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# Caffeine consumption, intoxication, and stress among female university students: a cross-sectional study

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## Abstract

**Background:** University students use caffeine to cope with stress in spite of its adverse effects. The purpose of this study is to explore caffeine consumption among university students in Saudi Arabia, as well as its correlation with stress and caffeine intoxication. This cross-sectional study examined a convenience sample of 547 students at Princess Nourah Bint Abdulrahman University (PNU). A self-administrated questionnaire was used to assess caffeine consumption in milligrams per day, stress was assessed by the perceived stress scale (PSS), and caffeine intoxication was assessed using the DSM-5 criteria.

**Results:** The mean total caffeine consumption was  $424.69 \pm 385.31$  mg/day. High levels of caffeine consumption were found among students of non-health colleges and students who were undiagnosed with psychiatric disorders ( $p$  values  $<0.040$  and  $0.027$ , respectively). A significant positive correlation was found between caffeine consumption and perceived stress ( $p < 0.045$ ). Only 13.26% of all participants fulfilled the DSM-5 criteria for caffeine use disorder. The majority of participants showed moderate and high stress levels (69.9% and 18.7%).

**Conclusion:** This study revealed high caffeine consumption and perceived stress levels among female undergraduate students with a significant positive association between them. The results emphasize the importance of educational campaigns about caffeine consumption and intoxication. They also encourage the development of stress management programs. Longitudinal studies need to be designed for evidence-based intervention.

**Keywords:** Caffeine consumption, Intoxication, Stress, Students

## Background

Caffeine is a stimulant of the central nervous system and metabolism that is used for recreational and for medical reasons, such as decreasing physical exhaustion and increasing mental alertness [1]. Caffeine intake has positive and negative effects. The positive effects are enhanced mood and readiness, improved ability to stay conscious and alert, and strengthened exercise performance [2]. On the other hand, negative effects may occur when caffeine intake exceeds 250 mg, it can result in a condition called caffeine intoxication. Symptoms include fidgeting,

excitement, insomnia, increased urination, gastrointestinal disturbance, muscle twitching, irregular or rapid heartbeat, and psychomotor agitation according to the criteria of the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5) [3].

Students experience stressful times in college due to classes, homework, exams, projects, and extracurricular activities [4]. Studies done on college students in Puerto Rico, Saudi Arabia, and Turkey showed that 49%, 49.5%, and 58.99% of them use caffeine as a coping mechanism, respectively [2, 5, 6]. In order to deal with this stress and fulfill academic requirements, college students may consume caffeine in the belief that it can aid their academic performance [4].

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In Bahrain, the mean of daily caffeine consumption was assessed among college students. Females were consuming less than males (246 and 306 mg/day respectively) [7]. Another study assessed caffeine consumption and sleep habits among a sample of 228 students at Princess Nourah Bint Abdulrahman University (PNU) and found that most of them had high caffeine consumption, and a need for future studies concerning caffeine intoxication was suggested [8]. In this study, we aimed to estimate the level of caffeine consumption among students at health colleges and non-health colleges in PNU and to explore the correlation of caffeine consumption (including all types of caffeinated beverages) with caffeine intoxication and perceived stress.

## Methods

### Study design and population

This cross-sectional study examined a convenience sample of students who were Arabic speakers at the age of 18 years or above at health and non-health colleges at PNU, Riyadh, Saudi Arabia. PNU is the first women's university in the Middle East and also the largest one. It accommodates 33,825 students and includes 18 colleges.

A self-administrated questionnaire was distributed conveniently in October 2019 to 547 students from different colleges. Equal numbers of questionnaires were distributed to health and non-health colleges (humanities, community, and science). The comparison was chosen to be between health and non-health colleges based on the significant differences in the studying years, academic system, training requirements, and health-related knowledge. Health college students have an average of 6 years of studying and non-health college students have an average of 4 years. These factors may affect the level of their perceived stress and caffeine consumption.

The consenting process started by going to the students on the campus and explaining to them the study and asks them if they are willing to participate, mentioning that their identity is confidential as it does not require a name or an ID. If they agree to participate, a copy of the questionnaire will be given to them, and they will be encouraged to read the front page thoroughly which has a statement saying "Filling this questionnaire means you agree to be part of this study." It also has the information and purpose of the study and the contact information.

Previous literatures showed that the average daily caffeine consumptions vary from 10 to 11.2 mg/day, and the standard deviation was around 5 mg/day. Gpower software was used to calculate the minimal size required for this study, considering  $\alpha = 0.05$  (level of significance of 95%) and  $\beta = 0.20$  (power of the study is 80%), the minimal sample size required is 548.

### Data collection tool

The questionnaire included four main divisions. The first one covered demographic characteristics, academic-related characteristics, and personal clinical history. The second and third divisions covered caffeine consumption and caffeine intoxication. The fourth division assessed perceived stress level by PSS-10. The first three division of the survey were first written in Arabic then translated to English by a professional translator, then reviewed and translated into Arabic by bilingual speakers. Pilot test was done for the Arabic version, and then face validation was done by sending the survey to four mental health professionals. Furthermore, the fourth division involved the Arabic version of PSS-10, which has been validated previously by Chaaya et al. The PSS-10 was translated from English into Arabic, and then it was reviewed by a bilingual psychiatrist. After that, it was back translated into English by the psychiatrist and a comparison with the original one was done [9].






### Demographic characteristics, academic-related characteristics, and personal clinical history

Demographic characteristics included age, nationality, marital status, number of children, and income, which was estimated among students as having enough income, enough income with saving, not enough income, or debt. Academic-related characteristics included college, academic level (first and second-years were counted as "juniors," whereas third, fourth, and fifth years were accounted as "seniors"), GPA, and academic satisfaction. Personal clinical history included questions about their history of diagnosed chronic diseases or psychiatric disorders, received psychiatric help, and smoking.

### Caffeine consumption

Caffeine intake per day was measured in milligrams. A table was included in the questionnaire (Table 1). The common caffeinated drinks had been enlisted in the table. All common caffeinated drinks were investigated, including drinks such as coffee, decaffeinated coffee, tea, cola, citrus, and energy drinks. The table included the size and the number of cup/cans per day for each drink. A reference image was attached to illustrate the size, and the amount of fluid in ounces. The participants were asked to fill out only the size and number of the drinks they regularly consume. The amount of caffeine in each drink size was calculated (Table 2), which were later multiplied by the number of cups/cans consumed daily. Then, the total numbers of caffeine milligrams per day were summed. Caffeine intake was examined as "low" and "high." Low intake was considered less than 250 mg per day, while high intake was considered more than 250 mg per day. The validity and reliability of measurements have been confirmed in similar studies [10, 11].

**Table 1** Beverages intake by type, size, and number of cups

						
	4oz	8oz S	12oz M	16oz L	20oz XL	
<b>Beverage category/ type/ description</b>	<b>Size of cup</b>				<b>Number of cups/cans per day</b>	
<b>Caffeinated coffee</b>						
Regular, brewed		S	M	L	XL	
K cups		S	M	L	XL	
instant		S	M	L	XL	
Prepared from flavored mix (e.g., pistachio latte )		S	M	L	XL	
Specialty coffees, with additional ingredients (e.g., latte, mocha, cappuccino, Americano)		S	M	L	XL	
espresso		S	M	L	XL	
Ready-to-drink, bottled or canned		S	M	L	XL	
Arabic coffee	Single size					
<b>Decaffeinated coffee</b>						
All types including regular, brewed, specialty, brand or brand not specified, ready-to-drink, bottled or canned		S	M	L	XL	
<b>Tea</b>						
Black tea		S	M	L	XL	
Green tea		S	M	L	XL	
Ready-to-drink, bottled tea		S	M	L	XL	
<b>Carbonated soft drinks</b>						
Cola: All types, caffeinated, regular or diet, including with added flavors (e.g., cherry cola), brand not specified	Single size					
Citrus: All types, caffeinated, brand specified	Single size					
<b>Energy drinks</b>						
bottles or cans, diet or regular	Single size					

**Caffeine intoxication**

Intoxication was assessed using the criteria of DSM-5, which includes 12 symptoms. Participants were asked if they developed symptoms during or shortly after caffeine consumption. Any participant with five or more symptoms was diagnosed with caffeine intoxication according to the criteria.

**Perceived stress level**

Stress level was measured using the Arabic version of the PSS, which is a 10-question tool that is used to measure perception of stress over the past 30 days. The scale was developed in 1983 [12] and was modified in 1988 by Cohen [13]. It is a validated stress questionnaire with established acceptable psychometric properties [14, 15]. A Likert-type scale was used to capture responses to

**Table 2** Beverages caffeine content in mg/oz

Type	Mg/oz			
	Size			
	S	M	L	XL
Regular	95.2	142.8	190.4	238
Arabic	4.1			
K cups	120	180	240	300
Instant	75.2	122.8	150.4	188
Flavored	48	72	96	120
Specialty	94.8	142.2	189.6	237
Espresso	219			
Canned coffee	16.4	24.6	32.8	41
D-café	2	3	4	5
Black tea	47.2	70.8	94.4	118
Green tea	24.8	37.2	49.6	62
Canned tea	16	24	32	40
Cola	24			
Citrus	36.8			
Energy drinks	80			

the PSS (“never,” “almost never,” “sometimes,” “fairly often,” and “very often”). A score of 0-13 is considered as low stress, 14-26 is considered moderate, and 27-40 is considered high perceived stress.

### Statistical analysis

Data were analyzed using SPSS 23. We described the variables as means  $\pm$  the standard deviation (SD) or percentages as appropriate. A *t* test was used to determine the difference between quantitative variables, while the chi-squared test was used to determine the association between qualitative variables.

## Results

### Demographic characteristics, academic-related characteristics, and personal clinical history

The total number of participants in the study was 547, and the average age was  $20.30 \pm 1.91$  years. The majority were Saudi (98.40%) and single (96%). More than half of the participants (59.20%) reported that their income was enough, and 29.20% reported that their income was enough with saving.

Almost half of the participants were from health colleges (50.10%), whereas the other half were from non-health colleges (49.90%). More than half of the participants were junior students (61.80%). The GPA 4.50-5.00 for 42.50% of the participants, and only 9.40% of them had a GPA less than 3.50. More than half of them were either satisfied or very satisfied with their academic achievement (46.60% and 22.80%, respectively).

A minority of the participants reported that they were diagnosed with chronic diseases and psychiatric disorders (6.80% and 10.10%, respectively). Half of those who had been diagnosed with a psychiatric disorder received psychiatric help (56.36%). In addition, the majority of participants were non-smokers (93.90; Table 3).

### Caffeine consumption

The mean total caffeine consumption per day was  $424.69 \pm 385.31$  mg. Specialty coffee was the most consumed caffeine source with a mean of  $93.06 \pm 126.99$  mg, followed by regular brewed coffee, capsule coffee, and black tea with means of  $62.74 \pm 114.30$  mg,  $55.39 \pm 114.62$  mg, and  $51.60 \pm 83.98$  mg, respectively (Table 4). The mean of low caffeine consumption group ( $< 250$  mg/day) was  $126.6 \pm 68.01$  mg/day, while it was  $628.28 \pm 381.6$  mg/day for the high caffeine consumption group ( $> 250$  mg/day).

A high level of caffeine consumption was significantly more evident among students of non-health colleges than health college students (53.50% versus 46.50%, respectively;  $p < 0.040$ ). In addition, a high level of caffeine consumption was significantly more evident among students undiagnosed with psychiatric disorders than diagnosed students (87.60% versus 12.40%, respectively;  $p < 0.027$ ). Moreover, a high level of caffeine consumption was significantly more evident among students who experienced caffeine intoxication symptoms than asymptomatic students (75% versus 57.1%;  $p < 0.005$ ). Finally, students who had a high level of caffeine consumption had significantly higher mean scores of perceived stress than students with a low level of caffeine consumption ( $21.40 \pm 6.38$  and  $20.27 \pm 6.31$ , respectively;  $p < 0.045$ ; Table 5).

### Symptoms of caffeine intoxication

The reported caffeine intoxication symptoms in descending order were diuresis, insomnia, tachycardia or arrhythmia, gastrointestinal disturbance, restlessness, nervousness, rambling flow of thought and speech, muscle twitching, periods of inexhaustibility, psychomotor agitation, excitement, and flushed face (43.70%, 43.50%, 38.90%, 25.80%, 16.80%, 15.90%, 13.90%, 11.70%, 11%, 9.50%, 7.50%, and 5.10%, respectively). However, more than three quarters of them had no clinically significant distress or impairment of function (78%). Only 13.26% of all participants fulfilled DSM-5 criteria for caffeine use disorder.

### Perceived stress

More than two-thirds of the participants showed moderate stress levels (69.9%), whereas 18.7% reported high stress levels (Table 6). There were significant associations between the level of perceived stress and academic satisfaction. A high level of stress was also more evident

**Table 3** Characteristics of study sample,  $n=547$ 

Item	Frequency (%)
Age (years)	20.30 ±1.91
<b>Nationality</b>	
Saudi	538 (98.40%)
Non-Saudi	9 (1.60%)
<b>Marital status<sup>a</sup></b>	
Single	524 (96.00%)
Married	18 (3.30%)
Separated	4 (0.70%)
<b>Kids</b>	
Have kids	9 (1.70%)
Does not have kids	538 (98.40%)
<b>Income<sup>a</sup></b>	
Enough	322 (59.20%)
Enough with saving	159 (29.20%)
Not enough	54 (9.90%)
In debt	9 (1.70%)
<b>College</b>	
Health	274 (50.10%)
Non-health	273 (49.90%)
<b>Academic level</b>	
Junior	338 (61.80%)
Senior	209 (38.30%)
<b>GPA<sup>a</sup></b>	
5-4.50	228 (42.50%)
4.49-4	178 (33.10%)
3.9-3.50	80 (14.90%)
Less than 3.50	51 (9.40%)
<b>Academic satisfaction<sup>a</sup></b>	
Very satisfied	124 (22.80%)
Satisfied	254 (46.60%)
Not satisfied	121 (22.20%)
Very unsatisfied	44 (8.10%)
<b>Chronic diseases<sup>a</sup></b>	
Diagnosed	37 (6.80%)
Not diagnosed	509 (93.20%)
<b>Psychiatric disorders<sup>a</sup></b>	
Diagnosed	55 (10.10%)
Not diagnosed	491 (89.90%)
<b>Psychiatric help<sup>a</sup></b>	
Received help	30 (54.50%)
Did not receive	23 (41.80%)
<b>Smoking<sup>a</sup></b>	
Smoker	33 (6.10%)
Non-smoker	508 (93.90%)

Values are presented as mean ± standard deviation or number (%)

<sup>a</sup>Missing data: 1: marital status, chronic disease, and psychiatric disorder. 2: academic satisfaction. 3: income and psychiatric help. 6: smoking. 10: GPA

**Table 4** Caffeine consumption level (mg/day) by beverage category,  $n=547$ 

Beverage category	Level
Arabic coffee	11.86±15.78
Regular brew coffee	62.74±114.30
K cups	55.39±114.62
Instant coffee	46.47±95.86
Flavored coffee	24.87±44.35
Specialty coffee	93.06±126.99
Espresso coffee	46.51±113.64
Canned coffee	2.89±9.33
Decafe coffee	0.21±0.92
Black tea	51.60±83.98
Green tea	7.07±19.94
Canned tea	3.08±9.87
Cola	10.70±16.91
Citrus	5.25±15.51
Energy drinks	11.40±36.05
<b>Total caffeine consumption</b>	<b>424.69±385.31</b>

Values are presented as mean ± standard deviation

among students who were academically very unsatisfied or not satisfied than those who were satisfied or very satisfied ( $25.87±6.57$  and  $22.43±6.20$  versus  $20.23±5.95$  and  $19.33±6.17$ , respectively;  $p<0.001$ ).

In addition, the level of perceived stress was significantly associated with students' income; a higher level of stress was more evident among students who expressed that they were in debt or their income is not enough those who had enough income or enough income with savings ( $24.11±6.95$  and  $23.24±7.90$  versus  $20.99±5.75$  and  $20.16±6.69$ , respectively;  $p<0.008$ ). Another significant association was found between the level of perceived stress and some personal clinical histories. A high level of stress was more evident among students who were diagnosed with psychiatric disorders than undiagnosed students ( $25.20±6.31$  versus  $20.52±6.20$ , respectively;  $p<0.001$ ). The level of stress was also significantly higher among students diagnosed with chronic disease than undiagnosed students ( $23.69±6.17$  versus  $20.80±6.33$ , respectively;  $p<0.008$ ). Furthermore, a high level of stress was more evident among smokers than non-smokers ( $24.36±7.44$  versus  $20.79±0.02$ , respectively;  $p<0.002$ ). Finally, a high level of stress was more evident among students who experienced caffeine intoxication symptoms than asymptomatic students ( $24.12±5.92$  than  $20.51±6.28$ , respectively;  $p<0.001$ ; Table 7).

## Discussion

This study represents the first Saudi university-based survey of caffeine consumption including all types of

**Table 5** Characteristics of the subjects according to caffeine consumption level

Characteristic	Caffeine consumption (mg/day)		P value
	Low level (<250 mg) n=214	High level (>250 mg) n=314	
<b>Age</b> (year)	20.38 ±1.962	20.25 ±1.90	0.466
<b>College</b>			0.040
Health	119 (55.60%)	146 (46.50%)	
Non-health	95 (44.40%)	168 (53.50%)	
<b>Nationality</b>			0.107
Saudi	208 (97.20%)	311 (99.00%)	
Non-Saudi	6 (2.80%)	3 (1.00%)	
<b>Marital status<sup>a</sup></b>			0.766
Single	205 (96.20%)	300 (95.50%)	
Married	6 (2.80%)	12 (3.80%)	
Separated	2 (0.90%)	2 (0.60%)	
<b>Kids</b>			0.070
Have kids	1 (0.50%)	8 (2.50%)	
Does not have kids	213 (99.50%)	306 (97.50%)	
<b>Income<sup>a</sup></b>			0.236
Enough	125 (58.70%)	188 (60.30%)	
Enough with saving	70 (32.90%)	83 (26.60%)	
Not enough	16 (7.20%)	36 (11.50%)	
In debt	2 (0.90%)	5 (1.60%)	
<b>Academic level</b>			0.698
Junior	130 (60.70%)	196 (62.40%)	
Senior	84 (39.30%)	118 (37.60%)	
<b>GPA<sup>a</sup></b>			0.553
5-4.50	95 (45.70%)	123 (39.70%)	
4.49-4	64 (30.80%)	111 (35.80%)	
3.9-3.50	30 (14.40%)	48 (15.50%)	
Less than 3.50	19 (9.10%)	28 (9.00%)	
<b>Academic satisfaction<sup>a</sup></b>			0.145
Very satisfied	48 (22.50%)	71 (22.70%)	
Satisfied	109 (51.20%)	136 (43.50%)	
Not satisfied	45 (21.10%)	73 (23.30%)	
Very unsatisfied	10 (4.70%)	32 (10.20%)	
<b>Chronic diseases<sup>a</sup></b>			0.402
Diagnosed	17 (7.90%)	19 (6.10%)	
Not diagnosed	197 (92.10%)	294 (93.90%)	
<b>Psychiatric disorders<sup>a</sup></b>			0.027
Diagnosed	14 (6.50%)	39 (12.40%)	
Not diagnosed	200 (93.50%)	275 (87.60%)	
<b>Psychiatric help<sup>a</sup></b>			0.693
Received help	8 (61.50%)	21 (55.30%)	
Did not receive	5 (38.50%)	17 (44.70%)	
<b>Smoking<sup>a</sup></b>			0.704
Smoker	11 (36.70%)	19 (63.30%)	

**Table 5** Characteristics of the subjects according to caffeine consumption level (Continued)

Characteristic	Caffeine consumption (mg/day)		P value
	Low level (<250 mg) n=214	High level (>250 mg) n=314	
Non-smoker	198 (40.20%)	295 (59.80%)	
<b>Caffeine intoxication<sup>a</sup></b>			0.005
Intoxication symptoms	17 (25.00%)	51 (75.00%)	
No intoxication symptoms	196 (42.90%)	261 (57.10%)	
<b>Perceived stress scale</b>	20.27±6.31	21.40±6.38	0.045

Values are presented as mean ± standard deviation or number (%)

<sup>a</sup>Missing data: 1: marital status, chronic disease, and psychiatric disorder. 2: academic satisfaction. 3: income and psychiatric help. 6: smoking. 10: GPA

caffeinated beverages among students from both health and non-health colleges to explore the correlation with perceived stress and caffeine intoxication. The results showed that the mean total caffeine consumption was 424.69±385.31 mg/day. This could be alarming as the recommended use for healthy adult is 400 mg/day [16]. This result is comparable to that of an Egyptian study, which found that caffeine consumption was 405.47±396.43 mg/day among university students [17]. These two results are slightly higher than a Lebanese result that showed a mean total caffeine consumption of 193.32±361.81 mg/day for medical students [18]. This can be explained by the result of the current study as it showed higher caffeine consumption among non-health college student. The lower caffeine consumption level reported by students of health colleges could be due to their awareness about the side effects of caffeine. On the other hand, the total mean caffeine consumption in the current study is much higher (by at least twice) than in

other studies that were conducted among another various populations, like army soldiers (285 mg/day), psychiatric patients (281±325 mg/day), office workers (205.7±34.9 mg/day), the general populations (164.5 ± 0.9 mg/day and 193 mg/day), adolescents (25.92±41.25 mg/day and 91.5 ± 4.7 mg/day), and children (76.1 ± 6.3 mg/day) [10, 11, 19–22]. This could be due to the higher level of perceived stress that was found among university students in this study as caffeine may relieve stress [23]. In addition, other numerous factors for caffeine intake among undergraduate university students were reported in the USA including improving alertness, concentration, mood, energy, and enjoying the taste [24].

Furthermore, the level of caffeine consumption was significantly lower among students diagnosed with psychiatric disorders, which could be attributed to their awareness or previous experience of the effects of excessive caffeine consumption, which increases the risk of anxiety, panic attacks, and psychotic symptoms [25, 26].

**Table 6** Responses to the perceived stress scale from students, n=546

Perceived stress scale	Never	Almost never	Sometimes	Fairly often	Very often
1. In the last month, how often have you been upset because of something that happened unexpectedly?	137 (25.10%)	97 (17.80%)	175 (32.10%)	84 (15.40%)	53 (9.70%)
2. In the last month, how often have you felt that you were unable to control the important things in your life?	79 (14.50%)	103 (18.90%)	179 (32.80%)	114 (20.90%)	70 (12.80%)
3. In the last month, how often have you felt nervous and "stressed"?	48 (8.80%)	49 (9.00%)	153 (28.00%)	160 (29.30%)	136 (24.90%)
4. In the last month, how often have you felt confident about your ability to handle your personal problems?	53 (9.70%)	77 (14.10%)	188 (34.40%)	167 (30.60%)	61 (11.20%)
5. In the last month, how often have you felt that things were going your way?	89 (16.30%)	140 (25.60%)	193 (35.30%)	99 (18.10%)	25 (4.60%)
6. In the last month, how often have you found that you could not cope with all the things that you had to do?	69 (12.60%)	96 (17.60%)	218 (39.90%)	109 (20.00%)	54 (9.90%)
7. In the last month, how often have you been able to control irritations in your life?	63 (11.50%)	127 (23.30%)	209 (38.30%)	119 (21.80%)	28 (5.10%)
8. In the last month, how often have you felt that you were on top of things?	74 (13.60%)	130 (23.80%)	224 (41.00%)	102 (18.70%)	16 (2.90%)
9. In the last month, how often have you been angered because of things that were outside of your control?	48 (8.80%)	84 (15.40%)	165 (30.20%)	155 (28.40%)	94 (17.20%)
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	75 (13.70%)	120 (22.00%)	157 (28.80%)	103 (18.90%)	91 (16.70%)

Values are presented as mean ± standard deviation

**Table 7** Characteristics of the subjects according to perceived stress level,  $n=547$ 

Item	Mean $\pm$ SD	P value
Age (year)	20.29 $\pm$ 1.91	0.105
<b>College</b>		0.135
Health	21.39 $\pm$ 6.72	
Non-health	20.57 $\pm$ 5.94	
<b>Nationality</b>		0.100
Saudi	20.93 $\pm$ 6.36	
Non-Saudi	24.44 $\pm$ 4.71	
<b>Marital status<sup>a</sup></b>		0.785
Single	21.00 $\pm$ 6.36	
Married	20.55 $\pm$ 6.17	
Separated	23.00 $\pm$ 6.21	
<b>Kids</b>		0.755
Have kids	20.33 $\pm$ 5.31	
Does not have kids	21.00 $\pm$ 6.37	
<b>Income<sup>a</sup></b>		0.008
Enough	20.99 $\pm$ 5.75	
Enough with saving	20.16 $\pm$ 6.69	
Not enough	23.24 $\pm$ 7.90	
In debt	24.11 $\pm$ 6.95	
<b>Academic level</b>		0.460
Junior	20.83 $\pm$ 6.26	
Senior	21.24 $\pm$ 6.51	
<b>GPA<sup>a</sup></b>		0.329
5-4.50	20.48 $\pm$ 6.25	
4.49-4	21.15 $\pm$ 6.41	
3.99-3.50	21.86 $\pm$ 6.27	
Less than 3.49	21.50 $\pm$ 6.05	
<b>Academic satisfaction<sup>a</sup></b>		<0.001
Very satisfied	19.33 $\pm$ 6.17	
Satisfied	20.23 $\pm$ 5.95	
Not satisfied	22.43 $\pm$ 6.20	
Very unsatisfied	25.86 $\pm$ 6.57	
<b>Chronic diseases<sup>a</sup></b>		0.008
Diagnosed	23.69 $\pm$ 6.17	
Not diagnosed	20.80 $\pm$ 6.33	
<b>Psychiatric disorders<sup>a</sup></b>		<0.001
Diagnosed	25.20 $\pm$ 6.31	
Not diagnosed	20.52 $\pm$ 6.20	
<b>Psychiatric help<sup>a</sup></b>		0.618
Received help	24.79 $\pm$ 7.39	
Did not receive	25.69 $\pm$ 4.98	
<b>Smoking<sup>a</sup></b>		0.002
Smoker	24.36 $\pm$ 7.44	

**Table 7** Characteristics of the subjects according to perceived stress level,  $n=547$  (Continued)

Item	Mean $\pm$ SD	P value
Non-smoker	20.79 $\pm$ 0.02	
<b>Caffeine intake<sup>a</sup></b>		0.045
Low (<250 g)	20.27 $\pm$ 6.31	
High (>250 g)	21.40 $\pm$ 6.38	
<b>Caffeine intoxication<sup>a</sup></b>		<0.001
Intoxication symptoms	24.12 $\pm$ 5.92	
No intoxication symptoms	20.51 $\pm$ 6.28	

Values are presented as mean  $\pm$  standard deviation or number (%)

<sup>a</sup>Missing data: 1: marital status, chronic disease, and psychiatric disorder. 2: academic satisfaction. 3: income and psychiatric help. 6: smoking. 10: GPA. 19: caffeine intake

And those who are suffering from anxiety conditions may have more caffeine sensitivity, which contribute in caffeine avoidance due to the undesirable effects [27–29]. It could also be attributed to their awareness or previous experience with the potential interaction of caffeine with psychotropic drugs that are used for their psychiatric conditions, which is due to the metabolism of caffeine by CYP1A2 enzyme. Caffeine can inhibit this enzyme and cause side effects that may affect their treatment plan [30]. In addition, a high level of caffeine consumption was significantly more evident among students who experienced caffeine intoxication because the more caffeine they consume, the more symptoms they experience. A related study done in the USA showed that excessive caffeine consumption can lead to caffeine intoxication [4]. And it was found that only 13% of participants experienced caffeine intoxication according to the DSM-5 criteria. This is similar to the prevalence of intoxication that was found among psychiatric patients in Italy (10.3%), which was significantly higher compared to healthy participants (2.9%). However, comparing our results with the Italian results was limited by the samples differences as the Italian study had wider age range and more severe psychiatric cases compared to our study [22].

Perceived stress was prevalent in this study. This is not surprising as similar results were found in previous studies that were conducted among university students in Saudi Arabia, Iran, and Malaysia [5, 31–33]. In addition, a significant positive relationship was found between the level of caffeine consumption and the level of perceived stress. This is supported by a previous study that found a significant positive relationship between the consumption of energy drinks and stress [34, 35]. This might be due to the beneficial effects of caffeine in maintaining cognitive function under conditions of stress and improving work performance [23].

Moreover, smoker students reported significantly higher stress levels. There are several theories on the



role of stress and smoking behaviors. Smokers use cigarettes to relieve stress. However, several studies have shown that while smoking may temporarily relieve perceived stress, it actually may generate or aggravate negative emotional states and propagate negative coping strategies, leading to higher stress levels overall [36].

Perceived stress was found to be significantly higher among students who were diagnosed with psychiatric disorder or chronic disease. This is not surprising as it is evident that stress is a risk factor for various psychiatric and medical conditions [37–40]. Research shows that almost every system in the body can be influenced by chronic stress. When chronic stress goes unreleased, it suppresses the body's immune system and ultimately manifests as illness. If stress continues and the body is unable to cope, there is likely to be a breakdown of bodily resources [41].

### Limitations

This is the first Saudi university-based survey of caffeine consumption among students from both health and non-health colleges that included all types of caffeinated beverages. The results provided valuable information about caffeine consumption, caffeine intoxication, and stress. However, the convenience sampling and female participants limit the generalizability of the study. Although all common caffeinated drinks were investigated in this study, other possible sources of caffeine such as caffeine pills and chocolate were not included. In addition, even if intoxication symptoms listed in the survey were developed during or shortly after caffeine intake, it was difficult to differentiate between caffeine intoxication and symptoms of other medical or psychiatric conditions. Furthermore, a cross-sectional study cannot identify causality relationships.

### Conclusion

Caffeine is highly consumed by female undergraduate students, mostly specially coffee, and the level is significantly higher among students of non-health colleges. In addition, caffeine consumption levels are positively and significantly correlated with perceived stress levels, which were prevalent among the students. However, only 13.26% of all participants fulfilled DSM-5 criteria for caffeine use disorder which was associated with high level of stress. This emphasizes the importance of educational campaigns about caffeine consumption and intoxication. Furthermore, this study could be useful for future university education and stress management planning. It could also be used as a primary resource for future investigations. However, longitudinal studies need to be designed for evidence-based intervention. Further studies also need to involve both sexes and postgraduate students.

### Abbreviations

PSS: Perceived stress scale; DSM-5: The Diagnostic and Statistical Manual of Mental Disorders, fifth edition

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### Authors' contributions

RMA and NA were responsible of designing the study. MA and RM were in charge of collecting and entering the data. And they helped in the analysis. RMA and RIA were responsible of interpreting and analyzing of the data. DA was responsible of the general process, editing, and publication of paper. All authors took a part in writing, revising and approving the final manuscript. The authors read and approved the final manuscript.

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### Availability of data and materials

All data and material of this study are available upon request from the corresponding author.

### Declarations

#### Ethics approval and consent to participate

Ethical approval was obtained from the Institutional Review Board at Princess Nourah bint Abdulrahman University, Riyadh, KSA (IRB-PNU:19-0234), on 20 November 2019. Informed verbal consent was acquired from all participants before enrollment in the study. The ethics committee approved the verbal consent. Using verbal consent was recommended by the IRB in surveys if the data was taken from human subjects who cannot be identified, and their responses could not put them at risk of criminal or civil liability and could not damage their reputation or employability.

#### Consent for publication

Not applicable.

#### Competing interests

No conflict of interest.

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