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# Eveningness Chronotype, Daytime Sleepiness, Caffeine Consumption, and Use of Other Stimulants Among Peruvian University Students

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***Objectives:*** The aims of this study were to evaluate patterns of circadian preferences and daytime sleepiness, and to examine the extent to which the consumption of stimulant beverages is associated with daytime sleepiness and evening chronotype among Peruvian college-age students.
***Methods:*** A total of 2,581 undergraduate students completed a self-administered comprehensive questionnaire that gathered information about sleep habits, sociodemographic and lifestyle characteristics, and the use of caffeinated beverages. The Morningness–Eveningness Questionnaire (MEQ) and Epworth Sleepiness Scale (ESS) were used to assess chronotype and daytime sleepiness. We used multivariable linear and logistic regression procedures to estimate odds ratios (OR) and 95% confidence intervals (95% CI) for the associations of sleep disorders with sociodemographic and behavioral factors.
***Results:*** The prevalence of daytime sleepiness was 35% [95% CI 32.7–36.4] and eveningness chronotype was 10% [95% CI 8.8–11.1%]. Age, sex, cigarette smoking, and alcohol consumption were significantly associated with an evening chronotype. After adjusting for age, sex, smoking, body mass index, and physical activity, students who reported consumption of any stimulant beverages had 1.25 increased odds of excessive daytime sleepiness (OR = 1.25 [95% CI 1.03–1.53]) compared with students who did not consume stimulant beverages. Consumption of any stimulant beverages was not statistically significantly associated with being an evening chronotype (OR = 1.30 [95% CI 0.86–1.96]).
***Conclusions:*** Excessive daytime sleepiness and eveningness chronotype are common among Peruvian college students. MEQ scores were associated with age, sex, smoking, and alcohol consumption. Regular stimulant beverage consumption tended to be positively associated with excessive daytime sleepiness.

## Introduction

Insufficient sleep—sleep of shorter duration than the average 7–8 hours per night—negatively impacts many areas of life, including cognition, performance, safety, and health.[1–3] In a recent multi-country sleep study, high levels of poor sleep quality were reported among Peruvian, Thai, Ethiopian, and Chilean university students.[4–7] Each of the populations studied showed associations between poor sleep and the consumption of stimulant beverages.[4–7] Taylor and Bramoweth[8] found that 60% of university-age students reported consuming stimulant beverages (e.g., sodas and coffee) to combat daytime sleepiness.[8] Approximately 96% of Peruvian medical students reported regular consumption of caffeinated drinks,[9] and 34% of them reported using energy drinks.[10] Furthermore, studies have shown that among Peruvian medical students, 58–74% have reported poor sleep quality and 26–34% have reported excessive daytime sleepiness, with several students also reporting consuming caffeine and tobacco and using sleep aids.[11,12] Roehrs and Roth[13] suggested a bidirectional relationship of caffeine and daytime sleepiness. Namely, the authors noted that poor sleep quality can lead to caffeine consumption to combat sleepiness, which can in turn negatively impact sleep quality and increase sleepiness.[13] Lund *et al*.[14] noted that individuals in a ''stimulant–sedation loop'' may be at higher risk for developing a drug dependency.

An emerging body of evidence has shown the impact of caffeinated drinks in disrupting an individual's preferred sleep timing or chronotype.[15] Sleep timing depends on both the length of prior wakefulness (homeostasis) and

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on the control of the circadian clock. Circadian clocks synchronize with their environment predominantly with the light–dark cycle of day and night.[16] Three chronotypes have been identified—morningness, intermediate, and eveningness—and are based on peak times of day according to one's circadian rhythm.[17] Individuals classified with an evening chronotype have significantly later peak times than those with a morning chronotype.[17] Taillard *et al.*[18] noted that evening chronotypes: need more sleep, spend less time in bed during the week, spend more time in bed during the weekend, have generally more irregular sleep habits, and consume more caffeinated drinks.[18] Nova *et al.*[19] found that caffeinated drinks do not appear to affect wake after sleep onset in those with an evening chronotype. Evening chronotypes are associated with increased risk of behavioral problems, lower self-esteem, hyperactivity, and psychiatric disorders.[20,21] Those with an evening chronotype are also more likely to have respiratory syndromes, bronchial asthma, and a higher body mass index (BMI).[20,22] For university-age students, an evening chronotype has been positively associated with cognitive ability, and negatively associated with indicators of academic achievement.[23] Eveningness preference compared with morningness has been associated with the consumption of alcoholic drinks, stimulants, and cigarettes.[21,24,25]

University students who use energy drinks and other caffeinated beverages have been associated with more sleep disturbances than those who do not use them.[5,6,21] Although caffeine is the primary ingredient in energy drinks, some popular brands are more caffeinated; Red Bull, for instance, contains 80 mg of caffeine per serving.[26] Energy drinks also contain additional ingredients that may have a stimulating effect. Commonly stated reasons for using stimulants included improving work performance and concentration, even though stimulant usage has been associated with lower grade-point averages.[26,27] Given the increased consumption of energy drinks among college students and the limited studies[6] that evaluate their possible adverse impact on sleep disorders among young Peruvian adults, we conducted this study to evaluate patterns of circadian rhythm characteristics and daytime sleepiness and to examine the extent to which the consumption of caffeinated beverages is associated with the evening chronotype and daytime sleepiness among Peruvian college-age students.

## Methods and Materials

### Study population

The data used in this study were collected from undergraduate students at the Universidad Nacional Mayor de San Marcos and the Universidad San Martin de Porres in Lima, Peru, from November 2010 through May 2011 as part of a larger, multi-country sleep study. A more detailed description of the study's procedures including data collection, setting, and the study design has been provided previously.[6] Individuals with missing information on sleep characteristics and energy drinks were excluded from the analyses. The final study sample used in the analyses included 2,581 students (1,579 female and 1,002 male). The procedures used in this study were approved by the institutional review boards of Dos de Mayo Hospital and Universidad Nacional Mayor de San Marcos in Lima, Peru, and the University of Washington, Seattle, WA. The Harvard School of Public Health Office of Human Research Administration granted approval to use the de-identified data set for analysis.

### Data collection

Anonymous, self-administered surveys were given to participants to complete without time limits. Questions included demographic information and behavioral risk factors (e.g., cigarette smoking status, alcohol consumption, energy drink consumption, coffee consumption). After survey completion, trained research staff took measurements of participants' waist, height, hip, and weight measurements in order to compute BMI values and other anthropometric measurements.

### Variable specification

Stimulant beverage consumption was defined as the usage of one or more caffeinated beverages (e.g., Coca-Cola, Pepsi, coffee) or energy drinks (e.g., Red Bull, Evolution, Turbo, Maretazo, Shark, Burn) per week during the past month. Participants were asked about their levels of alcohol consumption (<1 drink/month, 1–19 drinks/month, ≥20 drinks/month)[28] and cigarette smoking status (never, former, current). Participants were surveyed regarding their level of physical activity. BMI was calculated as weight (kg) divided by height in meters squared ($m^2$). Participants' BMI values were categorized according to guidelines set by the World Health Organization (WHO; underweight <18.5 kg/$m^2$;

Table 1. Characteristics of Study Sample ($N$=2,581)

| *Characteristic* | n | % |
|---|---|---|
| Age, mean (±SD) | 21.1 (±2.7) | |
| Age (years)* | | |
| 18 | 498 | 19.3 |
| 19 | 403 | 15.6 |
| 20 | 339 | 13.1 |
| 21 | 410 | 15.9 |
| ≥22 | 930 | 36.0 |
| Sex | | |
| Male | 1,002 | 38.8 |
| Female | 1,579 | 61.2 |
| Cigarette smoking status | | |
| Never | 1,929 | 74.8 |
| Former | 220 | 8.5 |
| Current | 432 | 16.7 |
| Alcohol consumption | | |
| <1 drink/month | 522 | 20.2 |
| 1–19 drinks/month | 1,013 | 39.3 |
| ≥20 drinks/month | 1,046 | 40.5 |
| BMI (kg/$m^2$)* | | |
| Underweight (<18.5) | 84 | 4.3 |
| Normal (18.5–24.9) | 1,299 | 66.8 |
| Overweight (25.0–29.9) | 481 | 24.7 |
| Obese (≥30.0) | 82 | 4.2 |
| Any physical activity* | | |
| No | 907 | 35.6 |
| Yes | 1,644 | 64.4 |

*Numbers/percentages may not add up to the total number due to missing data.

BMI, body mass index.

Table 2. Prevalence Estimates of Morningness/Eveningness

| | *MEQ score cutoff* | *All % [95% CI]* | *Female % [95% CI]* | *Male % [95% CI]* |
|---|---|---|---|---|
| Evening type (*n* = 256) | ≤ 41 | 9.9 [8.8–11.1] | 9.5 [8.1–11.0] | 10.6 [8.7–12.6] |
| Intermediate (*n* = 1,925) | 42–58 | 75.0 [73.4–76.7] | 73.8 [71.7–76.0] | 76.9 [74.3–79.5] |
| Morning type (*n* = 384) | ≥ 59 | 14.9 [13.6–16.3] | 16.5 [14.7–18.4] | 12.4 [10.4–14.5] |

MEQ, Morningness–Eveningness Questionnaire.

normal 18.5–24.9 $kg/m^2$; overweight 25.0–29.9 $kg/m^2$; and obese ≥ 30 $kg/m^2$).[28]

### Epworth Sleepiness Scale

The Epworth Sleepiness Scale (ESS) is an 8-item questionnaire that measures a person's general level of daytime sleepiness.[29] Questions relate a respondent's likelihood to fall asleep during common situations.[29] Scores range from 0 to 24, with an ESS score ≥ 10 indicative of increased daytime sleepiness for adults.[29] The ESS has been widely used globally in several countries across Latin America, including Peru.[30,31]

### Morningness–Eveningness Questionnaire

The Morningness–Eveningness Questionnaire (MEQ) is a 19-item questionnaire classifying morning, intermediate, and evening chronotype preference.[17] Scores range from 16 to 86, and place participants into one of five categories: definite evening, moderate evening, intermediate (neutral), moderate morning, and definite morning chronotype. Higher scores are indicative of a stronger morning chronotype preference.[17] We used the following classification for the chronotypes in this study: 16–41 for evening, 42–58 for intermediate, and ≥ 59 for morning types. In this study, we excluded intermediate types from the analysis.

### Statistical analyses

We computed frequency distributions of the categorical characteristics in the study. Prevalence estimates and associated 95% confidence intervals (CIs) of the evening chronotype and daytime sleepiness are also provided. Chi-square tests and variance tests were used to investigate bivariate (unadjusted) associations. Logistic regression analysis was used to investigate adjusted associations between consumption of stimulant beverages and sleep disorders. These associations are summarized using odds ratios (ORs) and their corresponding 95% CIs. Statistical analyses were performed using IBM SPSS Statistics for Windows v19 (IBM Corp., Armonk, NY). All *p*-values and associated test statistics reported are for two-sided hypothesis tests.

## Results

Table 1 summarizes the characteristics of the 2,581 study participants included in the analysis. The overall mean age was 21.1 years (*SD* = 2.7). Approximately 61% of participants were female, 17% were current smokers, and 41% of the sampled participants reported consuming 20 or more alcoholic drinks per month. Nearly 25% of participants were classified as being overweight, and 4.2% were classified as obese. The majority of students (64%) participated in some sort of physical activity.

Table 2 reports the estimates of morning, intermediate, and evening chronotype preferences. The intermediate chronotype was the most common chronotype overall (75.0% [95% CI 73.4–76.7]). Approximately 10% [95% CI 8.8–11.2] of students were found to be evening chronotypes, while 14.9% [95% CI 13.6–16.4] were morning chronotypes.

Table 3 summarizes bivariate associations of demographic and life-style characteristics of the study cohort and the morning and evening chronotype status. Age, sex, cigarette smoking status and alcohol consumption were significantly associated with chronotype. Neither BMI nor physical activity was significantly associated with evening chronotype status.

Table 3. Characteristics of Study Sample by Morningness/Eveningness

| *Characteristic* | *Morning type* (n = *384*) n *(%)** | *Evening type* (n = *256*) n *(%)** | p-*Value* |
|---|---|---|---|
| Age, mean (± SD) | 21.5 (± 2.9) | 20.5 (± 2.2) | < 0.001 |
| Age (years) | | | |
| 18 (*n* = 498) | 57 (53.3) | 50 (46.7) | 0.005 |
| 19 (*n* = 403) | 56 (47.9) | 61 (52.1) | |
| 20 (*n* = 339) | 50 (61.0) | 32 (39.0) | |
| 21 (*n* = 410) | 49 (70.0) | 21 (30.0) | |
| ≥ 22 (*n* = 930) | 172 (65.2) | 92 (34.8) | |
| Sex | | | |
| Female (*n* = 1,002) | 260 (63.4) | 150 (36.6) | 0.019 |
| Male (*n* = 1,579) | 124 (53.9) | 106 (46.1) | |
| Cigarette smoking status | | | |
| Never (*n* = 1,929) | 311 (63.5) | 179 (36.5) | 0.003 |
| Former (*n* = 220) | 23 (54.8) | 19 (45.2) | |
| Current (*n* = 432) | 50 (46.3) | 58 (53.7) | |
| Alcohol consumption | | | |
| < 1 drink/month (*n* = 522) | 80 (62.9) | 47 (37.0) | < 0.001 |
| 1–19 drinks/month (*n* = 1,013) | 96 (42.7) | 129 (57.3) | |
| ≥ 20 drinks/month (*n* = 1,046) | 208 (72.2) | 80 (27.7) | |
| BMI ($kg/m^2$) | | | |
| Underweight (<18.5) (*n* = 84) | 15 (71.4) | 6 (28.6) | 0.122 |
| Normal (18.5–24.9) (*n* = 1,299) | 216 (66.9) | 107 (33.1) | |
| Overweight (25.0–29.9) (*n* = 481) | 88 (74.6) | 30 (25.4) | |
| Obese (≥30.0) (*n* = 482) | 7 (46.7) | 8 (53.3) | |
| Any physical activity | | | |
| No (*n* = 907) | 111 (57.5) | 82 (42.5) | 0.422 |
| Yes (*n* = 1,644) | 268 (60.9) | 172 (39.1) | |

*Percentages displayed are row percent.

Table 4. Eveningness in Relation to Consumption of Energy Drinks, Caffeinated Beverages, and Stimulants

| *Exposure* | *Morning type (n=384) %* | *Evening type (n=256) %* | *Unadjusted OR [95% CI]* | *Adjusted OR** [95% CI]* |
|---|---|---|---|---|
| Any stimulant beverages | | | | |
| No | 46.6 | 33.6 | 1.00 (Reference) | 1.00 (Reference) |
| Yes | 53.4 | 66.4 | 1.73 [1.24–2.40] | 1.30 [0.86–1.96] |
| Type of beverage: | | | | |
| Red Bull | *9.9* | *21.1* | *2.43 [1.55–3.82]* | *1.62 [0.91–2.88]* |
| Evolution Drink | *4.2* | *3.1* | *0.74 [0.31–1.76]* | *0.42 [0.12–1.51]* |
| Turbo | *3.1* | *3.5* | *1.13 [0.47–2.72]* | *0.45 [0.12–1.67]* |
| Maretazo | *3.1* | *3.5* | *1.13 [0.47–2.72]* | *0.58 [0.18–1.90]* |
| Shark | *3.4* | *4.3* | *1.28 [0.57–2.91]* | *0.86 [0.31–2.41]* |
| Burn | *6.0* | *7.0* | *1.09 [0.58–2.03]* | *0.72 [0.31–1.68]* |
| Other energy drinks* | *0.8* | *2.0* | *2.53 [0.60–10.68]* | *ND* |
| Coffee | | | | |
| No | 74.5 | 71.9 | 1.00 (Reference) | 1.00 (Reference) |
| Yes | 25.5 | 28.1 | 1.14 [0.80–1.63] | 0.99 [0.63–1.57] |
| Coke/Pepsi | | | | |
| No | 79.4 | 67.6 | 1.00 (Reference) | 1.00 (Reference) |
| Yes | 20.6 | 32.4 | 1.85 [1.29–2.66] | 1.45 [0.91–2.30] |

*Includes Liftoff and Vortes.
**Adjusted for age, sex, smoking, body mass index, and physical activity.
ND, not determined.

In Table 4, we examined the adjusted associations between evening chronotype and the consumption of stimulant beverages. After adjusting for age, sex, smoking, BMI, and physical activity, consumption of any stimulant beverages was not statistically significantly associated with being an evening chronotype (OR = 1.30 [95% CI 0.86–1.96]). Consumption of specific types of stimulants was not statistically significantly associated with being an evening chronotpe.

As shown in Table 5, students who reported consuming any type of stimulant beverage had 1.37-fold higher odds of daytime sleepiness [95% CI 1.16–1.63]. In multivariable adjusted models, the odds ratio was slightly attenuated toward the null but remained statistically significant (OR = 1.25 [95% CI 1.03–1.53]). Individuals who consumed coffee had 1.27-fold higher odds of having daytime sleepiness compared to those who did not (OR = 1.27 [95% CI 1.06–1.53]). After adjusting for age, sex, smoking, BMI, and physical activity, coffee consumption was marginally associated with daytime sleepiness (OR = 1.20 [95% CI 0.96–1.50]). Consumption of Burn and other energy drinks were not statistically significantly associated with daytime sleepiness,

Table 5. Daytime Sleepiness in Relation to Consumption of Energy Drinks, Caffeinated Beverages, and Stimulants

| | *Daytime sleepiness* | | | |
|---|---|---|---|---|
| *Exposure* | *Yes (n=866) %* | *No (n=1,639) %* | *Unadjusted OR [95% CI]* | *Adjusted OR** [95% CI]* |
| Any stimulant beverages | | | | |
| No | 34.4 | 41.9 | 1.00 (Reference) | 1.00 (Reference) |
| Yes | 65.6 | 58.1 | 1.37 [1.16–1.63] | 1.25 [1.03–1.53] |
| Type of beverage: | | | | |
| Red Bull | *14.2* | *13.1* | *1.10 [0.87–1.40]* | *0.85 [0.62–1.15]* |
| Evolution Drink | *3.2* | *2.9* | *1.11 [0.69–1.78]* | *1.14 [0.64–2.02]* |
| Turbo | *3.0* | *3.2* | *0.95 [0.59–1.52]* | *0.93 [0.51–1.68]* |
| Maretazo | *3.0* | *2.7* | *1.12 [0.69–1.84]* | *1.28 [0.69–2.38]* |
| Shark | *2.8* | *2.8* | *0.99 [0.60–1.63]* | *1.07 [0.56–2.04]* |
| Burn | *6.7* | *7.8* | *0.85 [0.61–1.17]* | *0.65 [0.42–0.98]* |
| Other energy drinks* | *1.4* | *0.7* | *1.91 [0.85–4.26]* | *7.18 [1.99–25.93]* |
| Coffee | | | | |
| No | 70.2 | 75.0 | 1.00 (Reference) | 1.00 (Reference) |
| Yes | 29.8 | 25.0 | 1.27 [1.06–1.53] | 1.20 [0.96–1.50] |
| Coke/Pepsi | | | | |
| No | 75.6 | 76.4 | 1.00 (Reference) | 1.00 (Reference) |
| Yes | 24.4 | 23.6 | 1.05 [0.86–1.27] | 0.91 [0.72–1.15] |

*Includes Liftoff and Vortes. **Adjusted for age, sex, smoking, BMI, and physical activity.

even after adjusting for the aforementioned confounders. Those who consumed other type energy drinks (i.e., Liftoff and Vortes) had 7.18-fold higher odds of daytime sleepiness [95% CI 1.99–25.93].

## Discussion

In this large survey of Peruvian college students, we found 10% of the surveyed students were classified as being evening chronotypes, while 35% of them exhibited daytime sleepiness. After adjusting for age, sex, smoking, BMI, and physical activity, students who reported consumption of any stimulant beverages had 1.25 increased odds of excessive daytime sleepiness (OR = 1.25 [95% CI 1.03–1.53]) compared with students who did not consume stimulant beverages. Consumption of any stimulant beverages was not statistically significantly associated with being an evening chronotype (OR = 1.30 [95% CI 0.86–1.96]).

We found no clear evidence of association between consumption of stimulant beverages and being an evening chronotype, while consumption of stimulant beverages was associated with higher odds of daytime sleepiness after controlling for potential confounding factors. These findings are in general agreement with prior studies.[8,13,18] Caffeine has been found to lengthen sleep latency and alter sleep patterns, increasing stage 1 sleep and reducing stage 2 and slow-wave sleep.[32,33] This could be part of the reason why we found such a significant association between daytime sleepiness and caffeine consumption, and could also provide insight into directionality: if caffeine can increase tiredness by altering sleep, perhaps participants in our study began consuming stimulant beverages due to sleepiness, then felt compelled to continue consuming caffeine due to their altered sleep rhythms stemming from consumption of the drug. Other researchers have found support for this type of bidirectional relationship.[13] Furthermore, cessation of regular caffeine use has been associated with withdrawal syndrome, even from doses as low as 100 mg/day.[34,35]

The prevalence of other drugs that could affect sleep in Peruvian university students is notable: alcohol at 88%; tobacco at 70.8%; marijuana at 18.4%; tranquilizers at 12.2%; cocaine hydrochloride at 5.7%; and cocaine paste at 2.2%.[10] University students in other regions of the world have reported using alcohol to induce sleep.[8,14] Furthermore, smokers have reported significant problems in falling and remaining asleep, and also with feeling tired during the day.[36,37] Smokers have additionally reported a number of sleep problems similar to those found in patients with insomnia, which can affect daytime mood.[38] Approximately 39% and 41% of students reported using moderate and excessive alcohol consumption respectively. The combined usage of alcohol and caffeine can pose many problems, including stronger impairment while intoxicated, not feeling the effects of alcohol when using caffeine, participating in more risky behaviors, and consuming excessive alcohol compared to those not consuming energy drinks.[39–42] In our study, there was evidence that students who reported moderate alcohol consumption were more likely to be evening types. Overall, our findings showing increased odds of daytime sleepiness and evening chronotype with alcohol consumption and smoking reinforce epidemiological evidence linking sleep disturbances with unhealthy lifestyle characteristics.

Our findings should be interpreted in the context of the study's design and limitations. First, due to the cross-sectional study design, we cannot determine whether daytime sleepiness and evening chronotype drive energy consumption, the converse, or whether the relationship is mutual. Prospective studies with serial measurements of energy consumption and sleep disorders should be conducted to confirm and expand upon our observations, and to examine the effects of energy drinks over time more effectively. Second, our results may be subject to volunteer bias. Third, we did not have information concerning the frequency and dose of the consumption of caffeinated beverages in the present study. As a result, it is possible that the binary grouping of caffeinated beverage consumption attenuated the magnitude of association toward null. Lastly, our study was based on a self-administered survey. It is possible that subjective measures of sleep quality and other covariates may have introduced some degree of error in reporting behavioral covariates. These concerns are in part mitigated by our use of an anonymous questionnaire and validated instruments.

## Conclusion

Excessive daytime sleepiness and an evening chronotype are common among Peruvian college students, and the consumption of stimulant beverages is associated with daytime sleepiness. Chronotype is also significantly associated with age, sex, cigarette smoking status, and alcohol consumption, but not BMI or physical activity. Our research expands upon previous work on the topic of stimulant consumption and sleep, and provides support for patterns that have been documented internationally. Information about caffeine's potential adverse effects and recommendations for limiting its usage should be distributed to groups in which there is often a high amount of caffeine consumption, such as university students. Given high rates of stimulant use and other substances among Peruvian college students, and given the collective evidence of their adverse effects on sleep disorders, school administrators, parents, students, and school counselors should develop and implement multipronged wellness programs and policies that promote the avoidance of excessive use of caffeine, nicotine, and other stimulants and improvements in sleep hygiene.

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