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ORIGINAL ARTICLE

Global prevalence of cannabis and amphetamine/methamphetamine use among adolescents in 47 countries: a population-based study from WHO database

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Abstract

Background Adolescent drug use poses significant public health challenges worldwide, with detrimental effects on mental and physical health. Most existing research focuses on Western countries, holding a gap in understanding drug use in low- and middle-income countries. Thus, we aimed to assess the prevalence of cannabis and amphetamine or methamphetamine use among school-going adolescents aged 12–15 years across 47 countries globally.

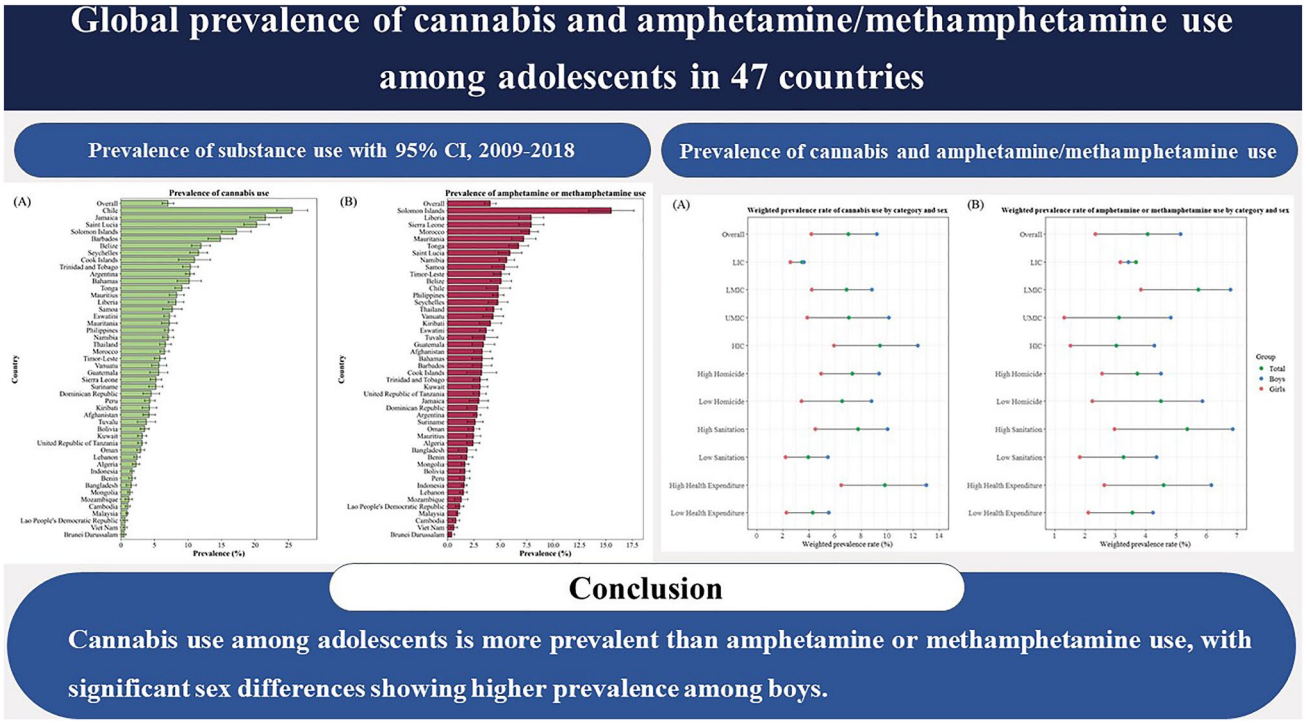
Methods We used data from the Global School-based Student Health Survey from 47 countries (2009–2018) to analyze cannabis and amphetamine/methamphetamine use and age at first drug use among adolescents ($n = 220{,}362$). A meta-analysis utilizing random-effects models estimated prevalence rates and weighted linear regression analyzed trends. Student's t tests were used to compare two-subgroup categories, while one-way ANOVA was employed for analyses involving the four-subgroup category. Stratification analysis by sex, World Bank income category, region, and country-specific characteristics based on World Health Organization data were also performed.

Results The study included a total of 220,362 school-going adolescents aged 12–15 years (49.96% girls) from 47 countries. The overall prevalence of cannabis use was 7.02% [95% confidence interval (CI) 6.16–7.89], with higher usage among boys [9.20% (95% CI 8.05–10.36)] compared to girls [4.20% (95% CI 3.68–4.72)]. Amphetamine/methamphetamine use prevalence was 4.05% (95% CI 3.51–4.60), also higher among boys [5.14% (95% CI 4.45–5.84)] than girls [2.34% (95% CI 2.00–2.69)]. The region of the Americas exhibited the highest prevalence of cannabis use [11.31% (95% CI 8.44–14.17)], while the African region showed the highest prevalence of amphetamine use [4.34% (95% CI 3.14–5.53)]. High-income countries reported the highest prevalence of cannabis use [9.45% (95% CI, 6.06 to 12.84)], whereas low-income countries had the lowest [3.46% (95% CI 2.01–4.91)]. Higher prevalence rates were associated with countries having higher homicide rates, better sanitation services, and higher health expenditures.

Conclusions Cannabis use among adolescents is more prevalent than amphetamine or methamphetamine use, with significant sex differences showing higher prevalence among boys. The highest prevalence of cannabis use was observed in Latin America, while Africa exhibited the highest rates of amphetamine use. Findings from the present study indicate a need for public policies and programs targeting adolescents to effectively reduce adolescent drug use.

Extended author information available on the last page of the article

Graphical abstract



Keywords Adolescents · Amphetamine · Cannabis · Drug · Methamphetamine · World Health Organization

Introduction

Globally, drug use disorders are among the most significant public health issues, accounting for 1.3% of the disease burden, especially disability-adjusted life years [1], and drug use is a major risk factor for premature mortality and disability [2]. Historically, various substances have been used recreationally, with illegal drugs being prohibited for non-medical use by regulations and international control systems [3]. Cannabis is in a transitional phase where several countries are legalizing or decriminalizing its use for adults, while it remains prohibited for adolescents [4]. Cannabis use and amphetamine or methamphetamine use are among the most prevalent drug use disorders worldwide [5].

In adults, deaths related to drug use disorders typically result from medical complications due to substances like methamphetamine, which can lead to various diseases such as stroke, myocardial infarction, and pulmonary hypertension [6]. While such medical complications are less common in adolescents, amphetamines or methamphetamines pose a significant risk of adverse health outcomes, including psychiatric, cardiovascular, and metabolic diseases [7]. Cannabis use is also associated with adverse effects such as depression and suicidality [8]. Furthermore, premature mortality in adolescents attributed to drug use disorders is often associated with risky behaviors [9]. The leading causes of death in adolescents (e.g., motor vehicle accidents, homicide, and suicide) are frequently related to high-risk behaviors associated with drug use disorders [9].

Adolescent drug use is associated with various adverse health outcomes, including psychological distress, poor academic performance, risky sexual behavior, suicidal behavior, smoking, appetite changes, and sleep disturbances [10]. Importantly, drug use during adolescence can adversely affect brain development, impacting neuropsychological abilities and the growth and integrity of certain brain structures [11]. Adolescent drug use can lead to long-term health consequences, including adult drug dependence, reduced work capacity, diabetes, mental health complications, and premature mortality [12]. While the harmful effects of adolescent drug use are well documented, there is limited research on recent trends in low- and middle-income countries (LMICs), especially low-income countries (LICs).

Previous studies have provided valuable insights into adolescent drug consumption trends in high-income countries (HICs). Given that drug suppliers and trafficking hubs are often located in LMICs, especially LICs, the relative lack of research on drug use among young adolescents in these regions represents a significant gap in the literature [1, 5]. Given this background, we aimed to investigate the

prevalence and temporal trends of drug use, specifically cannabis and amphetamine or methamphetamine use, in a survey-based cohort of 220,362 school-going adolescents aged 12–15 years from 47 countries, primarily in LMICs and LICs in Africa, Asia, and the Americas.

Methods

Survey and participants

This study analyzed the prevalence of cannabis and amphetamine/methamphetamine use, two of the most common psychoactive drugs, and examined the age of first drug use using Global School-based Student Health Survey (GSHS) data from 47 countries surveyed between 2009 and 2018. GSHS data consist of 10 core question modules, including substance use [13]. The questionnaire is translated and tested to ensure student understanding. GSHS data are owned by official country-level agencies such as the Ministry of Health, which conducts or sponsors the survey. World Health Organization (WHO) and US Centers for Disease Control and Prevention (CDC) provide ongoing technical support, including guidance in sample design, training, and data management. The GSHS used a standardized, school-based scientific sample selection process with a self-administered questionnaire and followed rigorous sampling. Participants were selected through a standardized two-stage sampling procedure [13]. In the first stage, schools were randomly selected, with probability proportional to the size of the school. In the second stage, classrooms containing students aged 12–15 years were randomly selected within the selected schools [14]. All GSHS surveys and protocols were approved by each country's government agency (primarily the Ministry of Health or Education), institutional ethics committees, and the US CDC [14]. Participant anonymity and voluntary participation were ensured, and data were statistically weighted to adjust for non-response and sampling variations.

We used publicly available data from the WHO data portal to account for country characteristics related to drug use. The data used are estimates of the rate of homicides per 100,000 population [15], population using safely managed sanitation services [16], and domestic general government health expenditure as a percentage of general government expenditure [17]. These parameters are categorized into high (first and second quartiles) and low (third and fourth quartiles) levels. Specifically, in the data from the WHO data portal, countries were categorized as having high or low homicide rates. The median homicide rate among the included countries was used to determine the grouping of high or low homicide rates. Countries were categorized based on income levels according to the World Bank classification: LICs, LMICs, upper middle-income countries (UMICs), and HICs [18]. In addition, regions were classified according to the WHO regional classification: Africa (AFR), the Americas (AMR), Southeast Asia (SEAR), Europe (EUR), Eastern Mediterranean (EMR), and Western Pacific (WPR). Countries from all WHO regions were included in this study. However, within AMR, only countries from Central and South America were represented.

Outcomes

We assessed cannabis use, amphetamine/methamphetamine use, and age at first drug use among adolescents using the GSHS database. Cannabis use was evaluated with the question, "During your life, how many times have you used marijuana (also called Chira)?" Amphetamine/methamphetamine use was assessed with the question, "During your life, how many times have you used amphetamines or methamphetamines?" Response options for both questions included "0 times," "1 or 2 times," "3 to 9 times," "10 to 19 times," and "20 or more times." For analysis, responses were dichotomized into "no" for "0 times" and "yes" for any other frequency of use. The age at first drug use was evaluated using the question, "How old were you when you first used drugs?" with options ranging from "I have never used drugs" to "12 years old or older." For data preprocessing, these responses were recategorized into three groups: those who had never used drugs, those who first used drugs at age 11 or younger, and those who first used drugs at age 12 or older. Missing responses to the cannabis and amphetamine/methamphetamine questions were excluded to ensure that prevalence rates were calculated using only valid responses. While the overall response rate was high (92.68%), variations in response rates for specific questions across countries may have affected the representativeness of the findings in countries with lower response rates.

Statistical analysis

Prevalence and 95% confidence intervals (CIs) for cannabis use, amphetamine or methamphetamine use, and age at first drug use were calculated for each country. Meta-analysis using random-effects models was applied to estimate prevalence rates by country characteristics [13]. The results of the meta-analysis performed at the continental level were evaluated by sex, and significant heterogeneity was considered to exist if the I^2 value exceeded 75% [18]. Student's t-tests were employed to compare two-subgroup categories, such as high versus low homicide rates, sanitation services, or health expenditures, and one-way ANOVA was utilized to analyze differences across the four-subgroup category, defined by World Bank income classifications [19]. *P*-values for each group comparison were reported. In addition, linear regression was conducted to assess annual trends in drug use by subgroup, and the regression coefficient (β) with its corresponding *P*-value were used to

Table 1 Prevalence of cannabis use and amphetamine/methamphetamine use among adolescents in 47 countries based on the latest available data from the GSHS

Countries	Cannabis use			Amphetamine or methamphetamine use		
	Total, % (95% CI)	Boys, % (95% CI)	Girls, % (95% CI)	Total, % (95% CI)	Boys, % (95% CI)	Girls, % (95% CI)
Overall	7.02 (6.16 to 7.89)	9.20 (8.05 to 10.36)	4.20 (3.68 to 4.72)	4.05 (3.51 to 4.60)	5.14 (4.45 to 5.84)	2.34 (2.00 to 2.69)
African region (AFR)						
Algeria	2.25 (1.71 to 2.80)	4.36 (3.27 to 5.44)	0.21 (−0.04 to 0.45)	2.44 (1.83 to 3.06)	4.25 (3.12 to 5.38)	0.54 (0.08 to 0.99)
Benin	1.66 (1.16 to 2.17)	1.80 (1.17 to 2.43)	1.13 (0.38 to 1.88)	1.84 (1.29 to 2.39)	1.99 (1.29 to 2.70)	1.14 (0.40 to 1.88)
Eswatini	7.25 (6.40 to 8.10)	11.08 (9.58 to 12.59)	3.66 (2.83 to 4.48)	3.68 (3.06 to 4.30)	5.61 (4.49 to 6.72)	1.84 (1.24 to 2.44)
Liberia	8.21 (7.05 to 9.36)	8.14 (6.54 to 9.74)	6.94 (5.35 to 8.53)	7.94 (6.77 to 9.11)	6.89 (5.32 to 8.46)	7.85 (6.17 to 9.53)
Mauritania	7.21 (6.06 to 8.36)	7.02 (5.38 to 8.66)	7.22 (5.61 to 8.84)	7.23 (6.07 to 8.38)	6.03 (4.48 to 7.57)	8.14 (6.42 to 9.86)
Mauritius	8.33 (7.24 to 9.43)	14.62 (12.50 to 16.74)	2.91 (2.05 to 3.76)	2.48 (1.81 to 3.15)	4.33 (3.04 to 5.62)	0.75 (0.23 to 1.27)
Mozambique	1.17 (0.63 to 1.72)	1.53 (0.78 to 2.28)	0.87 (0.03 to 1.71)	1.31 (0.68 to 1.94)	1.46 (0.58 to 2.34)	1.14 (0.19 to 2.10)
Namibia	7.05 (6.25 to 7.86)	9.62 (8.28 to 10.95)	4.66 (3.71 to 5.61)	5.63 (4.91 to 6.35)	7.21 (6.05 to 8.37)	4.02 (3.13 to 4.91)
Seychelles	11.59 (10.27 to 12.92)	16.06 (13.84 to 18.27)	7.30 (5.85 to 8.76)	4.78 (3.85 to 5.72)	6.93 (5.32 to 8.53)	2.74 (1.76 to 3.73)
Sierra Leone	5.24 (4.38 to 6.09)	6.66 (5.29 to 8.03)	3.49 (2.51 to 4.46)	7.94 (6.77 to 9.12)	8.58 (6.88 to 10.27)	7.00 (5.34 to 8.66)
United Republic of Tanzania	3.15 (2.53 to 3.76)	2.49 (1.72 to 3.26)	3.31 (2.41 to 4.21)	3.06 (2.45 to 3.67)	2.45 (1.67 to 3.23)	3.13 (2.24 to 4.02)
Pooled estimates	3.88 (3.66 to 4.10)	7.48 (5.05 to 9.91)	3.71 (2.27 to 5.16)	4.34 (3.14 to 5.53)	5.00 (3.59 to 6.40)	3.31 (2.15 to 4.46)
I^2 (%)	98.38	98.07	97.32	96.61	94.33	95.57
Region of the Americas (AMR)						
Argentina	10.30 (9.64 to 10.96)	12.76 (11.63 to 13.89)	7.98 (7.24 to 8.72)	2.80 (2.47 to 3.14)	3.74 (3.16 to 4.32)	1.84 (1.47 to 2.22)
Bahamas	10.19 (8.38 to 12.00)	13.83 (10.73 to 16.94)	6.79 (4.82 to 8.76)	3.30 (2.32 to 4.27)	5.30 (3.47 to 7.14)	1.27 (0.47 to 2.06)
Barbados	14.83 (12.98 to 16.68)	18.64 (15.67 to 21.60)	11.13 (8.89 to 13.38)	3.28 (2.36 to 4.20)	4.65 (3.02 to 6.29)	1.86 (1.00 to 2.73)
Belize	11.93 (10.52 to 13.34)	16.56 (14.18 to 18.94)	7.56 (5.99 to 9.13)	5.08 (4.09 to 6.07)	6.04 (4.47 to 7.60)	3.88 (2.67 to 5.08)
Bolivia	3.54 (2.89 to 4.20)	4.41 (3.33 to 5.48)	2.59 (1.81 to 3.37)	1.66 (1.20 to 2.12)	1.55 (0.89 to 2.22)	1.62 (0.99 to 2.24)
Chile	25.55 (23.25 to 27.84)	27.55 (24.21 to 30.90)	23.30 (20.06 to 26.54)	4.82 (3.68 to 5.96)	5.27 (3.60 to 6.94)	4.33 (2.75 to 5.91)
Dominican Republic	4.52 (3.29 to 5.75)	4.22 (2.46 to 5.97)	4.50 (2.74 to 6.26)	2.83 (1.84 to 3.81)	2.94 (1.41 to 4.47)	2.24 (1.04 to 3.44)
Guatemala	5.65 (4.31 to 6.99)	8.03 (5.74 to 10.31)	2.78 (1.59 to 3.98)	3.41 (2.35 to 4.47)	4.71 (2.92 to 6.49)	1.62 (0.72 to 2.52)
Jamaica	21.58 (19.22 to 23.94)	27.96 (24.02 to 31.91)	15.77 (13.10 to 18.44)	2.98 (2.07 to 3.89)	4.64 (2.99 to 6.29)	1.45 (0.61 to 2.30)
Peru	4.32 (3.54 to 5.09)	6.59 (5.22 to 7.97)	2.06 (1.34 to 2.77)	1.65 (1.17 to 2.13)	2.27 (1.46 to 3.08)	1.03 (0.50 to 1.56)
Saint Lucia	20.24 (18.35 to 22.12)	25.42 (22.42 to 28.41)	15.69 (13.27 to 18.11)	5.93 (4.81 to 7.05)	9.31 (7.26 to 11.37)	2.64 (1.60 to 3.68)
Suriname	5.21 (4.18 to 6.23)	6.11 (4.54 to 7.68)	4.27 (2.93 to 5.61)	2.63 (1.89 to 3.38)	3.96 (2.62 to 5.30)	1.41 (0.67 to 2.14)
Trinidad and Tobago	10.38 (9.20 to 11.55)	15.09 (13.02 to 17.15)	6.10 (4.89 to 7.32)	3.12 (2.45 to 3.79)	4.05 (2.90 to 5.21)	2.16 (1.43 to 2.89)
Pooled estimates	11.31 (8.44 to 14.17)	14.23 (10.56 to 17.89)	8.26 (6.03 to 10.49)	3.27 (2.67 to 3.87)	4.35 (3.41 to 5.29)	1.92 (1.54 to 2.30)
I^2 (%)	98.80	97.99	97.51	89.32	87.85	67.79

Table 1 (continued)

Countries	Cannabis use			Amphetamine or methamphetamine use		
	Total, % (95% CI)	Boys, % (95% CI)	Girls, % (95% CI)	Total, % (95% CI)	Boys, % (95% CI)	Girls, % (95% CI)
Eastern Mediterranean region (EMR)						
Afghanistan	4.20 (3.30 to 5.11)	4.39 (2.96 to 5.81)	2.38 (1.60 to 3.15)	3.30 (2.52 to 4.08)	2.61 (1.51 to 3.70)	2.53 (1.69 to 3.36)
Kuwait	3.17 (2.50 to 3.84)	5.69 (4.42 to 6.95)	0.43 (0.08 to 0.78)	3.10 (2.37 to 3.82)	5.01 (3.76 to 6.27)	0.70 (0.21 to 1.18)
Lebanon	2.39 (1.93 to 2.85)	3.99 (3.10 to 4.88)	1.04 (0.65 to 1.43)	1.52 (1.16 to 1.88)	2.41 (1.74 to 3.07)	0.76 (0.42 to 1.10)
Morocco	6.51 (5.83 to 7.20)	9.70 (8.54 to 10.86)	2.61 (1.97 to 3.26)	7.79 (6.98 to 8.59)	11.23 (9.90 to 12.56)	3.62 (2.81 to 4.42)
Pooled estimates	4.06 (2.18 to 5.93)	5.94 (3.28 to 8.60)	1.57 (0.61 to 2.54)	3.91 (1.34 to 6.49)	5.29 (1.68 to 8.90)	1.85 (0.65 to 3.05)
I^2 (%)	96.98	95.25	93.44	98.49	97.92	94.54
European region (EUR)						
Oman	2.96 (2.37 to 3.54)	4.80 (3.72 to 5.87)	0.84 (0.42 to 1.26)	2.50 (1.95 to 3.05)	3.91 (2.91 to 4.90)	0.86 (0.42 to 1.29)
South–east Asian region (SEAR)						
Bangladesh	1.53 (0.80 to 2.27)	2.03 (0.98 to 3.09)	0.33 (−0.14 to 0.80)	1.89 (1.04 to 2.73)	2.44 (1.21 to 3.68)	0.58 (0.00 to 1.17)
Indonesia	1.69 (1.42 to 1.95)	2.57 (2.09 to 3.05)	0.79 (0.53 to 1.05)	1.59 (1.33 to 1.86)	2.44 (1.97 to 2.91)	0.75 (0.50 to 1.00)
Thailand	6.63 (5.76 to 7.50)	10.81 (9.19 to 12.44)	3.06 (2.24 to 3.88)	4.40 (3.69 to 5.11)	7.28 (5.95 to 8.62)	1.83 (1.18 to 2.48)
Timor – Leste	5.81 (5.01 to 6.62)	6.31 (5.04 to 7.58)	4.22 (3.29 to 5.15)	5.10 (4.34 to 5.87)	5.60(4.37 to 6.83)	3.46 (2.64 to 4.27)
Pooled estimates	3.90 (1.42 to 6.38)	5.36 (2.21 to 8.51)	2.03 (0.66 to 3.41)	3.23 (1.39 to 5.08)	4.40 (2.12 to 6.68)	1.61 (0.56 to 2.66)
I^2 (%)	98.44	97.46	80.58	97.35	95.16	93.63
Western Pacific region (WPR)						
Brunei Darussalam	0.49 (0.19 to 0.78)	0.66 (0.16 to 1.17)	0.25 (−0.03 to 0.52)	0.41 (0.14 to 0.68)	0.56 (0.09 to 1.02)	0.20 (−0.05 to 0.44)
Cambodia	1.03 (0.67 to 1.38)	1.26 (0.72 to 1.81)	0.77 (0.33 to 1.21)	0.81 (0.48 to 1.15)	1.22 (0.64 to 1.79)	0.38 (0.06 to 0.69)
Cook Islands	10.98 (8.57 to 13.38)	12.82 (9.02 to 16.62)	9.14 (6.14 to 12.14)	3.24 (1.81 to 4.66)	4.46 (2.04 to 6.89)	1.80 (0.35 to 3.24)
Kiribati	4.27 (3.21 to 5.34)	7.57 (5.50 to 9.65)	1.39 (0.60 to 2.17)	4.08 (3.03 to 5.12)	7.13 (5.10 to 9.15)	1.40 (0.60 to 2.20)
Lao People's Democratic Republic	0.65 (0.32 to 0.98)	0.99 (0.41 to 1.58)	0.27 (0.03 to 0.51)	1.16 (0.76 to 1.55)	1.83 (1.14 to 2.52)	0.27 (0.03 to 0.51)
Malaysia	0.92 (0.77 to 1.08)	1.47 (1.21 to 1.74)	0.38 (0.22 to 0.54)	0.99 (0.83 to 1.14)	1.60 (1.32 to 1.87)	0.38 (0.23 to 0.53)
Mongolia	1.35 (1.02 to 1.68)	1.82 (1.27 to 2.38)	0.82 (0.46 to 1.18)	1.66 (1.29 to 2.03)	1.95 (1.35 to 2.54)	1.34 (0.89 to 1.79)
Philippines	7.13 (6.50 to 7.77)	9.69 (8.64 to 10.74)	4.64 (3.87 to 5.40)	4.81 (4.28 to 5.34)	6.10 (5.25 to 6.94)	3.51 (2.84 to 4.17)
Samoa	7.67 (6.21 to 9.13)	12.00 (9.17 to 14.83)	3.76 (2.55 to 4.97)	5.42 (4.21 to 6.63)	6.71 (4.51 to 8.91)	3.75 (2.52 to 4.99)
Solomon Islands	17.23 (15.01 to 19.44)	20.58 (17.15 to 24.01)	12.05 (9.47 to 14.63)	15.51 (13.37 to 17.66)	16.30 (13.12 to 19.49)	13.17 (10.41 to 15.93)
Tonga	9.10 (8.06 to 10.13)	15.53 (13.61 to 17.45)	2.78 (2.02 to 3.53)	6.74 (5.81 to 7.66)	10.60 (8.97 to 12.24)	2.61 (1.82 to 3.40)
Tuvalu	3.80 (2.47 to 5.14)	7.51 (4.84 to 10.18)	0.47 (−0.18 to 1.13)	3.56 (2.36 to 4.76)	7.35 (4.88 to 9.82)	0.20 (−0.20 to 0.61)
Vanuatu	5.68 (4.57 to 6.80)	8.25 (6.28 to 10.21)	3.31 (2.16 to 4.46)	4.33 (3.34 to 5.31)	6.10 (4.36 to 7.84)	2.74 (1.69 to 3.79)
Viet Nam	0.62 (0.33 to 0.92)	1.05 (0.48 to 1.62)	0.25 (0.00 to 0.50)	0.62 (0.29 to 0.94)	0.94 (0.39 to 1.48)	0.34 (−0.04 to 0.71)
Pooled estimates	4.66 (3.62 to 5.71)	6.62 (5.09 to 8.15)	1.99 (1.42 to 2.56)	3.49 (2.64 to 4.33)	4.72 (3.56 to 5.89)	1.60 (1.10 to 2.09)
I^2 (%)	98.78	98.25	96.03	98.10	96.95	95.14

GSHS Global School-based Student Health Survey, *CI* confidence interval

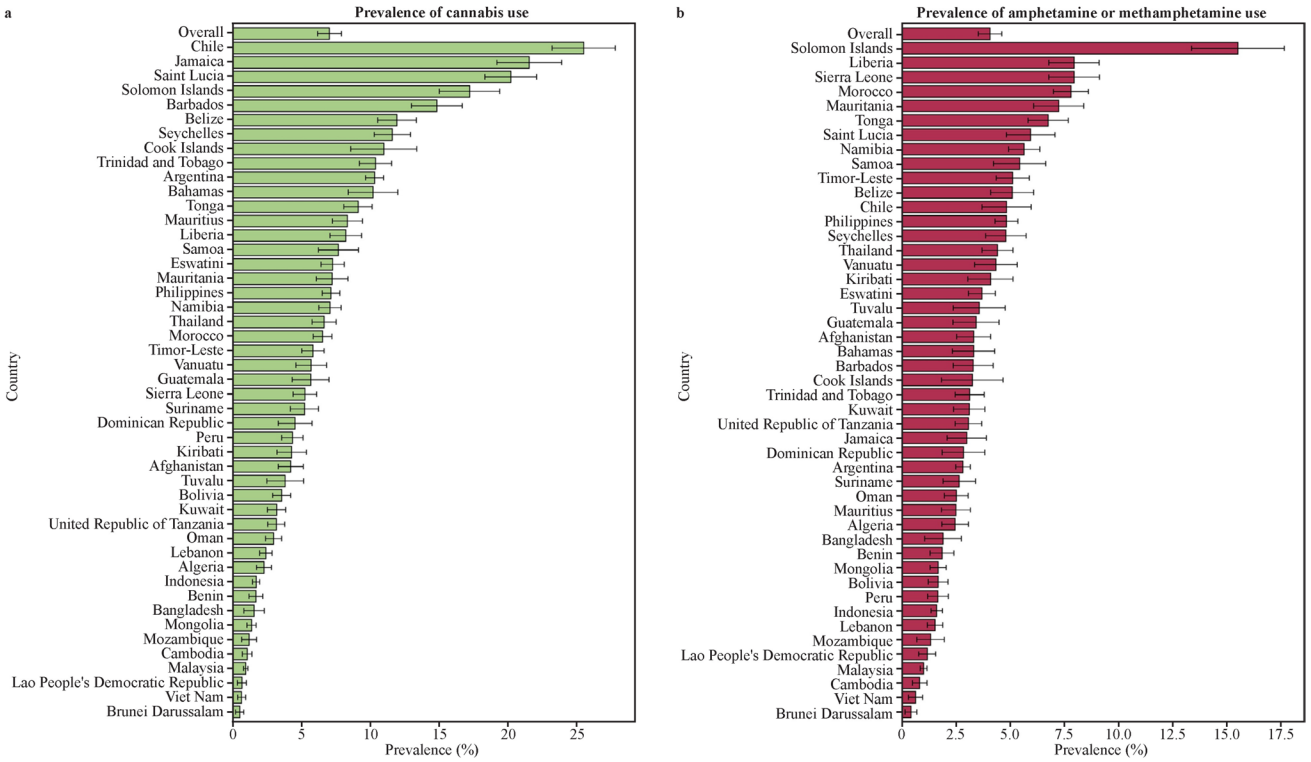


Fig. 1 Prevalence of substance use among young adolescents based on the most recent GSHS from 47 countries with 95% CI 2009–2018. **a** Prevalence of cannabis use and **b** prevalence of amphetamine or methamphetamine use. *CI* confidence interval, *GSHS* Global School-based Student Health Survey

determine the significance of these trends. All analyses were performed using *R* software (version 4.3.2; *R* Foundation, Vienna, Austria) and Python (version 3.11.4; Python Software Foundation, Wilmington, DE, USA). A *P*-value of ≤ 0.05 was considered statistically significant in two-tailed tests. Sampling weights and cluster sample designs were applied to enhance the reliability and representativeness of the findings, ensuring robustness in the results [18].

Results

This study included a total of 220,362 school-going adolescents aged 12–15 years (50.04% boys) from 47 countries, with data collected up to December 2018 (Supplementary Table 1). The analysis utilized GSHS data from six WHO regions: 11 countries from the AFR, 13 from the AMR, 4 from the EMR, 1 from the EUR, 4 from the SEAR, and 14 from the WPR. The overall response rate was 92.68%, ranging from 71.91% (2012/2798) in Sierra Leone to 98.86% (3293/3331) in Vietnam. Sample sizes for overall questions ranged from 701 in the Cook Islands (2015) to 28,368 in Argentina, with a median sample size of 2771. Regarding country income levels, the distribution was relatively higher in LMICs and LICs.

The overall prevalence of cannabis use was 7.02% (95% CI 6.16–7.89; Table 1). The lowest prevalence was observed in Brunei Darussalam at 0.49% (95% CI 0.19–0.78), and the highest prevalence was in Chile at 25.55% (95% CI 23.25–27.84; Table 1 and Fig. 1). The prevalence was 9.20% (95% CI 8.05–10.36) in boys (lowest in Brunei Darussalam and highest in Jamaica) and 4.20% (95% CI 3.68–4.72) in girls (lowest in Algeria and highest in Chile). In 44 (93.6%) of the 47 countries, boys used cannabis more frequently than girls. The AMR exhibited the highest prevalence of cannabis use at 11.31% (95% CI 8.44–14.17), with 14.23% (95% CI 10.56–17.89) in boys and 8.26% (95% CI 6.03–10.49) in girls.

Overall, the prevalence of amphetamine or methamphetamine use was 4.05% (95% CI 3.51–4.60), with a prevalence of 5.14% (95% CI 4.45–5.84) in boys and 2.34% (95% CI 2.00–2.69) in girls (Table 1). In 43 (91.5%) of the 47 countries, boys used amphetamine or methamphetamine more frequently than girls. Specifically, the lowest and highest prevalence were observed in Brunei Darussalam [0.41% (95% CI 0.14–0.68)] and Solomon Islands [15.51% (95% CI, 13.37–17.66)], respectively (Table 1 and Fig. 1).

Table 2 Prevalence of drug use initiation age among adolescents in 47 countries based on the latest GSHS data

Countries	Start before 11 years old			Start after 12 years old		
	Total, % (95% CI)	Boys, % (95% CI)	Girls, % (95% CI)	Total, % (95% CI)	Boys, % (95% CI)	Girls, % (95% CI)
Overall	5.64 (4.96 to 6.31)	7.26 (6.39 to 8.13)	3.43 (3.02 to 3.84)	5.90 (5.22 to 6.59)	7.45 (6.59 to 8.31)	3.75 (3.36 to 4.14)
African region (AFR)						
Algeria	2.77 (2.22 to 3.45)	4.70 (3.67 to 6.00)	0.82 (0.49 to 1.36)	2.47 (1.95 to 3.12)	4.86 (3.83 to 6.16)	0.14 (0.04 to 0.44)
Benin	1.87 (1.36 to 2.57)	1.71 (1.14 to 2.58)	1.79 (1.02 to 3.13)	2.30 (1.76 to 3.01)	2.80 (2.06 to 3.78)	1.37 (0.75 to 2.51)
Eswatini	3.43 (2.87 to 4.10)	5.38 (4.37 to 6.60)	1.66 (1.16 to 2.36)	8.98 (8.08 to 9.98)	13.21 (11.64 to 14.95)	5.14 (4.23 to 6.23)
Liberia	11.45 (10.10 to 12.96)	10.60 (8.85 to 12.66)	11.33 (9.35 to 13.66)	4.96 (4.12 to 5.97)	5.39 (4.16 to 6.95)	4.39 (3.30 to 5.82)
Mauritania	8.02 (6.85 to 9.37)	7.86 (6.22 to 9.87)	8.08 (6.49 to 10.02)	3.21 (2.48 to 4.14)	2.82 (1.89 to 4.19)	3.34 (2.34 to 4.75)
Mauritius	3.06 (2.43 to 3.84)	5.14 (4.01 to 6.58)	1.21 (0.69 to 2.14)	7.39 (6.40 to 8.53)	12.32 (10.44 to 14.49)	3.23 (2.42 to 4.29)
Mozambique	2.70 (1.87 to 3.87)	3.46 (2.21 to 5.38)	1.51 (0.71 to 3.16)	1.56 (1.10 to 2.21)	2.41 (1.67 to 3.46)	0.73 (0.29 to 1.83)
Namibia	6.59 (5.84 to 7.42)	8.22 (7.03 to 9.58)	4.88 (3.99 to 5.94)	12.11 (11.11 to 13.20)	15.93 (14.31 to 17.70)	8.81 (7.60 to 10.18)
Seychelles	6.66 (5.66 to 7.81)	9.79 (8.06 to 11.84)	3.76 (2.83 to 4.98)	8.79 (7.66 to 10.07)	10.92 (9.13 to 13.02)	6.82 (5.51 to 8.42)
Sierra Leone	9.85 (8.58 to 11.30)	9.53 (7.81 to 11.58)	10.24 (8.37 to 12.46)	4.95 (4.06 to 6.03)	6.44 (5.03 to 8.21)	3.15 (2.21 to 4.45)
United Republic of Tanzania	5.28 (4.54 to 6.13)	4.75 (3.78 to 5.94)	5.06 (4.06 to 6.27)	0.64 (0.40 to 1.04)	0.44 (0.21 to 0.95)	0.86 (0.47 to 1.58)
Pooled estimates	5.54 (4.04 to 7.05)	6.39 (4.66 to 8.13)	4.38 (2.90 to 5.86)	5.19 (3.23 to 7.15)	6.98 (4.25 to 9.72)	3.37 (2.10 to 4.65)
I^2 (%)	97.26	94.97	96.49	98.85	98.91	97.92
Region of the Americas (AMR)						
Argentina	3.36 (2.98 to 3.79)	4.28 (3.66 to 4.99)	2.34 (1.91 to 2.88)	8.59 (8.02 to 9.20)	10.19 (9.23 to 11.23)	7.14 (6.49 to 7.86)
Bahamas	7.97 (6.53 to 9.70)	12.12 (9.53 to 15.31)	3.99 (2.75 to 5.76)	6.58 (5.25 to 8.23)	8.02 (5.95 to 10.72)	5.22 (3.66 to 7.39)
Barbados	10.51 (9.02 to 12.22)	14.49 (11.97 to 17.43)	6.67 (5.14 to 8.61)	10.54 (9.04 to 12.26)	12.01 (9.71 to 14.77)	9.19 (7.35 to 11.44)
Belize	8.06 (6.90 to 9.40)	10.13 (8.30 to 12.30)	6.02 (4.67 to 7.72)	11.62 (10.27 to 13.13)	14.77 (12.61 to 17.24)	8.65 (7.05 to 10.57)
Bolivia	2.38 (1.88 to 3.00)	2.38 (1.68 to 3.38)	2.30 (1.66 to 3.19)	3.12 (2.55 to 3.82)	4.20 (3.26 to 5.40)	1.99 (1.38 to 2.86)
Chile	4.13 (3.23 to 5.28)	6.46 (4.82 to 8.61)	1.78 (1.11 to 2.85)	23.66 (21.47 to 26.00)	23.78 (20.73 to 27.13)	23.39 (20.28 to 26.81)
Dominican Republic	4.50 (3.42 to 5.92)	4.76 (3.19 to 7.04)	4.06 (2.68 to 6.10)	2.39 (1.63 to 3.51)	1.82 (0.93 to 3.50)	2.69 (1.60 to 4.48)
Guatemala	3.64 (2.73 to 4.84)	5.39 (3.82 to 7.55)	1.68 (0.98 to 2.85)	5.05 (3.93 to 6.46)	6.31 (4.55 to 8.67)	3.54 (2.40 to 5.18)
Jamaica	11.26 (9.58 to 13.19)	15.73 (12.78 to 19.21)	7.30 (5.64 to 9.40)	15.83 (13.83 to 18.06)	20.68 (17.30 to 24.53)	11.59 (9.42 to 14.17)
Peru	1.66 (1.23 to 2.24)	2.04 (1.37 to 3.02)	1.23 (0.76 to 1.99)	3.91 (3.24 to 4.72)	5.86 (4.69 to 7.30)	2.01 (1.41 to 2.85)
Saint Lucia	11.42 (10.00 to 13.02)	16.95 (14.48 to 19.74)	6.53 (5.08 to 8.36)	13.75 (12.20 to 15.45)	16.60 (14.17 to 19.36)	11.36 (9.41 to 13.65)
Suriname	3.75 (2.96 to 4.75)	4.75 (3.50 to 6.42)	2.58 (1.73 to 3.84)	4.68 (3.80 to 5.76)	4.77 (3.57 to 6.34)	4.67 (3.45 to 6.29)
Trinidad and Tobago	6.26 (5.39 to 7.27)	8.51 (7.00 to 10.31)	4.14 (3.25 to 5.26)	7.41 (6.46 to 8.49)	10.83 (9.16 to 12.77)	4.50 (3.55 to 5.69)
Pooled estimates	5.96 (4.55 to 7.38)	8.07 (6.02 to 10.12)	3.71 (2.81 to 4.62)	8.90 (6.64 to 11.16)	10.56 (7.81 to 13.32)	7.12 (5.16 to 9.08)
I^2 (%)	97.20	96.32	90.73	98.39	97.16	96.99

Table 2 (continued)

Countries	Start before 11 years old			Start after 12 years old		
	Total, % (95% CI)	Boys, % (95% CI)	Girls, % (95% CI)	Total, % (95% CI)	Boys, % (95% CI)	Girls, % (95% CI)
Eastern Mediterranean region (EMR)						
Afghanistan	5.93 (4.93 to 7.11)	6.06 (4.62 to 7.93)	4.25 (3.25 to 5.55)	2.77 (2.10 to 3.65)	3.32 (2.32 to 4.74)	1.38 (0.85 to 2.23)
Kuwait	2.58 (2.00 to 3.32)	4.14 (3.14 to 5.43)	0.62 (0.29 to 1.31)	1.84 (1.35 to 2.49)	2.98 (2.15 to 4.11)	0.46 (0.19 to 1.11)
Lebanon	2.28 (1.85 to 2.80)	3.86 (3.03 to 4.90)	0.95 (0.64 to 1.40)	1.27 (0.96 to 1.68)	1.93 (1.36 to 2.71)	0.71 (0.44 to 1.15)
Morocco	7.43 (6.71 to 8.22)	10.96 (9.75 to 12.29)	2.99 (2.38 to 3.75)	6.86 (6.10 to 7.71)	9.98 (8.73 to 11.40)	3.14 (2.43 to 4.06)
Pooled estimates	4.54 (2.04 to 7.03)	6.24 (2.97 to 9.52)	2.11 (0.81 to 3.42)	3.17 (1.03 to 5.30)	4.52 (1.45 to 7.59)	1.34 (0.50 to 2.19)
I^2 (%)	98.07	96.60	94.94	98.10	97.33	92.52
European region (EUR)						
Oman	4.03 (3.39 to 4.78)	5.79 (4.68 to 7.13)	2.08 (1.50 to 2.88)	2.79 (2.26 to 3.43)	4.38 (3.43 to 5.56)	1.14 (0.73 to 1.77)
South–East Asian region (SEAR)						
Bangladesh	1.67 (1.04 to 2.65)	2.26 (1.36 to 3.72)	0.28 (0.08 to 0.98)	1.28 (0.77 to 2.10)	1.63 (0.91 to 2.88)	0.63 (0.25 to 1.61)
Indonesia	2.10 (1.81 to 2.42)	3.37 (2.85 to 3.98)	0.83 (0.61 to 1.14)	0.61 (0.47 to 0.79)	1.07 (0.81 to 1.43)	0.15 (0.07 to 0.33)
Thailand	5.54 (4.79 to 6.39)	8.88 (7.47 to 10.51)	2.69 (2.02 to 3.56)	4.39 (3.73 to 5.17)	7.20 (5.97 to 8.67)	2.06 (1.49 to 2.85)
Timor – Leste	6.96 (6.13 to 7.91)	7.79 (6.48 to 9.33)	5.29 (4.35 to 6.42)	2.63 (2.08 to 3.30)	2.84 (2.02 to 3.98)	1.82 (1.24 to 2.65)
Pooled estimates	4.05 (1.69 to 6.41)	5.52 (2.70 to 8.34)	2.13 (0.94 to 3.33)	2.21 (0.55 to 3.87)	3.12 (0.96 to 5.27)	1.10 (0.28 to 1.93)
I^2 (%)	98.09	96.23	97.48	97.78	96.39	94.58
Western Pacific region (WPR)						
Brunei Darussalam	0.49 (0.28 to 0.86)	0.69 (0.36 to 1.34)	0.23 (0.07 to 0.74)	0.74 (0.44 to 1.25)	0.80 (0.41 to 1.57)	0.54 (0.23 to 1.27)
Cambodia	1.33 (0.97 to 1.82)	1.65 (1.12 to 2.43)	1.00 (0.58 to 1.71)	2.21 (1.73 to 2.83)	3.30 (2.46 to 4.42)	1.04 (0.67 to 1.60)
Cook Islands	5.40 (3.92 to 7.39)	6.54 (4.24 to 9.97)	4.43 (2.74 to 7.09)	8.71 (6.73 to 11.20)	8.88 (6.06 to 12.85)	8.36 (5.85 to 11.82)
Kiribati	6.28 (5.12 to 7.67)	10.83 (8.63 to 13.51)	2.18 (1.39 to 3.40)	16.90 (15.04 to 18.94)	26.61 (23.28 to 30.22)	8.52 (6.82 to 10.61)
Lao People's Democratic Republic	0.63 (0.39 to 1.02)	0.82 (0.44 to 1.52)	0.43 (0.21 to 0.87)	1.77 (1.31 to 2.37)	3.10 (2.27 to 4.22)	0.29 (0.13 to 0.66)
Malaysia	1.15 (1.00 to 1.33)	1.80 (1.53 to 2.12)	0.49 (0.35 to 0.69)	0.80 (0.68 to 0.95)	1.09 (0.89 to 1.33)	0.51 (0.37 to 0.71)
Mongolia	3.52 (3.03 to 4.09)	4.49 (3.70 to 5.43)	2.51 (1.96 to 3.21)	5.50 (4.88 to 6.20)	7.54 (6.50 to 8.73)	3.63 (2.96 to 4.44)
Philippines	7.44 (6.83 to 8.11)	9.01 (8.04 to 10.08)	5.90 (5.13 to 6.78)	3.11 (2.72 to 3.55)	4.54 (3.88 to 5.30)	1.75 (1.35 to 2.25)
Samoa	8.38 (7.01 to 10.00)	11.83 (9.29 to 14.96)	4.71 (3.53 to 6.27)	3.62 (2.72 to 4.79)	5.39 (3.71 to 7.77)	1.97 (1.26 to 3.05)
Solomon Islands	15.82 (13.58 to 18.36)	16.80 (13.54 to 20.66)	12.31 (9.50 to 15.80)	17.75 (15.63 to 20.10)	20.65 (17.51 to 24.20)	14.84 (11.96 to 18.27)
Tonga	8.96 (7.94 to 10.09)	14.32 (12.50 to 16.35)	3.50 (2.68 to 4.54)	5.78 (4.97 to 6.71)	9.15 (7.69 to 10.86)	2.52 (1.88 to 3.38)
Tuvalu	9.58 (7.78 to 11.75)	16.14 (12.83 to 20.10)	3.78 (2.38 to 5.93)	3.96 (2.85 to 5.48)	5.10 (3.37 to 7.65)	2.98 (1.73 to 5.08)
Vanuatu	3.21 (2.46 to 4.18)	5.10 (3.68 to 7.04)	1.56 (1.00 to 2.42)	6.72 (5.53 to 8.15)	9.30 (7.24 to 11.88)	4.54 (3.29 to 6.21)
Viet Nam	0.94 (0.64 to 1.36)	1.39 (0.88 to 2.18)	0.54 (0.28 to 1.06)	0.49 (0.27 to 0.91)	0.64 (0.31 to 1.30)	0.37 (0.12 to 1.09)
Pooled estimates	4.91 (3.78 to 6.05)	6.68 (5.11 to 8.25)	2.41 (1.81 to 3.00)	5.21 (4.01 to 6.41)	6.85 (5.34 to 8.36)	2.52 (1.92 to 3.11)
I^2 (%)	98.76	98.04	96.64	98.73	98.27	96.31

GSHS Global School-based Student Health Survey, *CI* confidence interval

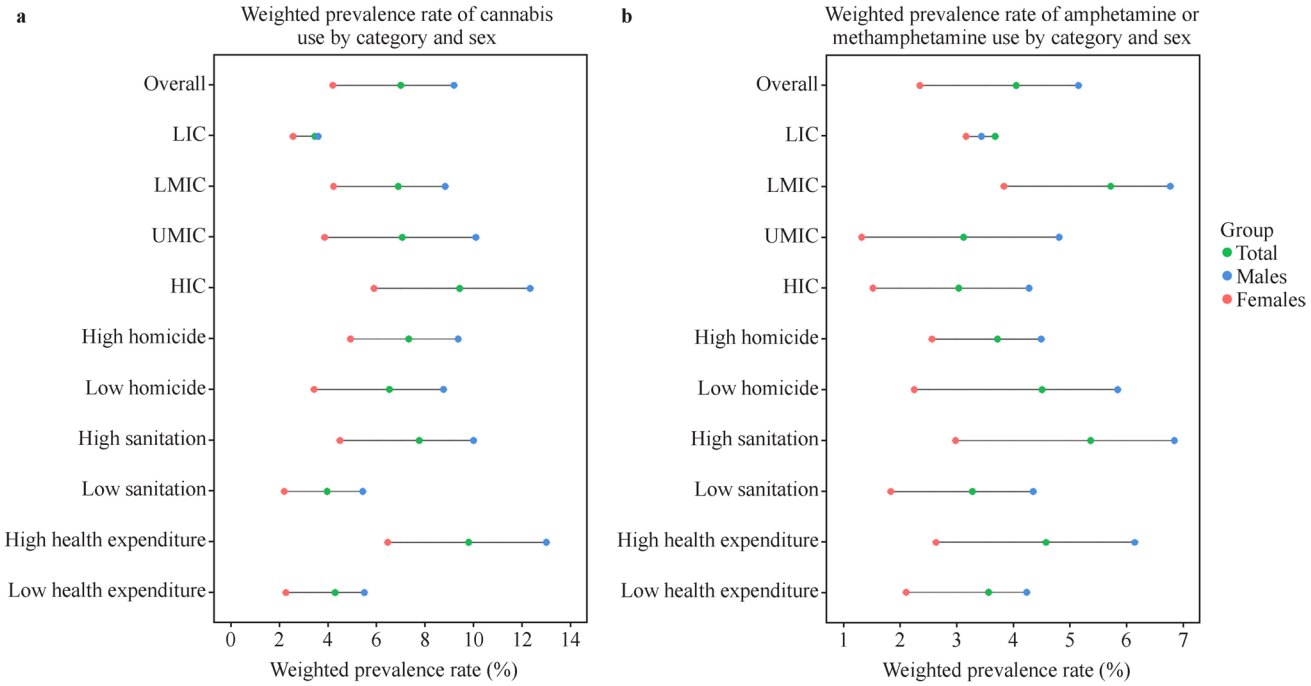


Fig. 2 Prevalence of combined categories of cannabis and amphetamine/methamphetamine use among adolescents in 47 countries based on data obtained from the GSHS. **a** Weighted prevalence rate of cannabis use and **b** weighted prevalence rate of amphetamine or methamphetamine use. *GSHS* Global School-based Student Health Survey, *HIC* high-income countries, *LIC* low-income countries, *LMIC* lower middle-income countries, *UMIC* upper middle-income countries

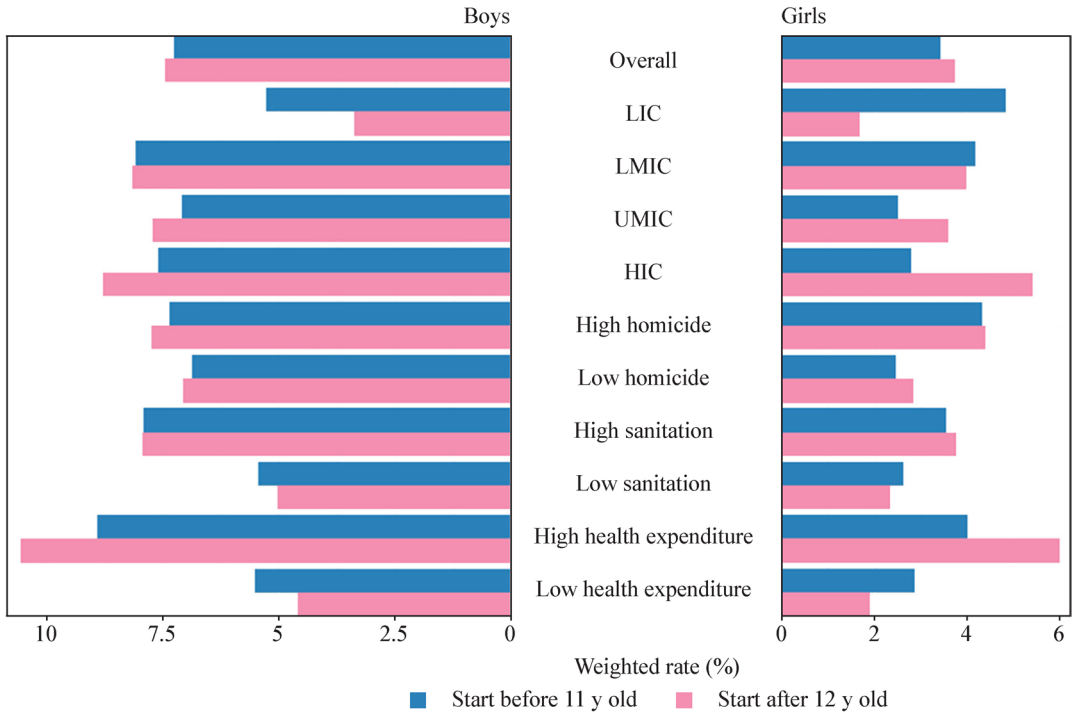


Fig. 3 Prevalence of combined categories of drug initiation age among adolescents in 47 countries based on data obtained from the GSHS. *GSHS* Global School-based Student Health Survey, *HIC* high-income countries, *LIC* low-income countries, *LMIC* lower middle-income countries, *UMIC* upper middle-income countries

Among WHO regions, AFR had the highest prevalence of amphetamine or methamphetamine use with 4.34% (95% CI 3.14–5.53), particularly 5.00% (95% CI 3.59–6.40) in boys and 3.31% (95% CI 2.15–4.46) in girls.

The prevalence of drug use initiation was 5.64% (95% CI 4.96–6.31) for those starting before 11 years old, with the lowest prevalence in Brunei Darussalam and the highest in the Solomon Islands. For those beginning after 12 years old, the prevalence was 5.90% (95% CI 5.22–6.59), with the lowest in Viet Nam and the highest in Chile (Table 2). Among WHO regions, the AMR exhibited the highest prevalence for both age groups: 5.96% (95% CI 4.55–7.38) for initiation before 11 years old and 8.90% (95% CI 6.64–11.16) for initiation after 12 years old. In 89.4% (42/47) and 93.6% (44/47) of countries, respectively, boys initiated drug use more frequently than girls in both age groups.

HICs had the highest prevalence of cannabis use [9.45% (95% CI 6.06–12.84)], while LICs showed the lowest prevalence [3.46% (95% CI 2.01–4.91); Fig. 2 and Supplementary Table 2]. Countries with higher homicide rates exhibited a higher prevalence of cannabis use at 7.34% (95% CI 5.94–8.74). In addition, countries with higher sanitation services had a higher prevalence of both cannabis use at 7.76% (95% CI 5.85–9.68) and amphetamine or methamphetamine use at 5.36% (95% CI 3.99–6.73). Furthermore, countries with higher health expenditures had a higher prevalence of both cannabis use at 9.82% (95% CI 7.95–11.69) and amphetamine or methamphetamine use at 4.58% (95% CI 3.66–5.49). These trends were not observed in the group that initiated drug use before the age of 11 years, but similar trends were seen in the group that initiated drug use after 12 years old, with higher prevalence in HICs [7.38% (95% CI 4.87–9.89)], countries with high homicide rates [6.13% (95% CI 4.93–7.34)], countries with high sanitation services [6.41% (95% CI 4.65–8.16)], and countries with high health expenditures [8.33% (95% CI 6.72–9.94)]; Fig. 3 and Supplementary Table 3).

Linear regression analyses were performed to assess the associations between World Bank income categories, health expenditure levels, homicide rates, or sanitation service levels, and the prevalence of cannabis and amphetamine/methamphetamine use over time (Supplementary Figs. 1–4). Across all subgroups, the regression coefficients (β) for these trends were not statistically significant (all $P > 0.05$).

Discussion

This global database study, which included a large representative cohort of school-going adolescents aged 12–15 years from 47 countries, yielded several key findings. First, the overall prevalence of cannabis use among adolescents was 7.02%, with boys (9.20%) using cannabis more frequently than girls (4.20%). In addition, the overall prevalence of amphetamine or methamphetamine use was 4.05%, with boys (5.14%) using amphetamine or methamphetamine more frequently than girls (2.34%). Second, the highest prevalence of cannabis use was observed in the Americas at 11.31%, while the region with the highest prevalence of amphetamine or methamphetamine use was Africa at 4.34%. Third, HICs had the highest prevalence of cannabis use, whereas LICs had the lowest prevalence. Fourth, countries with higher homicide rates, better sanitation services, and higher health expenditures showed higher prevalence rates for both cannabis and amphetamine/methamphetamine use. Lastly, trend analysis revealed significant increasing trends in the prevalence of cannabis use among boys in Tonga (2010–2017), while substantial decreasing trends were observed in Lebanon and Samoa (2011–2017). For amphetamine or methamphetamine use, significant increases were shown in Mauritius (2011–2017), while significant decreases were observed in Lebanon and Samoa (both 2011–2017).

Previous studies have similarly identified country-specific patterns in adolescent drug use, such as sub-Saharan Africa (sample size $n = 15{,}553$ across 8 countries) [20], LMICs (16 countries) [21], and specific countries such as Sierra Leone (Sierra Leone $n = 1314$) [22]. These studies highlighted regional trends but needed to be more global in scope and scale. Globally, studies using data from the National Surveys on Drug Use and Health in the United States have reported a lifetime prevalence of cannabis use among adolescents aged 12 to 17 years at 15.4% [23]. Within 12 months of initiation, the adjusted prevalence of cannabis use disorder in this population was 10.7% [23]. In contrast, the lifetime prevalence of methamphetamine use was lower, at 2.5% among young adults aged 18 to 25 years, although the prevalence of methamphetamine use disorder within 12 months of initiation was notably higher [23].

Our study provides a more comprehensive analysis by covering data from 47 countries and 220,362 adolescents, offering a global perspective that previous studies often lacked. The overall prevalence of cannabis use in our study (7.02%) aligns with the upper range of the prevalence reported in LMIC studies but is notably lower than the rates reported in some HICs such as the United States. Conversely, the prevalence of amphetamine/methamphetamine use (4.05%) observed in regions such as Africa is higher than typically reported, potentially reflecting differences in study designs, populations, data collection periods, regional drug availability, or enforcement practices. By integrating findings from diverse regions and income levels, our study highlights the variability in substance use patterns across

different contexts. This broader perspective not only complements the more localized insights from previous studies but also emphasizes the importance of global public health strategies targeting adolescent drug use.

The higher overall prevalence of cannabis use compared to amphetamine or methamphetamine use among school-going adolescents can be attributed to several factors. Compared to amphetamines/methamphetamine, cannabis is relatively more accessible and carries a lower social stigma, and is often perceived as a less harmful drug with a lower disease burden, making it easier for adolescents to obtain and use [5]. In several countries, cannabis has been decriminalized or legalized for medical and/or recreational use, leading to increased production and distribution networks [24]. This can result in cannabis being more accessible to the general population, including adolescents [25, 26]. In contrast, amphetamines or methamphetamine are generally classified as controlled substances with stricter legal penalties for production, distribution, and possession [27]. This strict regulation limits their availability and makes them more expensive. In addition, amphetamines or methamphetamine hold a higher social stigma due to their association with severe addiction and health problems [28]. This stigma, combined with their higher cost and legal risks, makes them relatively less accessible to adolescents.

Adolescents in countries with higher homicide rates may face increased social instability, stress, or trauma, which could lead to higher drug use prevalence as a coping mechanism [29]. These environmental factors emphasize the complex interplay between societal challenges and adolescent health behaviors [9]. Similarly, countries with better sanitation services and higher health expenditures may inadvertently facilitate drug availability [30]. Higher health expenditures might improve access to healthcare systems where prescription medications could be misused, while better sanitation services often correlate with higher socioeconomic status, indirectly supporting increased drug use accessibility.

Social and cultural norms significantly influence sex differences in drug use. A previous study reported that boys are more likely to engage in risky behaviors, including alcohol consumption and smoking [20, 31]. Boys are often more exposed to environments where drug use is normalized or encouraged, and they may have greater access to drugs through peer-to-peer interactions compared to girls [32]. Furthermore, research has found that adolescents who receive support from their peers are at higher odds of using amphetamines, suggesting that peer influence can be a crucial factor in drug behaviors [21].

We found the highest prevalence of cannabis in AMR among WHO regions and it should be noted that our study did not cover countries in North America and included countries in South America. Many other countries in the AMR, such as Chile, Bolivia, and Argentina, have permitted and regulated the production of cannabis for scientific and medical purposes [24]. South America, including the top three highest countries such as Chile, Jamaica, and Saint Lucia, has higher rates of drug production and trafficking, increasing accessibility and exposure to cannabis [5, 33]. Relatively higher social acceptance against cannabis use, legalization and/or decriminalization, and proximity to drug suppliers could result in higher cannabis use in these regions. Chile decriminalized the personal use and cultivation of cannabis for medical purposes, increasing accessibility among adolescents [34]. Similarly, Jamaica amended its Dangerous Drugs Act in 2015 to decriminalize possession of small amounts of cannabis and allow its use for religious, medicinal, and therapeutic purposes [35]. This change, coupled with religious and cultural acceptance and recognition of cannabis as a meditative or "holy herb", such as in the Rastafarian community, has increased cannabis use among adolescents [35].

The highest prevalence of amphetamine or methamphetamine use is observed in AFR, including Liberia, Sierra Leone, and Mauritania, attributed to weak drug enforcement and regulatory frameworks. A study revealed that the highest prevalence of amphetamine or methamphetamine use is observed in sub-Saharan Africa, with similar contributing factors [20]. Limited resources for effective public health services, such as drug enforcement, lead to weak regulation of drug markets, making amphetamines and methamphetamines more accessible [1]. Political instability and corruption also contributed to the higher prevalence of drug use by hindering the effective implementation of drug policies and allowing drug trafficking and production to thrive. Post-conflict instability in Liberia and Sierra Leone has left a legacy of weak institutions and limited resources to address drug use. These countries serve as transit points for drug trafficking, increasing the local availability of these substances [36].

HICs had a higher prevalence of cannabis use, likely owing to higher disposable income and better accessibility to cannabis [3]. In addition, urbanized and developed regions with better sanitation services and higher health expenditures may indirectly increase drug use prevalence by improving access to healthcare systems, including prescription medications that could be misused. This association highlights the need to explore how infrastructure and economic stability might facilitate drug availability and influence adolescent behaviors. Conversely, LICs showed lower prevalence rates due to reduced availability and higher costs relative to income. However, this may also be due to underreporting issues in LMICs and LICs with low-resource settings [37, 38]. Adolescents in countries with higher homicide rates may face increased social instability,

stress, or trauma, which could lead to higher drug use prevalence as a coping mechanism. These environmental factors emphasize the complex interplay between societal challenges and adolescent health behaviors [39].

Changing cultural attitudes towards cannabis, increased availability and influence from other regions where cannabis use is rising contribute to the increase in cannabis use in Tonga [40]. Effective public health interventions and regulation of cannabis use explain the decrease in cannabis use in Mongolia and Samoa. In addition, increased availability and trafficking, driven by socioeconomic changes and regional trade dynamics, could result in the increasing trend of amphetamine use in Mauritius [41].

This study highlights that drug use, particularly cannabis and amphetamine/methamphetamine use, among adolescents is a critical public health issue requiring global attention. Both substances, despite their medical applications, pose significant risks of adverse health outcomes in adolescents [8, 28]. For instance, a meta-analysis revealed that cannabis use may be associated with mental health risks, including anxiety symptoms, among adolescents [42]. Other studies found associations between adolescent drug use and suicidal attempts [43–46]. Moreover, a study in Chile found that current changes in cannabis policies are not significantly affecting the age of onset of cannabis use [47].

Therefore, effective policies are essential to reduce drug use among this demographic. For cannabis, even with legalization and decriminalization in various countries, policies must minimize adverse effects on adolescents [8]. This includes setting minimum age limits, regulating sales, and employing taxation and pricing mechanisms to reduce demand [48]. Public awareness campaigns should emphasize the health and social issues related to adolescent cannabis use. In addition, it is crucial to support effective cannabis policies, provide accessible treatment for cannabis use disorders, and implement screening and intervention programs in healthcare settings.

Furthermore, targeted interventions in regions with higher homicide rates, better sanitation services, and higher health expenditures are necessary to address the underlying drivers of drug use [37]. For example, public health policies should incorporate mental health support and trauma-informed care in high-risk communities, where social instability and stress contribute to higher prevalence rates. Addressing these structural and societal factors can enhance the effectiveness of prevention strategies.

In many LMICs and LICs, access to mental health and substance abuse treatment services is limited, hindering individuals who use drugs from receiving necessary help [30]. Social or cultural acceptance of drug use in some communities contributes to higher prevalence, as do peer pressure and normalization of drug use. Public health policies must address these factors through education and awareness campaigns. In addition, prior studies have identified an association between smoking behaviors and cannabis use among adolescents, showing the need for targeted policies for adolescents under other risky behaviors [22].

The similar prevalence of drug use initiation before and after age 12 years suggests that interventions should target younger adolescents. School-based interventions should aim to prevent or delay drug use initiation, focusing on social norms, personal skills, interactive education, and peer leadership [49]. Comprehensive public health strategies involving education, regulation, and support services are required to address adolescent drug use effectively.

This study has several limitations. First, the characteristics of the survey-based dataset can lead to recall bias and variability in understanding the questions, particularly as some adolescents may have low literacy skills. Cultural factors can also result in different levels of acceptability towards drug use, affecting self-reporting and potentially increasing bias across countries [13]. In addition, underreporting is likely in countries with a strong stigma of drug use and in LMICs or LICs [38]. Second, the heterogeneity of results across countries should be considered when the overall and regional estimates are interpreted cautiously. Third, the findings are only generalizable to school-going adolescents, and the characteristics of students attending school may partly explain these trends [49]. In particular, the prevalence of drug use may be underestimated in countries where legal or cultural barriers discourage adolescents from honestly reporting their drug use experiences, even in anonymous surveys [13]. Fourth, while national estimates are representative, there is a lack of additional demographic variables to perform subgroup analysis by regions of residence (urban versus rural), socioeconomic status, types of schools (public versus private), or levels of academic achievement. Fifth, while sanitation was considered a variable in this analysis, it is important to note that countries with better sanitation services generally have higher income levels. The observed association between better sanitation and increased substance use may actually reflect the influence of higher income levels rather than sanitation alone. This suggests that income could play a primary role in substance use trends, with sanitation conditions acting as a secondary factor. Thus, further research controlling for income as a separate variable would be valuable to clarify the relationship between socioeconomic factors and substance use prevalence across countries. Sixth, our study dichotomized responses to the question of drug use for statistical analysis. This simplification reduced the response options to 'yes' or 'no' from the varying original responses. This methodological choice was made due to the low response rates in higher frequency categories, which could affect the robustness of statistical analysis. Seventh, missing responses to the specific drug use questions (cannabis and amphetamine/

methamphetamine) were excluded to ensure valid prevalence estimates. However, variations in the question-specific response rates across countries may introduce bias. For instance, in countries with relatively lower response rates, non-respondents may systematically differ from respondents in their drug use behaviors, potentially leading to either underestimation or overestimation of prevalence rates. Moreover, while this study focused on cannabis and amphetamine/methamphetamine use due to their prevalence and public health impact, other types of drug use (e.g., opioids, inhalants) were not analyzed because the data were either unavailable or inconsistently reported across countries. In addition, students absent during the survey, often engaging in higher risk behaviors, may have contributed to underestimation [13]. Future research should address these gaps by including a broader range of substances and accounting for response biases.

In conclusion, this study indicates a higher prevalence of cannabis use compared to amphetamine or methamphetamine use among adolescents, with significant sex differences, as boys show a higher prevalence than girls. The Latin American region reported the highest prevalence of cannabis use, while Africa had the highest prevalence of amphetamine or methamphetamine use, albeit with substantial variation between countries. The finding that drug use is relatively prevalent at age 12 years underscores the need for public policies and programs targeting a broader age range to effectively reduce adolescent drug use.

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Data availability Data are available on reasonable request. Study protocol, statistical code: available from JK (email: wltmd1006@gmail.com). Data set: available from the World Health Organization and the US Centers for Disease Control and Prevention through a data use agreement.

Declarations

Conflict of interest The authors declare that they have no competing interests. No financial or non-financial benefits have been received or will be received from any party related directly or indirectly to the subject of this article. The author YDK is a member of the editorial board for *World Journal of Pediatrics*. The paper was handled by the other editor and has undergone rigorous peer review process. The author YDK was not involved in the journal's review of, or decision related to this manuscript.

Ethical approval All GSHS surveys and protocols were approved by each country's government agency (primarily the Ministry of Health or Education), institutional ethics committees, and the US Centers for Disease Control and Prevention (CDC). Participant anonymity and voluntary participation were ensured, and data were statistically weighted to adjust for non-response and sampling variations.

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