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Daytime Sleepiness, Circadian Preference, Caffeine Consumption and Use of Other Stimulants among Thai College Students

Jason Tran[a], **Somrat Lertmaharit**[b,c], **Vitool Lohsoonthorn**[b], **Wipawan C. Pensuksan**[d], **Thanapoom Rattananupong**[b], **Mahlet G. Tadesse**[a,e], **Bizu Gelaye**[a], and **Michelle A. Williams**[a]

[a]Department of Epidemiology, Multidisciplinary Health International Research Training Program, Harvard School of Public Health, Boston, MA, USA [b]Department of Preventive and Social Medicine, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand [c]College of Public Health Sciences, Chulalongkorn University, Bangkok, Thailand [d]School of Nursing, Walailak University, Nakhon Si Thammarat, Thailand [e]Department of Mathematics & Statistics, Georgetown University, Washington, DC

Abstract

We conducted this study to evaluate the prevalence of daytime sleepiness and evening chronotype, and to assess the extent to which both are associated with the use of caffeinated stimulants among 3,000 Thai college students. Demographic and behavioral characteristics were collected using a self-administered questionnaire. The Epworth Sleepiness Scale and the Horne and Ostberg Morningness-Eveningness Questionnaire were used to evaluate prevalence of daytime sleepiness and circadian preference. Multivariable logistic regression models were used to evaluate the association between sleep disorders and consumption of caffeinated beverages. Overall, the prevalence of daytime sleepiness was 27.9 % (95% CI: 26.2–29.5%) while the prevalence of evening chronotype was 13% (95% CI: 11.8–14.2%). Students who use energy drinks were more likely to be evening types. For instance, the use of M100/M150 energy drinks was associated with a more than 3-fold increased odds of evening chronotype (OR 3.50; 95% CI 1.90–6.44), while Red Bull users were more than twice as likely to have evening chronotype (OR 2.39; 95% CI 1.02–5.58). Additionally, those who consumed any energy drinks were more likely to be daytime sleepers. For example, Red Bull (OR 1.72; 95% CI 1.08–2.75) or M100/M150 (OR 1.52; 95% CI 1.10–2.11) consumption was associated with increased odds of daytime sleepiness. Our findings emphasize the importance of implementing educational and prevention programs targeted toward improving sleep hygiene and reducing the consumption of energy drinks among young adults

Corresponding author. Dr. Bizu Gelaye, Department of Epidemiology, Harvard School of Public Health, 677 Huntington Ave, K501, Boston, MA 02115 USA, Telephone: 617-432-6477, Facsimile: 617-566-7805, bgelaye@hsph.harvard.edu.

Conflict of Interest

The authors have no competing interests to declare.

Introduction

Sleep is essential for maintaining good health in humans[1]. However, adolescents experience many changes in their sleep patterns in part due to physiological delayed sleep phase syndrome and disruption of the homeostatic sleep-wake cycle[2, 3]. The challenges associated with the transition to college, including reduced parental supervision extracurricular activities, academic workloads, and social commitments[2–4], adversely affect sleep duration and sleep patterns of college students[2, 5]. Irregular sleep patterns can lead to daytime sleepiness, which is a result of sleep loss and deprivation[6, 7]. There is a substantial body of evidence that shows daytime sleepiness is associated with reduced emotional intelligence, impaired constructive thinking skills, poor academic performance, job loss, headaches, and obesity[7–9].

Additionally, circadian rhythms and preferences can also be affected by social, biological, and environmental factors[10–12]. There are two major types of circadian preferences: morningness and eveningness[13, 14]. Morning types tend to wake up relatively early in the morning and work best during this time[13]. On the other hand, evening types wake up later in the day and prefer to work during the evening and night[13]. An accumulating body of literature has confirmed that evening types experience higher sleep apnea, increased stress hormones, less healthier lifestyles, and lower academic performances, although much of the research has focused on Western populations[10–12, 15].

Caffeinated beverages and energy drinks have been implicated as important risk factors for increased daytime sleepiness and evening chronotype among college students[16, 17]. Globally, energy drinks have gained popularity among adolescents and young adults to counteract tiredness and meet academic, physical, and cognitive demands[4, 18–20]. Some adverse effects of caffeine intake include energy loss, headaches, cardiac problems, and even sudden death[19, 21, 22].

Despite the rising trends and aggressive marketing strategies aimed toward college students, there has been little research done on college students' intake of energy drinks and their impact on sleep disorders[4, 23]. In particular, Thailand has one of highest rates of energy drink consumption per capita, but very few studies have focused on sleep-related health problems in Southeast Asian populations[24–28]. Given documented relationships between energy drinks and sleep disorders, we hypothesized that students who use more stimulants were more likely than non-users to experience daytime sleepiness[16, 19, 29]. We also hypothesized that students who use stimulants are more likely than non-users to be evening types[17]. From this study, we expect to provide evidence that will guide the development of health and wellness programs for young adults in Thailand.

Methods and Materials

Study Setting and Sample

This cross-sectional study was conducted between December 2010 and February 2011 at seven private and government colleges in Thailand[30]. Details of the study setting, sampling, and data collection procedures have been described previously[30]. A total of 3,000

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undergraduate students participated in the study and completed a self-administered survey. All study questionnaires were anonymous, and no personal identifiers were collected. Study procedures were approved by the institutional review boards of the Faculty of Medicine Chulalongkorn University, Walailak University, and the University of Washington, USA. The Harvard School of Public Health Office of Human Research Administration, USA, granted approval to use the anonymous data set for analysis.

Data Collection and Covariates

Demographics—In this study, a self-administered questionnaire was used to collect information on demographics and lifestyle characteristics. These include age, sex, education level, smoking status, physical activity, caffeine use, and alcohol consumption. The student's height, weight, waist, and hip circumference were measured by research nurses after the questionnaire was administered.

Use of Stimulant Beverages and Other Caffeinated Drinks—Participants were first asked if they consumed any stimulant or energy drink during the past week. Participants answering "Yes" were further asked to identify the specific types of energy drinks and/or stimulant drinks. These are beverages used to provide an extra boost in energy, promote wakefulness, and provide cognitive and mood enhancement[16]. In this study, we will be using the terms energy drinks and stimulant beverages interchangeably. To provide a range of popular energy drinks in the immediate geographic regions where the survey was administered, we included examples of energy drinks that were common on the campuses and in surrounding social establishments. These included global and local brands such as Red Bull, M100, M150, CarabaoDaeng, Lipovitan-D or Lipo, Wrangyer, and Sharks. For the purpose of this analysis, we combined energy drinks that were less commonly used (i.e., CarabaoDaeng, Lipovitan-D or Lipo, Wrangyer, and Shark) and classified them as "other energy drinks". Consumption of other caffeine-containing beverages included coffee, black tea, and stimulant beverages such as Coke and Pepsi or sugar-free Coke and Pepsi. Each caffeinated beverage was dichotomized (yes vs. no).

Other Covariates—Alcohol consumption was defined as low (<1 alcoholic beverage a week), moderate (1–19 alcoholic beverages a week), and high to excessive consumption (>19 alcoholic beverages a week)[31]. Other covariates considered were: age (years), sex, cigarette smoking history (never, former, current), and participation in moderate or vigorous physical activity (no vs. yes); BMI was calculated as weight (in kilograms) divided by height (in meters) squared. BMI thresholds were set according to previously defined WHO cut points (underweight, <18.5 kg/m^2; normal, 18.5–24.9 kg/m^2; overweight, 25.0– 29.9 kg/m^2; and obese, 30 kg/m^2)[32].

Epworth Sleepiness Scale (ESS)—The Epworth Sleepiness Scale (ESS) was used to evaluate general level of daytime sleepiness[33] and the capability to stay alert and awake during crucial moments of the day[7]. The ESS is a brief instrument that has been widely used globally among different study populations. It has 8 items capturing an individual's propensity to fall asleep during commonly encountered situations, each measured on a scale from 0 to 3. The scores for the eight questions are added together to obtain a single total score that ranges from 0 to 24. In adults, an ESS score ≥10 is taken to indicate increased daytime sleepiness[33]. In this study we used the ESS ≥10 cut point to define daytime sleepiness.

The Horne and Ostberg Morningness-Eveningness Questionnaire (MEQ)— Circadian preference was assessed using the Horne and Ostberg Morningness-Eveningness Questionnaire[14]. Used globally, the MEQ[14] is a 19-item questionnaire that identifies morningness-eveningess preference[13, 15]. Circadian rhythm is an individual's endogenous sleep-wake state during a 24-hour period, while circadian preference refers to a person's inclination to sleep and engage in activities during that same period[13, 14, 34]. The scores range from 16 to 86 and participants can be classified in five categories: definite and moderate evening (E)-type, neutral type, and moderate and definite morning (M)-type. Higher values on MEQ indicate stronger morningness preference. In this study we used the following cut offs: (1) 16 to 41 for evening; (2) 42–58 for intermediate; (3) 59 for morning. In this study, we excluded intermediate types from the analysis.

Statistical Analysis—We first examined the frequency distributions of socio-demographic and behavioral characteristics of the study participants. Characteristics were summarized using means (±standard deviation) for continuous variables and counts and percentages for categorical variables. Mean (±standard deviation) of MEQ and ESS scores were calculated across socio-demographic and behavioral characteristics and the associations were tested using a one-way ANOVA for multi-level characteristics and a two-sample t-test for two-level characteristics. Multivariable linear regression models were also fitted to evaluate the associations. We also calculated the distribution of morningness-eveningness chronotype across demographic and behavioral characteristics and Chi-square tests were used to determine bivariate differences. Additionally, we calculated the distribution of daytime sleepiness and evening chronotype across energy drink consumption status. Multivariable logistic regression models were used to calculate odds ratios (ORs) and 95 % confidence intervals (95 % CIs) for the associations. All analyses were performed using SPSS Statistical Software for Windows (IBM SPSS, version 20, Chicago, IL, USA). All reported p-values are two-sided and deemed statistically significant at a 0.05 level.

Results

Of the 3,000 college students who completed the survey and met participant guidelines, 66.9% of the students were females and the average reported age was 20.3 (±1.3) years (Table 1). About two-thirds of students reported never drinking, while 32.1% admitted drinking 1–19 drinks per month; very few (1.7%) used alcohol excessively. A large majority of students have normal BMI (68.9%), few are overweight (10%), and 16.5% are underweight. Over three-fourths of study participants reported engaging in some type of physical activity.

Table 2 shows the prevalence estimates of chronotype levels according to the Horne and Ostberg criteria. Thirteen percent of students were classified as evening types (12% in females and 15.1% in males), while 18.7% were classified as morning types (19.7% in females and 16.5% in males).

The prevalence of daytime sleepiness across age groups and sex is displayed in Figure 1. Daytime sleepiness (ESS≥10) was present in 27.9% of the students (95% CI: 26.2–29.5%). Overall males in the 18 and the 22-and-over age groups appear to have higher prevalence of daytime sleepiness compared to females; 27.6% of the 18 year-old males experience daytime sleepiness compared to 21.2% of females; 35% of males 22-and-over experience daytime sleepiness compared to 27.4% of females. For the other age groups, the prevalence of daytime sleepiness is higher among females. Looking at the distribution of ESS total score across sex the median ESS total score of females are higher than males.

As shown in Table 3, females (vs. males) and smokers (current and former vs. non-smokers) had a significantly higher MEQ score (p value<0.001). There is also a significant association between MEQ score and alcohol consumption (p value <0.001); we noted a trend lower MEQ scores with higher levels of alcohol consumption. Age, obesity status, and participation in physical activity were not found to be statistically significantly associated with MEQ scores. The multivariable linear regression model with all the demographic and lifestyle characteristics gave similar results, except that sex was no longer found to be significant (Supplementary Table 1).

As shown in Table 4, females (vs. males), alcohol consumers (vs. non-consumers), physically active respondents (vs. non-physically active respondents), and non-obese individuals (vs. obese individuals) had a significantly higher ESS score (p value≤0.037). Age and smoking status was not found to be significantly associated with ESS score. The results from the multivariable linear regression model were not appreciably different from the univariate analyses (Supplementary Table 2).

Table 5 summarizes the logistic regression results. Consumers of any stimulant beverage had 2.68-folds higher odds of being evening chronotypes compared to those who abstained from consuming stimulant beverages (OR 2.68; 95% CI 2.01–3.58), after adjusting for age, sex, smoking, BMI, and physical activity. When considering specific types of beverages, the odds of being evening chronotype were between 1.95- and 3.5-fold higher among users compared to non-users. Compared to those who consumed less than one stimulant beverages per week, those who consumed two per week have 2.65-folds higher odds of being evening chronotypes (OR 2.65; 95% CI 1.81–3.90) while those who consumed three or more have 3.65-folds higher odds of being evening chronotypes (OR 3.65; 95% CI 2.58–5.16). However, consuming one stimulant per week was not statistically significantly associated with the odds of being evening chronotypes (OR 1.21; 95% CI .73–2.00). Consumers of stimulant beverages had a 22% higher odds of experiencing daytime sleepiness compared to non-consumers (OR 1.22; 95% CI 1.03–1.44), after adjusting for demographic and lifestyle characteristics. When considering specific types of beverages, the odds of experiencing daytime sleepiness were between 1.07- and 1.72- fold higher among users compared to non-users; exceptions included coffee drinkers or consumers of other types of energy drinks, for whom no statistically significant association were found. Those who consumed three or more stimulants per week had a 37% higher odds of experiencing daytime sleepiness compared to those who do not use stimulants (OR 1.37; 95% CI 1.13–1.67).

Discussion

Approximately 28% (95%CI: 26.2–29.5%) experienced daytime sleepiness while 13% (95% CI 11.8–14.2) of our student cohort reported to be evening types. Overall, students with daytime sleepiness were more likely to be cigarette smokers, alcohol drinkers, obese, physically active, and stimulant beverage consumers. The odds of being evening types were elevated among cigarette smokers, alcohol consumers, and caffeinated stimulant users. To the best of our knowledge, this is the first study to examine the prevalence of daytime sleepiness and evening chronotype in relation to caffeine use in a Southeast Asian population.

Our results are in accordance with previous reports indicating prevalence of daytime sleepiness and eveningness chronotype, and extend this literature to assess their associations with consumption of stimulant beverages in Thai young adults[5, 12, 13, 35–39]. For instance, our result showing that 13% of Thai college students were evening types is consistent with reports from Chung and Cheung (2008) who reported a 13.1% prevalence of evening chronotype among Chinese students. Additionally, our findings showing a 27.9% daytime sleepiness are similar to those of Wu et al. (2012) who reported that 22.2% prevalence of daytime sleepiness. Other investigators, however, have reported higher prevalence estimates[40]. On balance, the results of our study and those of others emphasize the growing problem of sleep disorders among college students.

In our study of Thai college students, consuming any stimulant beverage was strongly associated with evening chronotype and daytime sleepiness. Prior studies have found similar results in other university settings[19, 29, 41–43]. College marks the beginning of new and stressful changes: increased academic workload, busier social lives, and later bed times[4, 5]. Several investigators determined that academic stress interferes with sleeping schedule, as students may stay up late into the night to study[5, 36]. Given the high prevalence of poor sleep quality, short sleep duration, and high rates of energy drink consumption among Thai college students[28, 44], it may be fitting to note that these undergraduates may sacrifice sleep for academic purposes and social commitments and drink caffeinated stimulants to remain alert[4, 16, 19]. As they stay up later to finish their work, they can become sleep deprived due to the morning-oriented schedules of college and thus experience daytime sleepiness[6, 45].

Several investigators have noted that evening types and daytime sleepers are more likely to have poor health[7–9, 11, 13, 45–47]. Our findings suggest that caffeine consumers were more likely to experience daytime sleepiness and be evening types. As a result, caffeine could possibly be linked to other poor health behaviors. Future research must evaluate the extent to which caffeinated beverages and energy drinks are associated with poor health traits.

The results from our study should be interpreted in the context of some limitations. First, our study could be subjected to volunteer bias, because the data were collected from willing participants instead of a random sample. Second, the temporal relationship between lifestyle characteristics and sleep disorders cannot be delineated due to the cross-sectional study design. To determine such relationship, a longitudinal study should be employed. Third, there may be lifestyle and dietary traits that are heterogeneous within daytime sleepers and evening types, which could affect the strength of the associations between sleep disorders and lifestyle traits. Lastly, we did not have information concerning frequency, timing, and dose of energy drink consumption in the present study. As a result, it is possible that the binary grouping of energy drink consumption may have attenuated the magnitude of the association toward the null.

The association between caffeinated drinks and circadian disruption and daytime sleepiness can be explained by the biological mechanism of melatonin suppression and adenosine blockage. During waking hours, light is known to suppress melatonin production[34, 48]. Given the demanding college workload and social commitments, students may stay up later into the night to study, which requires the use of lighting and encourages the consumption of caffeinated beverages to increase alertness. This increased light exposure leads to melatonin suppression, in which light exposure at night shifts one's chronotype towards eveningness[34, 49]. Another mechanism that can explain sleep disruption is caffeine's role in adenosine blockage. Within the basal forebrain, adenosine, an endogenous biochemical compound, regulates sleep by inhibiting the cholinergic neurons that create arousal[19, 50, 51]. As caffeine acts as an adenosine blocker, it negates the effects of adenosine to induce sleep[19]. Consequently, consuming caffeine at night prolongs wakefulness and decreases sleep duration, resulting in daytime sleepiness[6, 19, 29].

In summary, our findings underline the growing problem of energy drinks and their impact on both circadian preference and daytime sleepiness among Thai college students. Despite academics being the frequent reason given for energy drink consumption, evening types or daytime sleepers do not exhibit higher academic performance compared to their counterparts[12, 29, 36, 41, 42]. Additionally, there is a large body of evidence that shows daytime sleepers and evening types are strongly associated with numerous health and social problems[7–9, 11, 13, 46]. From a public health promotion and disease prevention standpoint, these findings suggest an obvious need for effective educational and prevention programs targeted toward improving sleep hygiene and reducing consumption of energy drinks among young adults. Future research that evaluates the impact of caffeinated beverages on various sleep disorders; and those that assess the effectiveness of health and wellness programs among young adults are needed.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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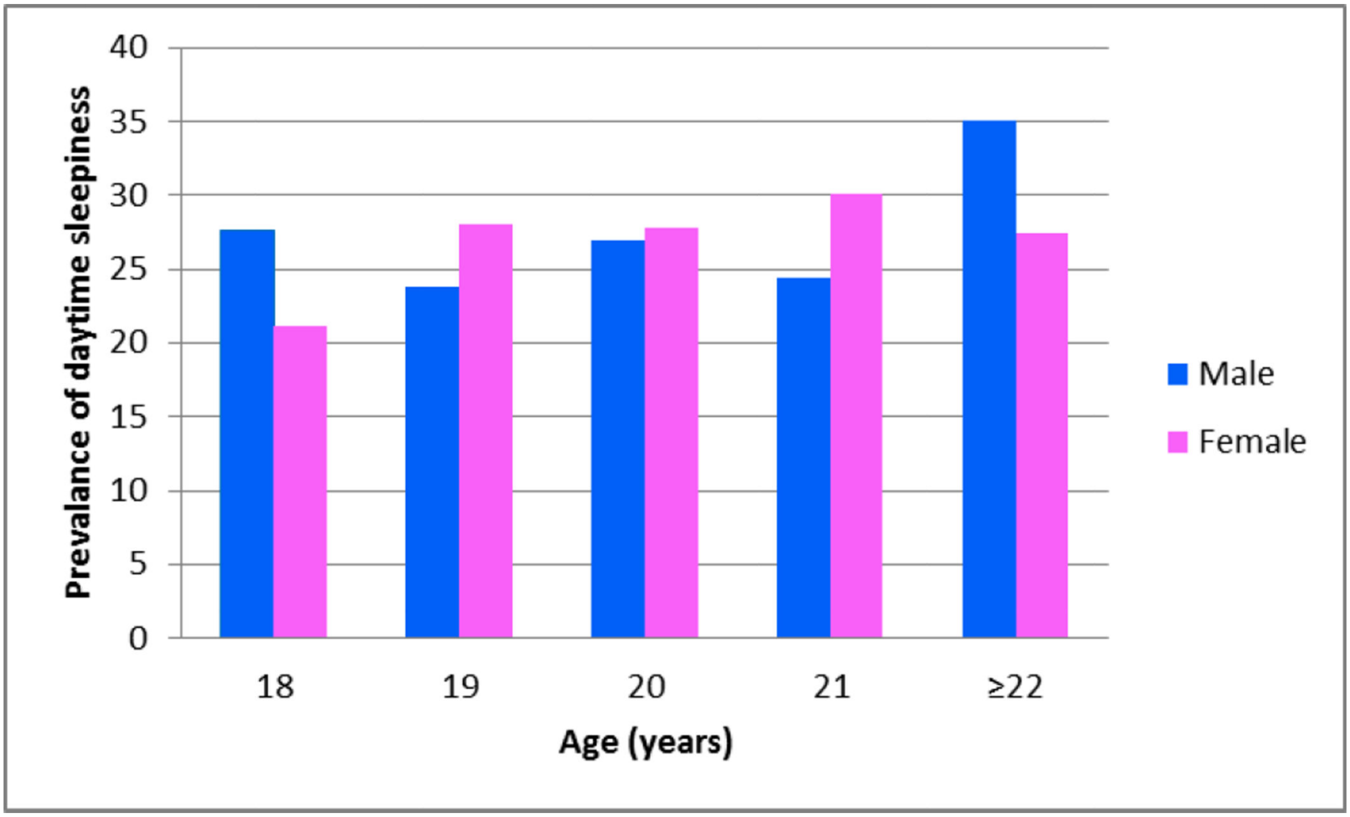

Figure 1.
Prevalence of Daytime Sleepiness by Age and Sex

Table 1

Characteristics of Study Sample

	N=3,000	
Characteristic	**n**	**%**
Age (Mean± SD)	20.3±1.3	
Age (years)		
18	162	5.4
19	705	23.5
20	860	28.6
21	728	24.3
≥ 22	545	18.2
Sex		
Female	2,008	66.9
Male	992	33.1
Cigarette smoking status		
Never	2,739	91.3
Former	55	1.8
Current	206	6.9
Alcohol consumption		
<1 drink/month	1,986	66.2
1–19 drinks/month	962	32.1
≥ 20 drinks/month	52	1.7
Body mass index (kg/m^2)		
Underweight (<18.5)	495	16.5
Normal (18.5–24.9)	2,068	68.9
Overweight (25.0–29.9)	298	10.0
Obese (≥30.0)	139	4.6
Any physical activity		
No	669	22.4
Yes	2,319	77.6

Table 2

Prevalence Estimates of Morningness /Eveningness Chronotype

	MEQ Score cut-off	All % (95% CI)	Female	Male
Evening type (n=378)	≤41	13.0 (11.7–14.2)	12.0 (10.5–13.4)	15.1 (12.8–17.3)
Intermediate (n=1,984)	42–58	68.2 (66.6–69.9)	68.2 (66.1–70.3)	68.4 (65.4–71.3)
Morning type (n=544)	≥59	18.7 (17.3–20.1)	19.7 (18.0–21.5)	16.5 (14.1–18.9)

Table 3

Morningness /Eveningness Questionnaire (MEQ) Scores by Demographic and Lifestyle Characteristics

	MEQ Score		
	Mean	**SD**	**p-value**
Age (years)			
18	50.70	8.28	0.241
19	51.66	8.02	.
20	50.87	8.09	
21	50.75	8.06	
≥ 22	50.97	8.44	
Sex			
Female	51.45	8.07	<.001
Male	50.19	8.23	
Cigarette smoking status			
Never	51.40	8.00	<.001
Former	47.56	8.97	
Current	47.02	8.56	
Alcohol consumption			
<1 drink/month	52.14	8.07	<.001
1–19 drinks/month	49.04	7.75	
≥ 20 drinks/month	45.31	8.76	
Obesity (≥30.0kg/m^2)			
No	51.07	8.15	0.334
Yes	50.38	7.99	
Any physical activity			
No	51.20	8.23	0.614
Yes	51.01	8.11	

Table 4

Epworth Sleepiness Scale (ESS) Scores by Demographic and Lifestyle Characteristics

	EES Score		
	Mean	**SD**	**p-value**
Age (years)			
18	7.44	2.84	0.635
19	7.56	3.35	
20	7.54	3.33	
21	7.57	3.47	
≥ 22	7.79	3.52	
Sex			
Female	7.68	3.32	0.037
Male	7.40	3.50	
Cigarette smoking status			
Never	7.54	3.36	0.059
Former	8.11	3.53	
Current	8.05	3.56	
Alcohol consumption			
<1 drink/month	7.46	3.39	0.009
1–19 drinks/month	7.84	3.32	
≥ 20 drinks/month	8.12	3.65	
Obesity (≥30.0 kg/m^2)			
No	7.62	3.39	0.016
Yes	6.96	3.09	
Any physical activity			
No	7.18	3.45	0.001
Yes	7.70	3.34	

Table 5

Evening Chronotype and Daytime Sleepiness in Relation to Stimulant Use

	Evening Chronotype				Daytime Sleepiness			
	Yes (N=378)	**No (N=544)**	**Unadjusted OR (95% CI)**	**Adjusted* OR (95% CI)**	**Yes (N=831)**	**No (N=2,152)**	**Unadjusted OR (95% I)**	**Adjusted* OR (95% CI)**
Any stimulant beverages	%	%			%	%		
No	29.6	54.6	1.00 (Reference)	1.00 (Reference)	38.6	43.7	1.00 (Reference)	1.00 (Reference)
Yes	70.4	45.4	2.86 (2.16–3.77)	2.68 (2.01,3.58)	61.4	56.3	1.24 (1.05–1.45)	1.22 (1.03–1.44)
Type of beverage								
Coffee	32.5	19.1	2.04 (1.51–2.76)	1.95 (1.42–2.67)	26.2	25.0	1.07 (0.89–1.28)	1.07 (0.89–1.29)
Tea	57.4	37.1	2.28 (1.75–2.98)	2.31 (1.75–3.05)	51.3	46.1	1.23 (1.05–1.45)	1.21 (1.03–1.43)
Coke/Pepsi with sugar	57.1	31.4	2.91 (2.22–3.82)	2.70 (2.03–3.58)	49.2	43.1	1.28 (1.09–1.50)	1.26 (1.07–1.48)
Coke/Pepsi sugar free	19.8	8.3	2.75 (1.847–4.08)	2.66 (1.77–4.00)	14.7	11.1	1.38 (1.09–1.74)	1.39 (1.10–1.76)
M 100/M 150	11.6	2.9	4.35 (2.41–7.83)	3.50 (1.90–6.44)	7.9	5.3	1.56 (1.14–2.13)	1.52 (1.10–2.11)
Red Bull	4.8	1.7	2.97 (1.32–6.69)	2.39 (1.02–5.58)	3.9	2.2	1.76 (1.11–2.77)	1.72 (1.08–2.75)
*Other Energy Drinks**	3.4	0.9	3.84 (1.36–10.86)	2.90 (0.98–8.62)	2.8	1.6	1.72 (1.01–2.93)	1.67 (0.97–2.88)
Number of different types of stimulants/week								
0	29.6	54.6	1.00 (Reference)	1.00 (Reference)	38.6	43.7	1.00 (Reference)	1.00 (Reference)
1	8.5	11.0	1.41 (0.87–2.29)	1.21 (0.73–2.00)	8.8	9.5	1.04 (0.78–1.40)	1.03 (0.76–1.39)
2	22.2	15.3	2.68 (1.85–3.90)	2.65 (1.81–3.90)	18.5	18.8	1.12 (0.89–1.40)	1.10 (0.87–1.38)
≥3	39.7	19.1	3.83 (2.75–5.327)	3.65 (2.58–5.16)	34.1	27.9	1.38 (1.14–1.67)	1.37 (1.13–1.67)

*Adjusted for age, sex, smoking, body mass index, and physical activity