.75–0.79)	0.91 (0.87–0.96)	0.88 (0.85–0.90)
Active (≥ 5 days/week)	0.86 (0.83–0.89)	0.74 (0.72–0.76)	0.66 (0.62–0.69)	0.85 (0.83–0.88)
Transportation to or from school				
Passive	1	1	1	1
Active	0.97 (0.95–0.99)	0.94 (0.92–0.96)	0.78 (0.75–0.81)	0.99 (0.97–1.02)
Sitting time				
Excess (≥ 3 h/day)	1	1	1	1
Acceptable (< 3 h/day)	1.48 (1.45–1.52)	1.68 (1.64–1.72)	1.68 (1.62–1.75)	1.66 (1.62–1.69)

Presented values: odds ratio (OR) with the respective 95% confidence interval (95% CI)

Analysis adjusted for sex, age and region

Table 3 Multiple logistic regression adjusted for independent and adjustment variables

	Tobacco use OR (95% CI)	Alcohol use OR (95% CI)	Binge drinking OR (95% CI)	Drunkenness OR (95% CI)
Model 1				
Insufficiently active (1–4/days)	0.79 (0.76–0.81)	0.74 (0.72–0.76)	0.86 (0.81–0.91)	0.84 (0.82–0.86)
Active (≥ 5/days)	0.75 (0.72–0.78)	0.69 (0.67–0.71)	0.62 (0.59–0.65)	0.77 (0.74–0.79)
Transportation active	0.98 (0.95–1.01)	0.94 (0.92–0.96)	0.77 (0.74–0.80)	0.98 (0.96–1.00)
Sitting time acceptable (< 3 h/day)	1.58 (1.54–1.62)	1.98 (1.94–2.02)	2.18 (2.09–1.26)	1.88(1.84–1.92)
Model 2				
Insufficiently active(1–4 days/week)	0.85 (0.82–0.88)	0.79 (0.77–0.81)	0.96 (0.91–1.01)	0.90 (0.88–0.93)
Active (≥ 5 days/week)	0.88 (0.85–0.92)	0.77 (0.74–0.79)	0.70 (0.67–0.75)	0.88 (0.85–0.90)
Transportation active	0.99 (0.97–1.02)	0.99 (0.96–1.01)	0.82 (0.79–0.86)	1.02 (1.00–1.05)
Sitting time acceptable (< 3 h/day)	1.47 (1.43–1.51)	1.66 (1.63–1.70)	1.67 (1.60–1.74)	1.65 (1.61–1.69)

Presented values: odds ratio (OR) with the respective 95% confidence interval (95%CI); independent variables: level of physical activity, transportation to or from school and sitting time

Model 1 mutually adjusted for independent variables with the level of physical activity categorized into three categories

Model 2 included model 1 plus sex, age, and region

influenced by cultural, social, and psychological factors that can promote alcohol use. This association is further reinforced by commercial interests that use sports to market al.coholic beverages and often link sports with alcohol in media representations [35]. In contrast, our study focused solely on PA and found it to be associated with lower use of tobacco and alcohol. El Kazdouh et al. also showed that individuals who are motivated to maintain their health are more likely to avoid substance use by engaging in beneficial activities such as PA. This supports the notion that PA can be a valuable tool for preventing substance use [36].

Another review that focused on PA, rather than sports participation, included only studies using questionnaire data, similar to the present study. This review included research from the USA, Canada, Europe, Brazil, and South Africa and found a positive association between PA and alcohol use in 14 studies, a negative association in 6 studies, and no association in 17 studies [17]. These findings suggest that the impact of PA and sports participation on tobacco and alcohol use can vary, depending on the sample and geographic location.

Active transportation to or from school is another important lifestyle behavior that has been linked to health, healthy habits, and the accumulation of PA [37]. For this study, active transportation was defined as walking or cycling to or from school on at least 3 days a week, representing more than half of the school week. This classification aligns with other studies using the same database and similar questionnaires [26]. The study found

that active transportation was also associated with a lower likelihood of tobacco and alcohol use, binge drinking, and a history of drunkenness. After adjusting for sex, age, and region, these associations remained largely unchanged, except for drunkenness, where the significance was lost. These findings underscore the importance of active transportation for promoting health among adolescents. It is associated not only with increased PA and reduced sedentary behavior but also with lower rates of tobacco and alcohol use, as well as binge drinking.

The role of sitting time in the epidemiology of inactivity has been increasingly debated, but results remain inconclusive [38, 39]. Our study hypothesized that sitting for an acceptable amount of time (less than 3 h) would be associated with lower tobacco and alcohol use. Contrary to this expectation, the data revealed a significantly higher risk of tobacco and alcohol use in the group with acceptable sitting time compared to those with excessive sitting time. These results are also in contrast with a systematic review that showed a predominance of studies indicating a negative association between sedentary behavior and alcohol use [17]. Differences in sitting time categorization among studies that found a negative association, such as using 4 h as a cutoff or employing scores, weighted averages, or quartiles and quintiles [40–43] may explain these conflicting results. Our categorization might have contributed to these discrepancies. Although we lack a clear recommendation for optimal sitting time, our findings suggest that the 3-hour cutoff [39, 44, 45] could be linked to other health risks but not necessarily to tobacco and alcohol use [44, 45].

However, a previous study has also observed a higher risk of smoking among those who spend less time sitting [42]. One hypothesis for the lack of sedentary time being a protective factor against tobacco use is that much of this sitting time occurs in front of a TV or computer, activities generally performed indoors where tobacco use is often restricted by family rules [42]. Additionally, many countries have smoking restrictions in places frequented by young people, such as cinemas and restaurants.

Our findings, combined with the discussion on the association between PA, active transportation, and sedentary behavior with tobacco and alcohol use, highlight the complexity of these behaviors. Several risk and protective factors influence substance use, including the availability of substances, family history, individual characteristics like sensation seeking, and social factors such as substance use among peers [46–48]. These factors operate at various levels community (e.g., local availability), family (e.g., parental history), individual (e.g., sensation seeking), and social (e.g., peer influence) [46]. Given the complex interaction of these factors a more inclusive understanding of their relationship is needed along with the implementation of multifaceted prevention and intervention strategies. While PA and active transportation play significant roles, other contextual and individual factors also affect substance use among adolescents.

Most studies cited in the reviews focused on data from adolescents in North America and Europe [17]. In contrast, our study includes global data from 66 countries, predominantly outside Europe and North America. This is a major strength of our study, along with its large sample size. Furthermore, the data presented are supported by high-quality standards endorsed by the WHO and the responsible agencies in the participating countries [20] .

There are, however, some limitations of this study. Being cross-sectional, it cannot establish causal relationships or observe changes over time. Additionally, the use of self-report questionnaires may introduce bias. Nevertheless, there is evidence that questionnaires have acceptable validity for measuring adherence to PA recommendations in adolescents, showing moderate to high correlation with accelerometers, which are considered the gold standard for measuring PA in free-living environments [49]. This study also did not incorporate a hierarchical model in the analyses. Another limitation is the high amount of data excluded due to missing information (43%). Even though we chose not to include participants with incomplete data the remaining sample remains representative and suitable for our research objectives. Despite this, generalization of the results should be approached with caution.

Additional research, particularly longitudinal studies, therefore, is needed to explore the potential of PA in preventing tobacco and alcohol use. Investigating factors that might divert adolescents from PA and lead them to substance use is also crucial. Further, future studies should examine potential regional differences in the results of the models used.

Conclusion

PA was associated with reduced tobacco and alcohol use, particularly with binge drinking and drunkenness. Even adolescents who engaged in PA below the recommended levels exhibited lower use of these substances compared to those who were inactive.

Public policies aimed at reducing the use of psychoactive substances, such as tobacco and alcohol, should promote PA among children and adolescents. Encouraging involvement in PA and creating environments that support an active lifestyle should be integral components of strategies to combat tobacco and alcohol use among adolescents.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12887-024-05079-1.

Supplementary Material 1.

Acknowledgements
We would like to thank the World Health Organization (WHO) and the Centers for Disease Control and Prevention (US CDC) for data produced with the Global School Health Survey, providing studies with data from low- and middle-income countries. This document uses data from the Global school-based student health survey (GSHS). The GSHS is maintained by the World Health Organization and the US Centers for Disease Control and Prevention.

Authors' contributions
Conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing—original draft preparation, writing—review and editing, visualization: ERV, GF, CD and DS. All authors have read and agreed to the published version of the manuscript.

Funding
This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

Availability of data and materials
This document uses data from the Global School-Based Student Health Survey (GSHS). The GSHS is maintained by the World Health Organization and the United States Centers for Disease Control and Prevention. All data from this study can be found on the website: https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/global-school-based-student-health-survey.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not Applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Disciplina de Alergia, Imunologia Clínica e Reumatologia do Departamento de Pediatria da Universidade Federal de São Paulo (UNIFESP), São Paulo, Brasil. [2]Universidad de Santiago de Chile (USACH), Escuela de Ciencias de la Actividad Física, el Deporte y la Salud, Santiago, Chile. [3]Facultad de Ciencias de la Salud, Universidad Autónoma de Chile, Providencia, Santiago, Chile. [4]Division of Sport, Physical Activity and Health, University of Education Upper Austria, Linz 4020, Austria.

Received: 12 April 2024 Accepted: 12 September 2024
Published online: 19 September 2024

References

1. World Health Organization. Young people's health–a challenge for society. Report of a WHO Study Group on young people and health for all by the Year 2000. World Health Organ Tech Rep Ser. 1986;731:1–117.
2. Degenhardt L, Stockings E, Patton G, Hall WD, Lynskey M. The increasing global health priority of substance use in young people. Lancet Psychiatry. 2016;3(3):251–64.
3. Liu H, Ma X, Shi L, Wang J, Juan JTH, Ma D, et al. Associations between tobacco and alcohol use and aggressive behavior among adolescents in 55 low- and middle-income countries. J Affect Disord. 2023;329:519–24.
4. Farnia V, Ahmadi Jouybari T, Salemi S. The prevalence of alcohol consumption and its related factors in adolescents: findings from global school-based student health survey. J Adolesc Health. 2024;19(4):e0297225.
5. Ma C, Bovet P, Yang L, Zhao M, Liang Y, Xi B. Alcohol use among young adolescents in low-income and middle-income countries: a population-based study. Lancet Child Adolesc Health. 2018;2(6):415–29.
6. Xi B, Liang Y, Liu Y, Yan Y, Zhao M, Ma C, et al. Tobacco use and secondhand smoke exposure in young adolescents aged 12–15 years: data from 68 low-income and middle-income countries. Lancet Glob Health. 2016;4(11):e795-805.
7. Global Burden of Disease Study. Global burden and strength of evidence for 88 risk factors in 204 countries and 811 subnational locations, 1990–2021: a systematic analysis for the Global Burden of Disease Study 2021. Lancet. 2024;403(10440):2162–203.
8. Fujii M, Kuwabara Y. Trends in the co-use of alcohol and tobacco among Japanese adolescents: periodical nationwide cross-sectional surveys 1996–2017. J Epidemiol. 2021;11(8):e045063.
9. Charakida M, Georgiopoulos G, Dangardt F, Chiesa ST, Hughes AD, Rapala A, et al. Early vascular damage from smoking and alcohol in teenage years: the ALSPAC study. Eur Heart J. 2019;40(4):345–53.
10. Münzel T, Hahad O, Daiber A. Double hazard of smoking and alcohol on vascular function in adolescents. Eur Heart J. 2019;40(4):354–6.
11. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep. 1985;100(2):126–31.
12. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. Br J Sports Med. 2020;54(24):1451–62.
13. Linke SE, Ussher M. Exercise-based treatments for substance use disorders: evidence, theory, and practicality. Am J Drug Alcohol Abuse. 2015;41(1):7–15.
14. Thompson TP, Horrell J, Taylor AH, Wanner A, Husk K, Wei Y, et al. Physical activity and the prevention, reduction, and treatment of alcohol and other drug use across the lifespan (the PHASE review): a systematic review. Ment Health Phys Act. 2020;19:100360.
15. Zschucke E, Heinz A, Ströhle A. Exercise and physical activity in the therapy of substance use disorders. Sci World J. 2012;2012:901741.
16. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT, et al. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet. 2012;380(9838):219–29.
17. West AB, Bittel KM, Russell MA, Evans MB, Mama SK, Conroy DE. A systematic review of physical activity, sedentary behavior, and substance use in adolescents and emerging adults. Transl Behav Med. 2020;10(5):1155–67.
18. World Health Organization. Global School-based Student Health Survey (GSHS) – Data catalog. Available from: https://extranet.who.int/ncdsmicrodata/index.php/catalog/GSHS/?page=1&ps=15&repo=GSHS. Accessed 10 Aug 2024.
19. World Health Organization. Global school-based student health survey (GSHS) - GSHS questionnaire. https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/global-school-based-student-health-survey/questionnaire. Accessed 2 Apr 2023.
20. World Health Organization. Global school-based student health survey (GSHS) - GSHS methodology. Available from: https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/global-school-based-student-health-survey/methodology. Accessed 02 Apr 2023.
21. Campisi SC, Carducci B, Akseer N, Zasowski C, Szatmari P, Bhutta ZA. Suicidal behaviours among adolescents from 90 countries: a pooled analysis of the global school-based student health survey. BMC Public Health. 2020;20(1):1102.
22. Beal T, Morris SS, Tumilowicz A. Global patterns of adolescent fruit, vegetable, carbonated soft drink, and fast-food consumption: a meta-analysis of global school-based student health surveys. Food Nutr Bull. 2019;40(4):444–59.
23. Abdalmaleki E, Abdi Z, Isfahani SR, Safarpoor S, Haghdoost B, Sazgarnejad S, et al. Global school-based student health survey: country profiles and survey results in the eastern Mediterranean region countries. BMC Public Health. 2022;22(1):130.

24. Ma C, Zhang Y, Zhao M, Bovet P. Physical activity and sedentary behavior among young adolescents in 68 LMICs, and their relationships with national economic development. J Glob Health. 2020;17(21):7752.
25. Bernabe-Ortiz A, Carrillo-Larco RM. Physical activity patterns among adolescents in Latin America and the Caribbean region. J Phys Act Health. 2022;19(9):607–14.
26. Aguilar-Farias N, Martino-Fuentealba P, Carcamo-Oyarzun J, Cortinez-O'Ryan A, Cristi-Montero C, Von Oetinger A, et al. A regional vision of physical activity, sedentary behaviour and physical education in adolescents from Latin America and the Caribbean: results from 26 countries. Int J Epidemiol. 2018;47(3):976–86.
27. Romo ML, Abril-Ulloa V, Kelvin EA. The relationship between hunger and mental health outcomes among school-going Ecuadorian adolescents. Soc Psychiatry Psychiatr Epidemiol. 2016;51(6):827–37.
28. Pengpid S, Peltzer K. Behavioral risk factors of non-communicable diseases among a nationally representative sample of school-going adolescents in Indonesia. Asia Pac J Public Health. 2019;12:387–94.
29. Medeiros PFP, Valente JY, Rezende LFM, Sanchez ZM. Binge drinking in Brazilian adolescents: results of a national household survey. Cad Saude Publica. 2022;38(12):e00077322.
30. Pengpid S, Peltzer K. Alcohol use and misuse among school-going adolescents in Thailand: results of a national survey in 2015. BMC Public Health. 2019;16(11):1898.
31. O'Donovan G, Lee I-M, Hamer M, Stamatakis E. Association of Weekend Warrior and other leisure time physical activity patterns with risks for all-cause, cardiovascular disease, and cancer mortality. JAMA Intern Med. 2017;177(3):335–42.
32. Sattelmair J, Pertman J, Ding EL, Kohl HW 3rd, Haskell W, Lee IM. Dose response between physical activity and risk of coronary heart disease: a meta-analysis. Circulation. 2011;124(7):789–95.
33. Kwan M, Bobko S, Faulkner G, Donnelly P, Cairney J. Sport participation and alcohol and illicit drug use in adolescents and young adults: a systematic review of longitudinal studies. Addict Behav. 2014;39(3):497–506.
34. Dunn MS. Association between physical activity and substance use behaviors among high school students participating in the 2009 Youth Risk Behavior Survey. Psychol Rep. 2014;114(3):675–85.
35. Zenic N, Lipowska M. Exploring the association between alcohol drinking and physical activity in adolescence: two-year prospective study in younger adolescents from Bosnia and Herzegovina. J Phys Act Health. 2021;18(22):11899.
36. El Kazdouh H, El-Ammari A, Bouftini S, El Fakir S, El Achhab Y. Adolescents, parents and teachers' perceptions of risk and protective factors of substance use in Moroccan adolescents: a qualitative study. Subst Abuse Treat Prev Policy. 2018;13(1):31.
37. Ding P, Ding C, Feng S. The health benefits of bicycling to school among adolescents in China: a propensity score matching study. Front Public Health. 2023;11:1049254.
38. Stamatakis E, Ekelund U, Ding D. Is the time right for quantitative public health guidelines on sitting? A narrative review of sedentary behaviour research paradigms and findings. Br J Sports Med. 2019;53(6):377–82.
39. Ekelund U, Steene-Johannessen J, Brown WJ, Fagerland MW, Owen N, Powell KE, et al. Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women. Lancet. 2016;388(10051):1302–10.
40. Dias PJ, Domingos IP, Ferreira MG, Muraro AP, Sichieri R, Gonçalves-Silva RM. Prevalence and factors associated with sedentary behavior in adolescents. Rev Saude Publica. 2014;48(2):266–74.
41. Iannotti RJ, Kogan MD, Janssen I, Boyce WF. Patterns of adolescent physical activity, screen-based media use, and positive and negative health indicators in the U.S. and Canada. J Adolesc Health. 2009;44(5):493–9.
42. Lazzeri G, Azzolini E, Pammolli A, De Wet DR, Giacchi MV. Correlation between physical activity and sedentary behavior with healthy and unhealthy behaviors in Italy and Tuscan region: a cross sectional study. J Prev Med Hyg. 2013;54(1):41–8.
43. Primack BA, Kraemer KL, Fine MJ, Dalton MA. Media exposure and marijuana and alcohol use among adolescents. Subst Use Misuse. 2009;44(5):722–39.
44. Vancampfort D, Van Damme T, Firth J, Hallgren M, Smith L, Stubbs B, et al. Correlates of leisure-time sedentary behavior among 181,793 adolescents aged 12–15 years from 66 low- and middle-income countries. PLoS ONE. 2019;14(11):e0224339.
45. Vancampfort D, Stubbs B, Firth J, Van Damme T, Koyanagi A. Sedentary behavior and depressive symptoms among 67,077 adolescents aged 12–15 years from 30 low- and middle-income countries. Int J Behav Nutr Phys Act. 2018;15(1):73.
46. Latimer W, Zur J. Epidemiologic trends of adolescent use of alcohol, tobacco, and other drugs. Child Adolesc Psychiatr Clin N Am. 2010;19(3):451–64.
47. Nawi AM, Ismail R, Ibrahim F, Hassan MR, Manaf MRA, Amit N, et al. Risk and protective factors of drug abuse among adolescents: a systematic review. BMC Public Health. 2021;21(1):2088.
48. Ryan SM, Jorm AF, Kelly CM, Hart LM, Morgan AJ, Lubman DI. Parenting strategies for reducing adolescent alcohol use: a Delphi consensus study. BMC Public Health. 2011;11:13.
49. Ridgers ND, Timperio A, Crawford D, Salmon J. Validity of a brief self-report instrument for assessing compliance with physical activity guidelines amongst adolescents. J Sci Med Sport. 2012;15(2):136–41.

Publisher's note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.