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Energy Drink Consumption among Adolescents between 13 and 18 Years in Lebanon: Prevalence, Patterns, and Predictors of Energy Drink Use and Dependence

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ABSTRACT: Energy drinks (ED) use and addiction among adolescents is a growing concern, as they contain high levels of caffeine and other stimulants that can be addictive. This study aims to determine the prevalence of ED consumption among adolescents and assess the use and dependence predictors. A cross-sectional study was conducted over eight months, targeting 1855 adolescents from 12 schools during the 2022/2023 academic year. 55.5% of participants consumed EDs at least once last year. Around 15% reported being dependent on EDs, 34.7% reported mixing them with alcohol, and 25.3% said that they mixed them with caffeinated beverages. The odds of ED use were 3.63 among alcohol consumers, 2.67 times higher among waterpipe smokers, and 1.97 among those consuming them as sports drinks. These odds were 53% and 34% lower among females who knew their side effects, respectively. Among others, these. As regards dependence on EDs, those using them daily or weekly had 2.62 times higher odds of dependence than those using them less frequently. Students using EDs before physical activity had 2.33 times higher odds of dependence, in addition to those using them for self-confidence or to enhance their moral state. Spending more than 7 USD on EDs increased 1.72 times the odds of dependence. A high prevalence of ED use was found in this study, in addition to a high risk of dependence. Findings call for parents, educators, and healthcare providers to educate adolescents about the risks.

Keywords: Energy drink; Adolescent; Consumption; Dependence; Predictors



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1. Introduction

Energy drinks (EDs) are beverages that usually contain high levels of caffeine, sugar, and other stimulants such as taurine, guarana, and ginseng [1]. They are marketed to increase energy and improve performance, particularly during fatigue or stress [2]. With over 500 brands, they are widely used for several reasons, including improvement of physical activity and endurance, promoting wakefulness, maintaining alertness, and enhancing cognition, mood, and intellectual function [2,3]. Energy drinks are popular among athletes, students, and people who work long hours or have a demanding lifestyle [4,5]. Athletes in gyms often use these drinks, and students in schools, clubs, bars, and restaurants [6]. While energy drinks may offer a short-term energy stimulation, some potential risks are associated with excessive or regular consumption [1]. These risks include (i) caffeine overdose, which can cause heart palpitations, nausea, vomiting, tremors, and heightened anxiety [7], (ii) dehydration due to their diuretic effect, potentially causing headaches, fatigue, dizziness, and dry mouth [8], (iii) sleep disturbance, such as insomnia or reduced sleep quality and duration [8,9], (iv) cardiovascular effects, including increased heart rate and blood pressure [10] and (v) addiction or dependence on caffeine and other stimulants, where habitual use may result in caffeine addiction and withdrawal symptoms like irritability, headaches, and impaired concentration [11]. Additionally, the high sugar content of many energy drinks can contribute to an increased risk of metabolic disturbances, including obesity [12], insulin resistance, and type 2 diabetes [13]. Frequent ED consumption has also been associated with poor dental health, particularly due to their acidity and

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sugar concentration, which can promote tooth erosion and cavities [14]. From a neurological perspective, EDs may exacerbate anxiety and panic disorders and have been linked to symptoms of agitation, restlessness, and, in some cases, seizures in young individuals, especially when consumed in combination with alcohol or other stimulants [15,16].

Despite the recommendation of the American Academy of Pediatrics that children and adolescents should avoid EDs, as the potential risks may outweigh any potential benefits [17], reports showed high ED use among them [18]. Since adolescents need more sleep than adults, consuming EDs can interfere with healthy sleeping hours and quality [19], leading to fatigue and difficulty concentrating during the day. Furthermore, adolescents are more susceptible to developing an addiction than adults and consuming energy drinks regularly may lead to dependence on caffeine and other stimulants. Numerous research have delved into the prevalence of energy drink consumption among adolescents [18,20,21], consistently highlighting a significant proportion of young individuals openly acknowledging their use of these beverages. Furthermore, investigations have sought to elucidate the intricate link between energy drink consumption and risky behaviors in adolescents [22,23], leading to poor academic performance, depressive symptoms, increased risk-taking behaviors, and co-use of substances like tobacco, alcohol, or cannabis.

While not explicitly classified within the domain of a substance use disorder, empirical observations indicate that certain adolescents can exhibit behavioural patterns reminiscent of addiction to energy drinks [24]. This is discernible through the manifestation of compulsive and problematic consumption, resulting in an inability to curtail intake despite encountering adverse consequences [23]. Notably, individuals engaging in regular consumption of energy drinks, particularly those containing high levels of caffeine, may grapple with withdrawal symptoms like headaches, fatigue, irritability, and difficulty concentrating when attempting to reduce or cease their consumption [25].

The intricate web of factors contributing to the problematic consumption of energy drinks among adolescents involves interconnected elements. Peer influence emerges as a pivotal determinant, with adolescents frequently swayed by the behaviours exhibited by their peers [26]. Additionally, the impact of marketing strategies employed by energy drink companies, coupled with the widespread accessibility of these beverages and the prevailing perception that consumption enhances social status or performance, collectively contributes to the intricate landscape of energy drink-related issues within this demographic [27,28]. Comprehending these multifaceted factors is paramount for developing effective interventions and strategies to mitigate potential risks associated with energy drink consumption among adolescents. ED consumption in Lebanon is common among the youth [24]. Although the Lebanese Ministries of Economy and Health had issued back in 2012 a policy obliging ED importers and producers to lower the caffeine level from 65 to 35 g, follow-up and control of this law were scarce, given that some marketed products contain up to 80 mg of caffeine [29]. A pilot cross-sectional study tackling ED consumption prevalence was previously conducted in the capital Beirut and showed an overall prevalence of 63.6% among those aged between 13 and 30 [26]. Nevertheless, little information exists about this consumption and the factors impacting ED use and adolescents' addiction. Therefore, the primary objective of this study is to determine the prevalence of ED consumption among adolescents in Lebanon and to assess the predictors of ED use and addiction.

Three hypotheses were formulated: (1) A significant proportion of Lebanese adolescents consume energy drinks, despite known health risks. (2) ED consumption and dependence are associated with sociodemographic characteristics (e.g., age, gender), or behavioral factors (e.g., peer influence, physical activity). (3) Adolescents who consume EDs more frequently are more likely to exhibit signs of problematic or dependent use.

2. Materials and Methods

2.1. Study Design

An observational multi-center cross-sectional study was performed over eight months during the 2022/2023 academic year, targeting adolescents from 12 schools in Lebanon.

2.2. Study Sample and Sample Size

Participants were recruited without selection criteria based on sex, nationality, or ethnicity. The sample included adolescents between 13 and 18 years old attending the selected schools from grades 9 to 12. Those who refused to answer or deliver the survey were excluded. The sample size was determined using the Epi Info 7 software version 7.2.4.0. The calculation assumed that the probability of consumption of EDs was 63.6% based on findings from a previous pilot study conducted in Lebanon among both college and university students [26]. A 95% confidence interval and a 5% acceptable margin of error were considered. We assumed a design effect of 5 to assess the variance of the sample estimate obtained from the variance of a simple random sample estimate of the same size. This yielded 1778

participants. Considering the values of skewness (0.117) and kurtosis (0.227), data were normally distributed and converged toward their expected values [30]. Thirty potential private schools were contacted, of which only 12 agreed to take part in the study after reviewing the survey and protocol. The selected schools were in three governorates: 4 in Beirut, 4 in Mount Lebanon, and 4 in the South. Despite being representative of adolescents in Lebanon, schools from other governorates did not agree to participate, and therefore, differences may arise.

2.3. Data Collection

Depending on the school's direction time preference, six pharmacists approached the students in classes from 8 a.m. to 2 p.m. on weekdays and explained the study objectives orally. They invited them to participate by filling out a printed survey. The first page included a written version of the objectives, and a consent form, with an estimated 20 min to answer.

2.4. Study Tool

After an extensive literature review, a questionnaire was developed and used for data collection. It was available in Arabic (the official language in Lebanon). It was initially piloted on 50 participants, and questions that needed more clarity were adjusted or deleted. To ensure content validity, the questionnaire was reviewed by a panel of public health and behavioral science experts and was afterward reviewed by two external reviewers to confirm that items were appropriate, relevant, and comprehensive. The internal consistency and reliability of the instrument were assessed using Cronbach's alpha during the pilot, with acceptable results across key domains (alpha values of 0.821).

The first part included questions about the participants' general characteristics, including sex, age, height, and weight, the location of the school (urban or rural area), and the school grade. This part also collected the lifestyle habits and sports practices of the sample, such as smoking (cigarettes, waterpipe, and passive smoking), alcohol consumption, comorbidities, physical activity, and its location (indoors, outdoors, at a gym or schools), and if they had a workout partner. The second part of the survey comprised questions related to ED consumption and dependence. Participants were also asked about the role of EDs (multiple answers were possible). These roles included physical power, stimulating awakeness, sports drinks, and improving mental activity. They were also asked if they consumed EDs in the last 12 months, the age of initial consumption, the average number of EDs per time, the frequency of consumption (daily, weekly, monthly, and rarely), and the monthly amount spent on EDs (in Lebanese pounds and was later transformed into United States Dollars (USD) based on the daily rate). Moreover, students reported having family members that consumed EDs, the place to drink them (clubs/restaurants, home or school), the time of consumption (at night, on special occasions, no specific time, before physical activity and during exams) and the reasons for ED consumption. They reported whether or not they mix EDs with alcohol or caffeinated beverages and their perceived dependence on EDs and overall satisfaction. The 5-item Alcohol Use Disorders Identification Test was used to assess dependence while replacing alcohol with ED. The questions covered included the frequency of drinking, the quantity of EDs consumed on a typical day, and the occurrence of binge drinking episodes. The test was scored on a scale of 0 to 12, with 4 or more for men and 3 or more for women used as cut-off points for dependence [31].

2.5. Statistical Analysis

Statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA) Version 28. Categorical variables were presented through frequencies and percentages; For continuous variables, including current age, Body Mass Index (BMI), age of energy drink initiation, and the number of cans consumed each time, means and standard deviations were reported**.**

To explore associations between ED use or dependence and participants' sociodemographic characteristics and consumption behaviors, bivariate analyses were performed. Chi-square or Fisher's exact tests were applied for categorical comparisons, while the unpaired Student's t-test or Mann-Whitney U test was used for continuous data, depending on distribution.

Multivariate logistic regression models were used to identify predictors of ED consumption and dependence. Results are presented as Odds Ratios (ORs) with corresponding 95% Confidence Intervals (CIs). Only variables showing statistical significance in the bivariate analyses were included in the multivariate models. A p-value less than 0.05 was considered indicative of statistical significance.

2.6. Ethical Considerations

The study protocol, including the survey instrument and consent form, received approval from the institutional review board of the faculty of pharmacy at the Lebanese University on 2 May 2019 (Reference: 4/23/D). Participation was voluntary, and all data collected were kept strictly anonymous and non-identifiable.

Written informed consent was first obtained from each participant's parent/legal guardian. Adolescents with parental approval were then invited to provide their own written consent before completing the questionnaire. Participants were assured that they could discontinue their involvement at any time. All collected information was used exclusively for research purposes.

3. Results

3.1. General Characteristics of the Participants

Overall, 1911 potential participants were approached, and 1855 agreed to participate in the study (97.0%). The general characteristics of the study participants are presented in Table 1. The sample comprised slightly more males (53.5%) than females (46.5%). The mean age of the students was 16.3 (1.3) years. Around 55% of schools were in urban areas, and 45.4% were in rural areas. As regards smoking status, 30.9% were current smokers, of which 11.1% were cigarette smokers, 62.1% were waterpipe smokers, and the rest (26.5%) smoked both. Only 3.5% of the sample reported having existing comorbidities, and 22.2% were alcohol consumers. Most participants (83.2%) practiced physical activity in locations: 40.3% indoors, 33.4% outdoors, 19.1% in a gym, and 7.2% at schools. Sixty-five percent of those who practiced sports reported having an exercise partner.

Table 1. Distribution of the general characteristics of the adolescents.

Total (N = 1855)		
		Frequency (%)
Sex	Male	993 (53.5%)
	Female	862 (46.5%)
Age (years)	Mean (SD)	16.3 (1.3)
BMI (Kg/m^2)	Mean (SD)	21.7 (3.7)
Location of the school	Urban area	1013 (54.6%)
	Rural area	842 (45.4%)
The school grade	Grade 9	187 (12.9%)
	Grade 10	506 (27.3%)
	Grade 11	525 (28.3%)
	Grade 12	585 (31.5%)
Monthly allowance (USD)	<100 USD	975 (52.5%)
	100–300 USD	736 (39.7%)
	>300 USD	144 (7.8%)
Smoking status	Smoker	574 (30.9%)
	Non-smoker	1281 (69.1%)
Type of smoking (N = 574)	Cigarettes	64 (11.1%)
	Waterpipe	357 (62.1%)
	Shisha and waterpipe	153 (26.5%)
Passive smoking	Yes	789 (42.5%)
	No	1066 (57.5%)
Comorbidities	Yes	64 (3.5%)
	No	1791 (96.5%)
Alcohol consumption	Yes	411 (22.2%)
	No	1444 (77.8%)
Physical activity	Yes	1543 (83.2%)
	No	312 (16.8%)
Location of physical activity (N = 1543)	Indoors (at home)	623 (40.3%)
	Outdoors	515 (33.4%)
	Gym	294 (19.1%)

	School	111 (7.2%)
Exercise partners (N = 1543)	Yes	1003 (65.0%)
	No	540 (35.0%)

Results are given in terms of frequency (percentage) or Mean (SD: Standard Deviation). BMI: Body Mass Index; USD: United States Dollars.

3.2. Prevalence and Characteristics of Energy Drink Consumption

Table 2 presents the prevalence of energy drink use among school students and its characteristics. When asked to choose which applies most to the role of EDs, 66.4% reported that they give physical power, 50.8% said they stimulate awakeness, 18.3% defined them as sports drinks, and only 7.1% reported that they improve mental activity. Overall, 55.5% of the sample used EDs during the past 12 months, with a mean age of initial consumption of 13.7 years, with 9.2% consuming them daily and around 21% consuming them weekly or monthly, respectively. Most students (71.9%) spent less than 7 USD per month on EDs, which they frequently consumed in clubs or restaurants (78.8%) and at home (55.6%). This consumption was reported more at night (43.3%), mainly to stimulate awakeness (54.3%) or as energy boosters (39.9%). Around 35% of the participants reported mixing EDs with alcohol, and 25.3% mixed them with other caffeinated beverages. Regarding dependence on EDs, 14.5% of the students reported being dependent on ED consumption.

Table 2. Prevalence and characteristics of energy drink consumption among adolescents.

Total (N = 1855)		
		Frequency (%)
Energy drink definition	Give physical power	1232 (66.4%)
	Stimulate awakeness	943 (50.8%)
	Sport drink	339 (18.3%)
	Improve mental activity	132 (7.1%)
Energy drink consumption during the past 12 months	Yes	1029 (55.5%)
	No	826 (44.5%)
Age of initial energy drink consumption (years)	Mean (SD)	13.7 (1.7)
The average number of energy drinks per time	Mean (SD)	1.4 (0.7)
Frequency of energy drink consumption (N = 1029)	Daily	95 (9.2%)
	Weekly	219 (21.3%)
	Monthly	223 (21.7%)
	Rarely	492 (47.8%)
Monthly amount spent on energy drinks (USD) (N = 1029)	<7 USD	740 (71.9%)
	7–20 USD	220 (21.4%)
	>20 USD	69 (6.7%)
Family members consuming energy drinks (N = 640/1029)	Siblings	397 (38.6%)
	Father	156 (15.2%)
	Mother	87 (8.5%)
The place for energy drink consumption (N = 1029)	Clubs/Restaurants	811 (78.8%)
	Home	572 (55.6%)
	School	76 (7.4%)
The common time for energy drink consumption (N = 1029)	Late at night	445 (43.2%)
	On special occasions	270 (26.2%)
	No specific time	253 (24.6%)
	Before physical activity	241 (23.4%)
	During exams	160 (15.5%)
Reason for energy drink consumption (N = 1029)	Stimulate awakeness	559 (54.3%)
	Energy booster	411 (39.9%)
	Enhance moral state	262 (25.5%)
	Taste/preference	215 (20.9%)
	Improve confidence	49 (4.8%)
Mixing energy drinks with alcohol (N = 1029)	Yes	357 (34.7%)
	No	672 (65.3%)

Mixing energy drinks with caffeinated drinks (N = 1029)	Yes	260 (25.3%)
	No	769 (74.7%)
Dependence on energy drinks (N = 1029)	Yes	149 (14.5%)
	No	880 (85.5%)

Results are given in terms of frequency (percentage) or Mean (SD: Standard Deviation). USD: United States Dollars.

When asked if EDs have side effects, around half of the participants (51.2%) agreed, 11.1% said that EDs have no side effects and the rest (37.7%) answered with "I do not know". Among those who responded positively, more than half (54.3%) reported tachycardia as a side effect, followed by polyuria (29.3%), headaches (25.0%), and agitation (23.0%). The least reported side effects were skin redness or urticaria (5.5%), stomach pain (18.0%), and nausea (18.4%) (Figure 1).

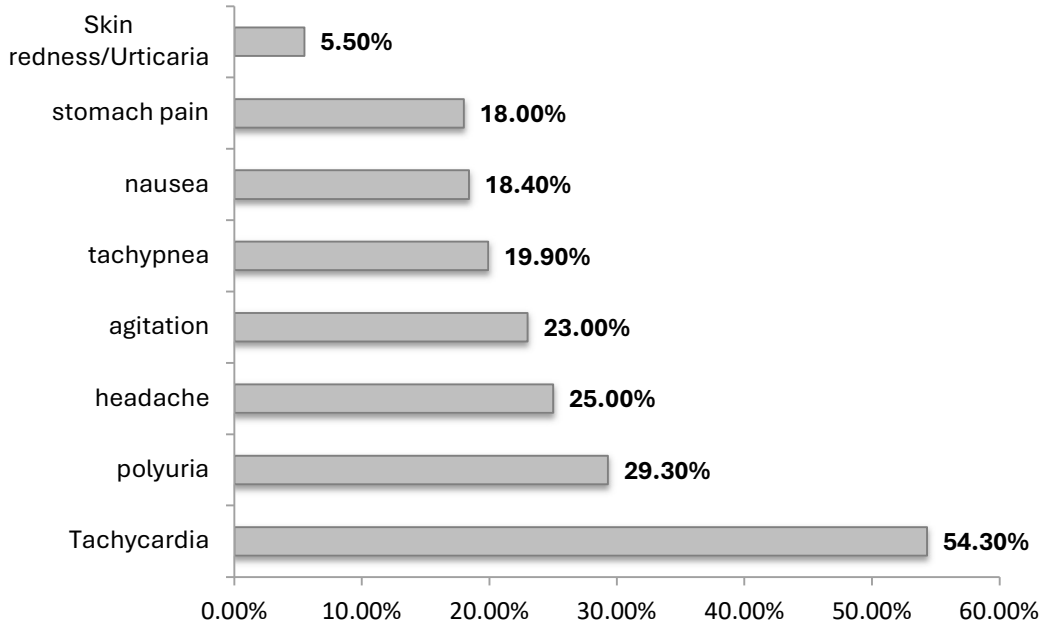


Figure 1. Energy drinks side effects (N = 949).

3.3. Association between Ed Use and Dependence on the General Characteristics of the Students and Patterns of Energy Drink Consumption

Table 3 shows the association between ED use and dependence on the general characteristics of adolescents and the patterns of ED consumption. Significantly more males (65.0%) used EDs than females (44.5%; $p < 0.001$). Students in grades 10 (46.8%) and 11 (55.4%) significantly consumed EDs more than those in grades 9 (32.3%) and 12 (33.9%; $p = 0.039$). The increase in monthly allowance significantly increased the use of EDs, where 66.7% of those receiving more than 300 USD used EDs compared to 49.1% of students receiving less than 100 USD per month ($p < 0.001$). Smoking and alcohol consumption were found to be associated with ED use, where 70.5% of cigarette smokers, 74.3% of waterpipe smokers, and 80.3% of alcohol consumers reported that they use EDs compared to significantly lower percentages among non-users ($p < 0.001$). Around 60.0% of students reported using EDs to stimulate awakeness compared to 50.3% of those who did not ($p < 0.001$), and 65.6% of students reporting that EDs were sports drinks were actual users compared to 53.2% of those who did not ($p < 0.001$). Furthermore, perceiving that EDs had no side effects (75.7%) was associated with their use ($p < 0.001$). Regarding the patterns associated with ED dependence, 69.5% of students consuming EDs daily reported dependence compared to significantly lower percentages of those consuming them less frequently ($p < 0.001$). Around half of those spending more than 20 USD per month on EDs reported being dependent, compared to only 5.4% of those spending less than 7 USD ($p < 0.001$). Moreover, students consuming EDs before physical activity or during the exam period reported higher dependence on EDs than others ($p < 0.001$). Dependence was significantly reported among 18.5% of those mixing EDs with alcohol and 28.8% of those mixing them with other caffeinated beverages than others ($p = 0.008$ and $p < 0.001$, respectively). The reasons for ED use were significantly associated with dependence, where 46.8% of students consumed them to increase self-confidence, 20.4%

of those used them for physical power, and 26% of those who consumed EDs to enhance their moral state reported dependence significantly more than others ($p < 0.001$). In addition, students reporting satisfaction with EDs had a higher association with dependence than others ($p < 0.001$).

Table 3. Association between energy drink use and dependence on the general characteristics of the students and patterns of energy drink consumption.

		ED Users	**Non-Users**	
		Frequency (%)	Frequency (%)	*p*-value
Age (years)	Mean (SD)	16.4 (1.3)	16.2 (1.2)	0.847
Sex	Male	645 (65.0%)	348 (35.0%)	<0.001
	Female	384 (44.5%)	478 (55.5%)	
Location of the school	Urban area	537 (53.0%)	476 (47.0%)	0.019
	Rural area	492 (58.4%)	350 (41.6%)	
The school grade	Grade 9	38 (32.2%)	80 (67.8%)	0.039
	Grade 10	72 (46.8%)	82 (53.2%)	
	Grade 11	160 (55.4%)	129 (44.6%)	
	Grade 12	65 (33.9%)	127 (66.1%)	
Monthly allowance (USD)	<100 USD	479 (49.1%)	496 (50.9%)	<0.001
	100–300 USD	454 (61.7%)	282 (38.3%)	
	>300 USD	96 (66.7%)	48 (33.3%)	
Cigarette smoking	Yes	153 (70.5%)	64 (29.5%)	<0.001
	No	876 (53.5%)	762 (46.5%)	
Waterpipe smoking	Yes	379 (74.3%)	131 (25.7%)	<0.001
	No	650 (48.3%)	695 (51.7%)	
Alcohol consumption	Yes	330 (80.3%)	81 (19.7%)	<0.001
	No	699 (48.4%)	745 (51.6%)	
EDs stimulate awakeness	Yes	570 (60.4%)	373 (39.6%)	<0.001
	No	459 (50.3%)	453 (49.7%)	
EDs give physical power	Yes	712 (57.8%)	520 (42.2%)	0.005
	No	317 (50.9%)	306 (49.1%)	
EDs are sports drinks	Yes	223 (65.6%)	117 (34.4%)	<0.001
	No	806 (53.2%)	709 (46.8%)	
EDs have side effects	Yes	503 (53.0%)	446 (47.0%)	<0.001
	No	156 (75.7%)	50 (24.3%)	
		ED dependents	Non-dependents	
		Frequency (%)	Frequency (%)	*p*-value
Frequency of ED consumption	Daily	66 (69.5%)	29 (30.5%)	<0.001
	Weekly	45 (20.5%)	174 (79.5%)	
	Monthly	24 (10.8%)	199 (89.2%)	
	Rarely	14 (2.8%)	478 (97.2%)	
Monthly amount spent on EDs	<7 USD	40 (5.4%)	700 (94.6%)	<0.001
	7–20 USD	72 (32.7%)	148 (67.3%)	
	>20 USD	37 (53.6%)	32 (46.4%)	
ED consumption before physical activity	Yes	53 (22.1%)	187 (77.9%)	<0.001
	No	95 (12.1%)	693 (87.9%)	
ED consumption during exams	Yes	37 (23.1%)	123 (76.9%)	0.001
	No	112 (12.9%)	757 (87.1%)	
Mixing EDs with alcohol	Yes	66 (18.5%)	291 (81.5%)	0.008
	No	83 (12.4%)	589 (87.6%)	
Mixing EDs with caffeinated drinks	Yes	75 (28.8%)	695 (90.4%)	<0.001
	No	74 (9.6%)	185 (71.2%)	
EDs improve confidence	Yes	23 (46.9%)	26 (53.1%)	<0.001
	No	126 (12.9%)	854 (87.1%)	
EDs give physical power	Yes	84 (20.4%)	327 (79.6%)	0.001

	No	65 (10.5%)	553 (89.5%)	
EDs enhance moral state	Yes	68 (26.0%)	194 (74.0%)	<0.001
	No	81 (10.6%)	686 (89.4%)	
Satisfaction with EDs	Yes	123 (19.8%)	497(80.2%)	<0.001
	No	26 (6.4%)	383 (93.6%)	

Results are given in terms of frequency (percentage). SD: Standard Deviation, USD: United States Dollars, ED: Energy drink. *p*-values < 0.05 are considered significant.

3.4. Predictors of Ed Use and Dependence among Adolescents

The combined effect of the predictors of ED use and dependence is presented in Table 4. After adjusting for covariates, the odds of ED use were 3.63 times higher among alcohol consumers than others (OR 3.63, 95% CI 2.75–4.79) and 2.67 times higher among adolescents who smoked waterpipe (OR 2.67, 95% CI 2.10–3.39). Students perceiving them as sports drinks had 1.97-fold higher odds of ED use than others (OR 1.97, 95% CI 1.47–2.64), and those who reported that EDs give physical power had 1.69-fold higher odds of their use than others (OR 1.69, 95% CI 1.34–2.14). These odds were also significantly higher among those receiving a monthly allowance ≥100 USD than adolescents receiving lower amounts (OR 1.25, 95% CI 1.06–1.47). In contrast, the odds of ED use were 24% lower among adolescents acknowledging that EDs have side effects than others (OR 0.76, 95% CI 0.65–0.89), with females having 53% lower odds than males (aOR 0.47, 95% CI 0.39–0.58). As regards the patterns predicting the dependence on EDs among adolescents, participants consuming EDs daily or weekly had 2.62 times higher odds of dependence than those using them less frequently (OR 2.62, 95% CI 2.00–3.42), and students reporting satisfaction with EDs had significantly higher odds of dependence than others (OR 2.41, 95% CI 1.42–4.11). These odds were 2.33 times higher among adolescents drinking EDs before physical activity (OR 2.33, 95% CI 1.75–4.27), 2.25 times higher among those using them to improve confidence (OR 2.25, 95% CI 1.02–4.99), and 2.17 times among participants consuming EDs to enhance their moral state (OR 2.17, 95% CI 1.05–2.59) than others. Adolescents spending more than 7 USD on EDs had 1.72-fold higher odds of dependence than others (OR 1.72, 95% CI 1.19–2.49).

Table 4. Predictors of ED use and dependence among adolescents in schools.

Energy Drink Use		
Adjusted model		
	aOR [95% CI]	*p*-value
Alcohol consumption (No as a reference)	3.63 [2.75–4.79]	<0.001
Waterpipe smoking (No as a reference)	2.67 [2.10–3.39]	<0.001
EDs are sports drinks (No as a reference)	1.97 [1.47–2.64]	<0.001
EDs give physical power (No as a reference)	1.69 [1.34–2.14]	<0.001
Monthly allowance (<100 USD as a reference)		
≥100 USD	1.25 [1.06–1.47]	0.008
EDs have side effects (No as a reference)	0.76 [0.65–0.89]	0.001
Female sex (Male as a reference)	0.47 [0.39–0.58]	<0.001
Energy drink dependence		
Adjusted model		
	aOR [95% CI]	*p*-value
Daily/Weekly consumption (Monthly/rarely as a reference)	2.62 [2.00–3.42]	<0.001
Satisfaction with ED consumption (No as a reference)	2.41 [1.42–4.11]	0.001
ED consumption before physical activity (No as a reference)	2.33 [1.75–4.27]	0.032
ED consumption to improve confidence (No as a reference)	2.25 [1.02–4.99]	0.041
ED consumption to enhance moral state (No as a reference)	2.17 [1.05–2.59]	0.029
Higher spending on ED (<7 USD as a reference)	1.72 [1.19–2.49]	0.004
Number of cans consumed (per increase of one unit)	1.32 [1.03–1.76]	0.046

The reference categories are "Do not use energy drinks" and "not dependent on energy drinks" OR: Odds ratio; CI: Confidence Interval; aOR: adjusted Odds ratio, ED: Energy Drink, USD: United States Dollars.

4. Discussion

This multi-center cross-sectional study aimed to determine the prevalence and patterns of ED consumption among adolescents and assess the predictors of ED use and addiction. Based on findings from the present study, the prevalence of ED consumption is high among the study sample (adolescents between 13 and 18 years) during the past year, but slightly lower than the one found in the previously conducted pilot study among youths between 13 and 30 years of age, and reporting lifetime consumption (63.6%) [26]. This prevalence (55.5%) is comparable to another study conducted among high school students in Canada (62.0%) also assessing ED use over one-year period [32], and another among German investigating adolescents' lifetime use (61.7%) [33]. A recently published systematic review showed that ED use at an early age increased the risk of substance use or risky behaviors later in life [23], which emphasizes the need for early interventions and policy implementation to prevent such long-term harm, particularly in a low-income country like Lebanon. Males significantly used EDs more than females, which agrees with the existing literature [34,35]. This variation may be attributable to the advertisements in which ED consumers are mainly males who use them to boost their confidence and improve their social lives [6,36].

Around half of the sample reported that EDs have side effects, of which tachycardia, polyuria, headache, and agitation were more common. Research highlighted these side effects that are significantly associated with the frequency and quantity consumed [37,38]. These adverse events were rising with the increasing monthly budget spent on EDs, possibly correlated with the higher exposure to caffeine since the corresponding side effects were found to be directly associated with the dose of caffeine consumed [39]. Despite the knowledge of the adverse outcomes of ED consumption, more than half of the students consumed them. The main reasons for ED use were to stimulate awakeness and gain physical power, which can explain the timing of ED consumption that was mainly during late nights. Such findings are concomitant with previous research in which ED users reported consuming them to stay awake and increase energy in parties [40,41]. Reports also showed associated behaviors with ED use, including smoking, and mixing them with alcohol or caffeinated beverages [40,42]. Consumers tended to mix EDs with alcohol, assuming to counteract the depressant effects of alcohol and thereby decrease hangover [8]. These practices, in addition to the relatively low price of cigarettes and alcohol in Lebanon and the absence of age restriction regarding their acquisition [43], can explain the higher ED use among cigarette and waterpipe smokers and alcohol consumers, which increased 2–3 folds the odds of ED use. Despite laws and regulations in place to prevent such activities, enforcement can sometimes be challenging, namely due to social pressures and norms deeming them acceptable. Communities, law enforcement, and regulators must collaborate, enforcing stricter penalties for supplying minors with tobacco and alcohol, enhancing ID verification, and raising awareness of the risks. Around 15% of the sample reported being dependent on EDs. This dependence was found to be associated with a higher susceptibility to other substance abuse or dependence [42,44]. Students used EDs to stimulate awakeness, enhance their morale, and boost their energy. A recent study found that low health-related quality of life among students [45], expected to be exacerbated during the pandemic and the economic crisis in Lebanon [46], which could be a coping mechanism to overcome this state.

This study has limitations. Despite considering the effect size in the sample size calculation, the included students were from private schools since no permission was obtained to enter public schools. Therefore, possible differences might exist between schools. The invited schools were distributed in urban and rural areas in the different governorates in Lebanon. Nevertheless, those who accepted to participate were from three main governorates. Findings from this study may differ compared to excluded adolescents (18–19 years) since easier access to alcohol and cigarettes may induce additional ED consumption. Recall bias can affect the findings since a self-reported survey was used for data collection. However, data collectors were uniformly trained and used the same form, and a different researcher performed data coding and analysis. While this study explored several sociodemographic and behavioral characteristics associated with ED consumption and dependence among adolescents, certain important dimensions were not assessed. Specifically, psychological and personality-related factors, such as sensation seeking, impulsivity, susceptibility to peer pressure, and attitudes toward marketing, were not included in the analysis due to the scope and design of the original questionnaire. These psychosocial determinants are known to influence substance-related behaviors and could further explain the motivations behind problematic energy drink use. Future research should incorporate validated psychological scales to better understand how individual personality traits and cognitive drivers interact with environmental and social influences to shape consumption patterns. Including these dimensions would provide a more holistic view and strengthen the design of targeted interventions and policy measures. The present study is among the few multi-center studies tackling the prevalence and patterns of ED consumption among adolescents and the predictors

of this consumption and possible dependence. Findings can allow better-informed decisions and tailored campaigns targeting this specific group in Lebanon and other similar settings worldwide.

5. Conclusions and Implications for Practice

A high prevalence of ED consumption was found among adolescents between 13 and 18 years, mainly males. ED use and dependence were associated with various lifestyles and misconceptions of EDs. The combined predictors of ED use and dependence should be considered to reduce the harm associated with uncontrolled consumption, which may lead to substance abuse at an older age. Interventions encouraging healthy alternatives are recommended, such as drinking water or natural juices instead of EDs or participating in physical activities that can boost their energy levels naturally.

The findings of this study have important implications for both public health practice and policymaking. Given the high prevalence of ED consumption and signs of dependence among adolescents, there is an urgent need to implement targeted educational programs in schools that raise awareness about the potential health risks associated with ED use, particularly those related to cardiovascular, neurological, and behavioral consequences. Health professionals, educators, and parents should be equipped with evidence-based resources to guide youth toward healthier choices. At the policy level, regulatory measures such as age restrictions for ED purchases, clearer labeling of caffeine and sugar content, restrictions on marketing directed at adolescents, and enforcement of existing caffeine content limits are crucial steps. Collaboration between the ministries of health, education, and youth affairs is essential to develop and enforce effective strategies that reduce access and appeal of EDs to minors, while promoting a culture of health and informed decision-making among the younger population.

Author Contributions

Conceptualization, S.M., M.C., S.A. and S.R.; Methodology, G.H., M.E.-H., S.A. and S.R.; Software, S.M. and G.H.; Validation, M.C., S.A. and S.R.; Formal Analysis, S.M., G.H., A.M. and M.E.-H.; Investigation, S.M., M.E.-H., F.B., A.M. and S.R.; Resources, S.M., M.C., A.M., M.E.-H. and F.B.; Data Curation, S.M. and G.H.; Writing—Original Draft Preparation, S.M., G.H., M.C., S.A., M.E.-H., A.M. and F.B.; Writing—Review & Editing, G.H., M.C., S.A. and S.R.; Visualization, G.H., A.M. and S.R.; Supervision, M.C. and S.R.; Project Administration, S.M., A.M., F.B. and S.R.

Ethics Statement

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board of the Faculty of Pharmacy at the Lebanese University on 2 May 2019 (Reference: 4/23/D). Participation was voluntary, and all data collected were kept strictly anonymous and non-identifiable.

Informed Consent Statement

Written informed consent was obtained from the parents or legal guardians of all participants under 18 years of age, and age-appropriate assent was also obtained from the adolescent participants themselves. Written informed consent was obtained directly from participants aged 18 years.

Data Availability Statement

Data are provided at a reasonable request from the corresponding author after approval of the scientific committee of the Lebanese University.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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