

# BPB Reports

## Regular Article

### Characteristics of Japanese Medical and Healthcare University Students with Habitual Consumption of Energy Drinks: Relationship with Perceived Stress

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**This cross-sectional study examined the sociodemographic characteristics associated with energy drink consumption at a medical and welfare university in Japan. Data were collected and analyzed from 1249 students (first to fourth year) belonging to a single university. We examined 19 sociodemographic variables through a questionnaire. Furthermore, we identified sociodemographic characteristics associated with the consumption of energy drinks using multivariate logistic regression analysis. We characterized students who consumed energy drinks using principal component analysis and hierarchical cluster analysis. Significance was established at  $P < 0.05$ . The findings of our study revealed that perceived stress ( $P = 0.01$ ) and experiencing strong sleepiness ( $P = 0.01$ ) during the day in males and females, as well as the frequency of alcoholic drink consumption were related to the habitual consumption of energy drinks. The students who consumed energy drinks were categorized into three clusters: male students who perceived stress, female students who perceived stress and wanted to consume alcohol, and male students who perceived stress and experienced excessive daytime sleepiness. Thus, perceived stress may be strongly correlated with the consumption of energy drinks. Therefore, educational interventions to promote awareness of the health risks of excessive energy drink consumption among students are warranted.**

**Key words** energy drinks, university students, medical and welfare university, stress

## INTRODUCTION

An energy drink is a type of soft drink containing stimulant compounds, usually caffeine. The use of caffeine-containing energy drinks has increased worldwide in recent years. Several studies have highlighted the health risks (e.g., cardiovascular disease (prolonged QTc interval and palpitations), reduced sleep quality, and behavioral problems) of energy drink consumption among young adults, adolescents,<sup>1-3)</sup> high school students,<sup>4)</sup> and university students.<sup>5-7)</sup> Although there is one case report on caffeine intoxication related to energy drink consumption in Japan,<sup>8)</sup> few studies have examined the association between energy drink consumption and sociodemographic characteristics of Japanese people.

Healthcare professionals are responsible for improving the nation's public health.<sup>9)</sup> In medical and welfare universities, students should be trained to become exemplary medical professionals for the public. However, few studies have attempted to survey the sociodemographic characteristics of energy drink consumers among medical and welfare university students. Therefore, this study aimed to examine the sociodemographic characteristics associated with energy drink consumption in a medical and welfare university in Japan.

## MATERIALS AND METHODS

**Study Design** A cross-sectional study was performed at

Suzuka University of Medical Science, which specializes in medicine and welfare. First, we collected sociodemographic characteristics of the participants through a questionnaire. Second, we identified sociodemographic characteristics associated with habitual consumption of energy drinks (more than once a week) through multivariate logistic regression analysis. Finally, we categorized students who habitually consume energy drinks according to the sociodemographic characteristics using principal component analysis and cluster analysis.

**Participants and Recruitment** Data were collected from first to fourth year students of a medical and welfare university, in June 2019. The study was initiated after approval from the Institutional Review Board of Suzuka University of Medical Science (No. 412). The study procedures were conducted in accordance with the ethical principles for medical research outlined in the Declaration of Helsinki 1964, and its subsequent revisions. Written informed consent was obtained from each student prior to study onset. The students were also informed of the study protocol. Those willing to participate anonymously completed the questionnaire.

**Collection of Sociodemographic Characteristics** The participants responded to a questionnaire that examined 19 sociodemographic variables. The variables included frequency of energy drink consumption (habitual or non-habitual), gender, the frequency of physical activity, leisure screen time, sleep hours, the frequency of meals, consumption of drinks including caffeine other than energy drinks (i.e., tea, black

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**Table 1.** Content of the Questionnaire

Questions (Sociodemographic characteristics)		Answer Options	
Q1	Do you habitually consume energy drinks? (More than once a week)	Yes	No
Q2	Please indicate your sex assigned at birth.	Male	Female
Q3	How often do you do a light sweat exercise?	Once a week	Less than once a week
Q4	How many hours of screen time (using devices such as TV, PC, tablet devices, and smart phones) do you engage in a day?	< 3 h	≥ 3 h
Q5	How many hours of sleep do you get at night?	< 7 h	≥ 7 h
Q6	How many times do you eat in a day?	< 2 times	≥ 2 times
Q7	Do you smoke tobacco?	Yes	No
Q8	Do you consume alcoholic drinks often?	Yes	No
Q9	Are you confident about your health?	Confident	Not sure / not confident
Q10	Are you confident about your physical fitness?	Confident	Not sure / not confident
Q11	Do you experience excessive daytime sleepiness?	Yes	No
Q12	Do you often feel stressed?	Yes	No
Q13	Do you feel sad more often than not?	Yes	No
<b>Do you consume any of the following caffeine-containing drinks at a high frequency?</b>			
Q14	Tea	Yes	No
Q15	Black tea	Yes	No
Q16	Coffee	Yes	No
Q17	Caffeinated cola	Yes	No
<b>Knowledge concerning energy drinks and caffeine addiction</b>			
Q18	Do you know that energy drinks contain caffeine?	Yes	No
Q19	Do you know that there are cases of death from acute caffeine poisoning?	Yes	No

tea, coffee, and cola), smoking history, consumption of alcohol, confidence in health, confidence in physical fitness, experiencing excessive daytime sleepiness, perceived stress or feelings of sadness, and knowledge concerning caffeine addiction (i.e., the knowledge that energy drinks contain caffeine and the possibility of death induced acute intoxication) (Table 1). We instructed the participants to answer each question based on their daily life experiences and habits, and by excluding particular situations such as during test periods. The trade names of Japanese energy drink (Red Bull, Monster Energy, Rockstar Energy Drink, Survivor Energy Drink, Burn Energy Drink, Energy Drink Raizin, Shark Energy Drink, Phiten Extreme Energy Dry, Hard Wake, Regain Energy Drink, Kiiva Energy Drink) were described in the questionnaire.

**Identification of Sociodemographic Characteristics Associated with Habitual Consumption of Energy Drinks** Associated sociodemographic characteristics for the habitual consumption of energy drinks were identified using multivariate logistic regression analysis. Odds ratios for target variables were adjusted by propensity score for each target variable, which was calculated using a multivariate logistic model including all variables other than the target variable.

**Categorization of Students Who Habitually Consume Energy Drinks** Principal component scores for identified associated sociodemographic characteristics were calculated by principal component analysis for students who habitually consumed energy drinks. Principal components were selected to ensure that the cumulative contribution was greater than 90%. Students who habitually consumed energy drinks were classified using Ward's hierarchical clustering method using principal component scores of the selected principal components. To characterize each cluster, the associated sociodemographic characteristics for the consumption of energy drinks were compared between each cluster.

**Statistical Analysis** All statistical analyses were performed using JMP version 7.0.1 (SAS Institute, Cary, NC, USA).

Significance was established at a P value < 0.05.

## RESULTS

**Participants** A total of 1375 students were enrolled in this study. Of them, 126 were excluded due to errors in the questionnaire. Finally, data of 1249 participants were included in the analysis.

**Demographic Data of the Participants** Demographic data of the participants are presented in Table 2. Of them, 701 participants were women. The ages of a majority of participants ranged from 18–20 years. Forty participants habitually consumed one or more energy drinks in a week. Following the classification of each group, demographic data of the habitual and non-habitual groups are shown in Appendix 1.

**Identification of Sociodemographic Characteristics Associated with Consumption of Energy Drinks** Adjusted odds ratios of each answer for “Q1: The frequency of energy drink consumption – habitual (More than once a week),” are shown in Fig. 1. There were significant positive associations between Q1 and the following answers (adjusted odds ratio [95% CI]): Q18: Yes (6.31 [1.23 - 118], P = 0.02); Q17: Yes (4.81 [2.26 - 9.82], P < 0.01); Q12: Yes (2.59 [1.23 - 5.99], P = 0.01); Q8: Yes (2.52 [1.01 - 5.64], P = 0.05); Q11: Yes (2.47 [1.21 - 4.97], P = 0.01); Q2: Male (2.20 [1.36 - 4.99], P = 0.04); and Q10: Confidence. (2.07 [1.04 - 4.07], P = 0.04). However, there was no significant negative association between Q1 and the other questions.

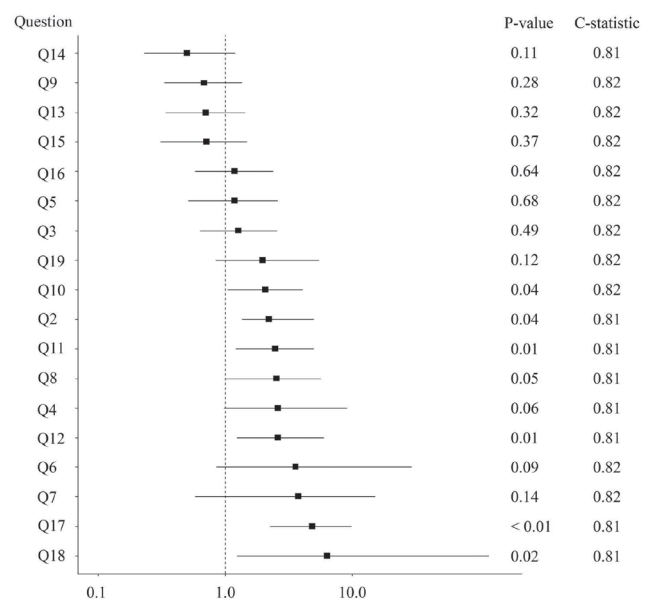
**Categorization of Students Who Habitually Consume Energy Drinks** Figure 2 shows the correlation of the principal component scores of sociodemographic characteristics associated with the habitual consumption of energy drinks between the non-habitual and habitual consumption group. Upon comparison with the non-habitual consumption group, there were large positive correlations between the following questions in the habitual consumption group: Q2 and Q10, Q2

**Table 2.** Participant Characteristics (n = 1249)

	Number (%)
Age	
18 years	326 (26.1)
19 years	502 (40.2)
20 years	325 (26.0)
21 years	62 (5.0)
22 years	13 (1.0)
23 years	6 (0.5)
24 years	4 (0.3)
> 25 years	11 (0.9)
Sex	
Male	548 (43.9)
Female	701 (56.1)
Do you habitually consume energy drinks? (More than once a week)	
Yes	40 (3.1)
No	1209 (96.9)

and Q17, Q10 and Q17, and Q10, and Q18. However, upon comparison with the non-habitual consumption group, there were large negative correlations between the following questions in habitual consumption group: Q2 and Q8, Q2 and Q18, Q11 and Q17, Q8 and Q17, and Q12 and Q17.

Principal component #1 to #4 were selected for cluster analysis because the cumulative contribution rate by these principal components was more than 90%. The participants were classified into three clusters by Ward's hierarchical clustering method using the principal component scores (Fig. 3a). The sociodemographic characteristics (i.e., Q2, Q8, Q10, Q11, Q12, Q17, and Q18) associated with habitual consumption of energy drinks were identified using multivariate logistic regression analysis and were compared among the three clusters (Fig. 3b). In Cluster 1, almost all participants were male (n = 19), and a large percentage of participants did not consume alcoholic drinks often (n = 4) or experience excessive

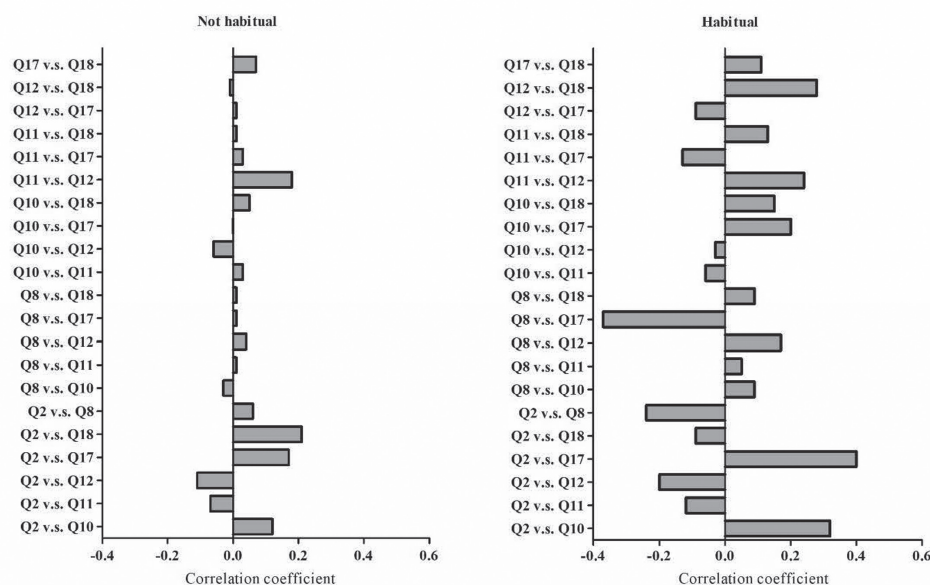
**Fig. 1.** Propensity Score Adjusted Odds Ratio of Each Question for Habitual Consumption Of Energy Drinks By Multiple Logistic Analysis

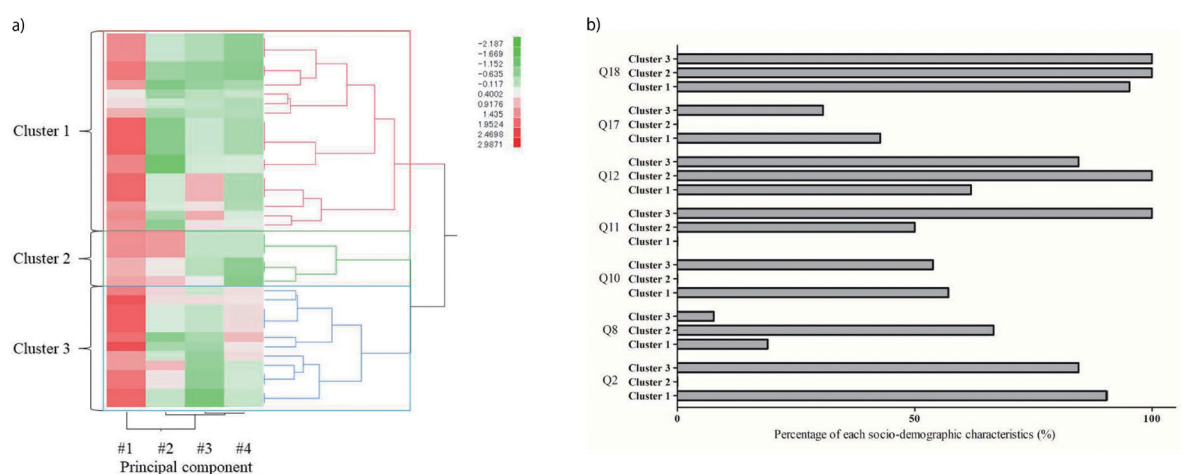
Q2, Q3, Q4, Q5, and Q6 represent odds ratio of "Male," "Once a week," "< 3 h," "< 7 h," and "< 2 times," respectively. Both Q9 and Q10 represent odds ratio of "Confidence." The others represent odds ratios of "Yes"

daytime sleepiness (n = 0). In Cluster 2, all participants were female; further, they reported perceived stress (n = 6), and a large percentage reported frequent intake of alcoholic drinks (n = 4) and did not consume caffeinated cola (n = 0). In Cluster 3, almost all participants were male, reported perceived stress, and experienced excessive daytime sleepiness (n = 11).

## DISCUSSION

The percentage of students who habitually consumed energy drinks was 0.03% (40 out of 1249) — lower than that reported in foreign countries (16%,<sup>10</sup> 27%,<sup>11</sup>) and 41%<sup>5</sup>). The propensi-

**Fig. 2.** Correlation Coefficient of Principal Component Scores among Each Socio-Demographic Characteristic Identified by Multiple Logistic Analysis



**Fig. 3.** a) Hierarchical Cluster Analysis and Heatmap Analysis using Principal Components Scores. b) The Differences of each Socio-demographic Characteristic Identified among Three Clusters by Multiple Logistic Analysis. Q2 and Q10 represent percentages of “Male” and “Confidence,” respectively. The others represent percentages of “Yes”

ty score-adjusted multivariate logistic analysis for each socio-demographic characteristic demonstrated that the consumption of energy drinks is associated with the following questions: Q2: Male (2.20 [1.36 - 4.99],  $P = 0.04$ ), Q8: Yes (2.52 [1.01 - 5.64],  $P = 0.05$ ), Q10: Confident (2.07 [1.04 - 4.07],  $P = 0.04$ ), Q11: Yes (2.47 [1.21 - 4.97],  $P = 0.01$ ), Q12: Yes (2.59 [1.23 - 5.99],  $P = 0.01$ ), Q17: Yes (4.81 [2.26 - 9.82],  $P < 0.01$ ), and Q18: Yes (6.31 [1.23 - 118],  $P = 0.02$ ) (Fig. 1). Students who habitually consumed energy drinks were classified into the following three clusters (Cluster 1, 2, and 3) by principal component analysis and hierarchical cluster analysis (Fig. 3b).

There were positive correlations between Q10 and Q2 and Q8, Q17, and Q18 in the principal component score for each question. These correlations were speculated to be related to both Cluster 1 and Cluster 3. The positive correlation between Q11 and Q18 was related to both Cluster 2 and Cluster 3, while that between Q8 and Q12 or Q18 were related to Cluster 2. Results indicated that students who habitually consumed energy drinks were related to a strong positive correlation between Q12 and Q18. Moreover, the negative correlations between Q12 and Q17, between Q8 and Q2 or Q17, and that between Q2 and Q18 was related to Cluster 2. It was speculated that the negative correlation between Q11 and Q17 was related to both Cluster 1 and Cluster 2. Therefore, it is likely that perceived stress and strong sleepiness during the day in males and females, as well as the frequency of alcoholic drink consumption are the sociodemographic characteristics related to the habitual consumption of energy drinks.

The results of our study are consistent with previous findings, since we found a correlation between perceived stress and energy drink consumption. Similarly, a descriptive-comparison study of nurses showed that nurses who consume energy drinks had increased levels of perceived stress, compared with non-caffeine consumers.<sup>12</sup> It has been reported that severe stress was correlated with the consumption of energy drink in Korean adolescents.<sup>13,14</sup> Moreover, a study on college students revealed positive correlations between perceived stress and energy drink consumption.<sup>15</sup> However, we are yet to see if perceived stress induces habitual consumption of energy drinks. It is likely that most students who habitually consume energy drinks have perceived stress. Thus, we need to investi-

gate whether a reduction in perceived stress improves energy drinks' consumption.

In our study, there was a strong independent correlation between habitual consumption of energy drinks and excessive daytime sleepiness (odds ratio [95% confidence interval]: 2.47 [1.21–4.97]). As suggested by a double-blind study, the ingredients found in energy drinks (i.e., caffeine, taurine, sucrose, and glucose) reduce sleepiness and increase alertness.<sup>16</sup> However, prior studies reveal that energy drinks decrease sleep quality<sup>17</sup> and reduce sleep time.<sup>18</sup> Therefore, early educational interventions are necessary to prevent students who consume energy drinks from developing sleep disorders.

Our study revealed an independent correlation between habitual consumption of energy drinks and males (odds ratio [95% confidence interval]: 2.20 [1.36–4.99]). In contrast, although most females who habitually consume energy drinks report perceived stress and have a high frequency of alcohol consumption, the percentage of those who had a high frequency of alcohol consumption was low in males (Fig. 3b). A previous study reported that being male significantly influenced the total energy drink consumption per week.<sup>19</sup> Thus, our results do not contradict previous studies. Meanwhile, a literature search suggested that heavy alcohol consumption is one of the several phenotypical differences between alcohol mixed with energy drink consumers and alcohol only consumers.<sup>20</sup> Taken together, although high frequency of alcohol consumption might have a correlation with the consumption of energy drinks, such a characteristic might be found only in women in Japan.

Our study had several limitations. First, since this study did not examine participants' daily intake of caffeine, we could not perform an analysis that includes caffeine intake as a confounding factor. Second, there may have been a selection bias, as this study was performed at only one medical university. Moreover, the number of students who consumed energy drinks was very low. Thus, the sociodemographic characteristics associated with consumption of energy drinks may be incorrectly extracted by multiple logistic regression analysis. To prevent incorrect extraction, we performed a more robust multiple logistic regression analysis by adjusting for the propensity score. However, due to a robust analysis, the study



may not always extract true socio-demographic characteristics associated with the consumption of energy drinks. Therefore, a multicenter study should be conducted.

The percentage of students who habitually consumed energy drinks among the students at a university specializing in medical welfare in Japan was 0.03% ( $n = 40$ ). The students who consumed energy drinks were categorized into three clusters: male students who had perceived stress, female students who had perceived stress and wanted to consume alcohol, and male students who had perceived stress and experienced excessive daytime sleepiness. Perceived stress may be strongly correlated with the consumption of energy drinks among students at Japanese universities, who are specializing in medicine and welfare.

**Implications For Research And Practice** Medical and welfare workers have a duty to improve the nation's health. The consumption of energy drinks may increase the risk of undesirable mental health outcomes.<sup>21)</sup> A previous study suggested that energy drink consumption may be an early precursor in the escalation to substance use.<sup>22)</sup> Moreover, educational interventions to inform university students about the risk of consuming energy drinks as well as about drug addiction would be crucial. In this study, perceived stress may be strongly correlated with the consumption of energy drinks. Thus, conducting a stress test to identify students who have a high risk of consuming energy drinks and providing them support in their daily lives may prevent such consumption.

**Conflict of interest** The authors declare no conflict of interest.

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