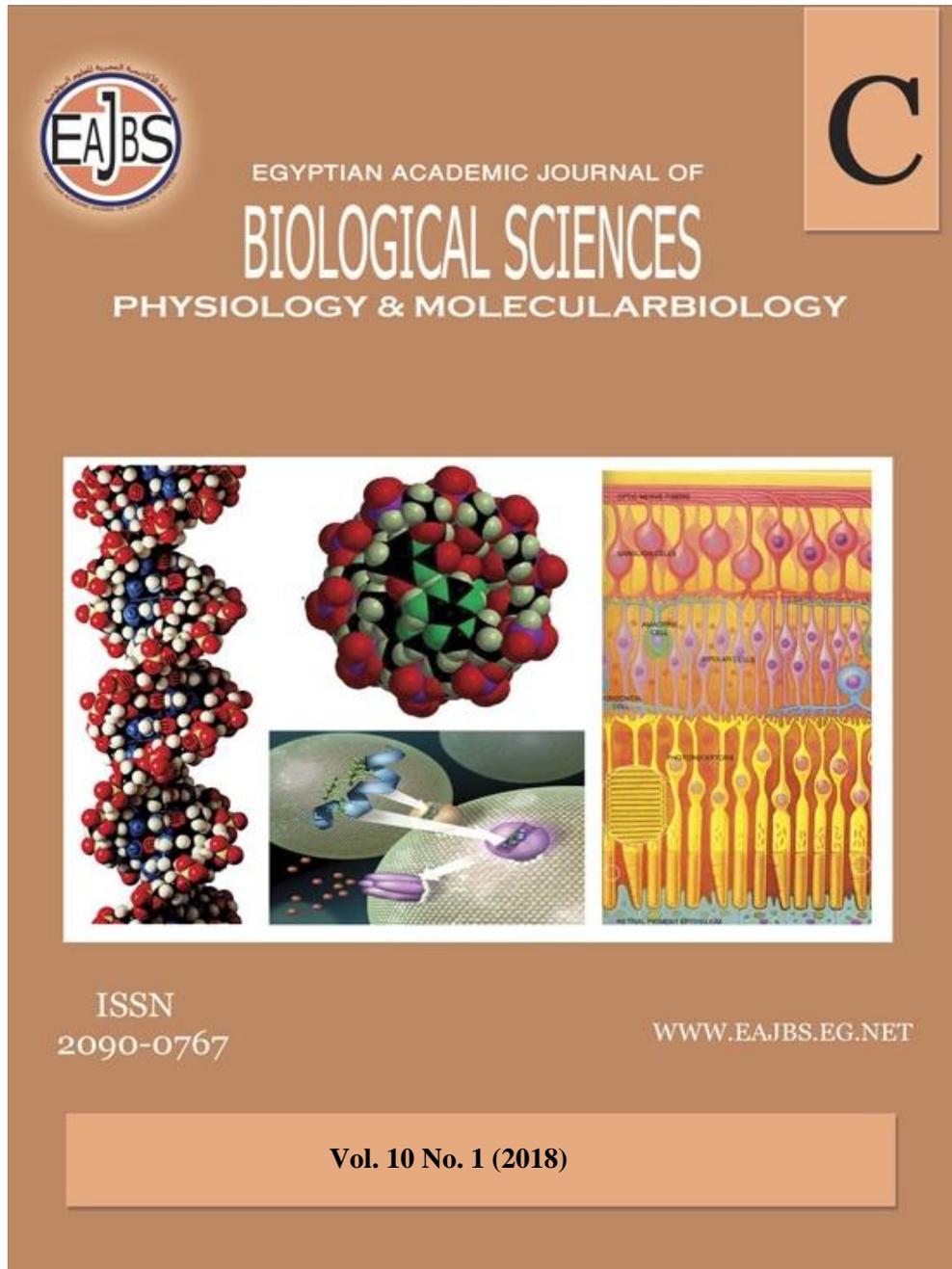


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## Association Between Caffeinated Beverages, Body Mass Index, And Academic Stress in Medical Students of Hail University - A Cross-Sectional, Questionnaire-Based Study

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### ABSTRACT

**Background:** Medical students are exposed to high academic stress and many of these students consume caffeinated beverages to enhance their performance. Short-term effects of caffeine consumption include enhanced mood and alertness. A lot of research was done on the association between caffeinated beverages consumption and its effect on academic load and stress, but there is no data concerning the students' perception of Hail University, especially medical students. The current study aimed to present cross-sectional data from the different educational level to investigate associations between caffeinated beverages, BMI, academic performance and stress in medical students of Hail University.

**Methodology:** This study was conducted with medical students (both male and female) at University of Hail between 2nd March 2018 and 18th March 2018. Data was collected using a self-reported questionnaire from 258 students. The questions included were about demographics, types. and number of cups per day of caffeine consumption and reasons for consuming. Academic stress and load on a five-point scale and also asked the effects and satisfaction of caffeinated beverages.

**Results:** The participation rate was 73.26%. The sample included 36 (19%), 32 (16.9%), 27 (14.3%), 54 (28.6%), 19 (10.1%) and 21 (11.1 %) of 1st, 2nd, 3rd, 4th, 5th and 6th year students respectively. The subjects were aged between 18 and 29 years [90 (47.6%) male and 99 (52.4%) female]. Comparatively black coffee, Arabian coffee and tea have more than other types of beverages and also these were high in obese students compare with other caffeinated beverages.

Overall most of the students' feel their self-perceived academic load were average (45.5%) or above average (29.1%). Academic stress with drinking more caffeinated beverages were reflected in academic performance. Increased caffeinated beverages drinking showed with increased effects of their anxiety and academic performance.

**Conclusion:** The prevalence of caffeinated beverage consumption was high with black coffee and Arabian coffee being the most frequently consumed of the beverages. Caffeinated beverages consumption, particularly, increased in academic stress and were used mainly to academic performance.

## INTRODUCTION

The consumption of caffeinated beverages is known to be a coping strategy used by college students in the management of stressful academic situations [Lazarus 1993; Thoits 1995]. Medical students are exposed to high academic stress [Banerjee I *et al* 2015] and many of these students consume energy drinks to enhance their performance [Attila S and Çakir B 2011]. Energy drinks are carbonated nonalcoholic beverages, which generally consist of caffeine, taurine, carbohydrates, amino acids, vitamins and vegetable extracts [Higgins JP *et al* 2010]. Caffeine is an alkaloid found in various plant constituents, such as coffee, cocoa beans, and tea leaves. Caffeine intakes from all sources up to 400 mg per day consumed throughout the day do not give rise to safety concerns for healthy adults [EFSA NDA Panel 2015].

Moderate caffeine intake has an awakening effect improving alertness and reducing fatigue by stimulating the nervous system [Griffiths RR *et al* 2003; Ferre S 2008]. When caffeine is absorbed, it reaches to the bloodstream in 20–45 minutes [Liguori A 1997] and is rapidly excreted with the half-life of 4–6 hours [Denaro CP and Benowitz NL 1991]. In the general population, negative effects of caffeine are usually observed in relation to excessive intake. At extremely high doses its consumption can induce a condition known as ‘caffeinism’. Symptoms include anxiety, nervousness, restlessness, insomnia, excitement, psychomotor agitation, dysphoria and a rambling flow of thoughts and speech [Gilliland and Andress 1981; Greden, 1974], which have been considered to mimic a clinical picture known as ‘mixed mood state’ [Lara 2010]. Also it may lead to decreased sleep hours and academic performance [Pattison S 2016]. Recent studies have shown that a chemical name acrylamide is carcinogenic and it is found

in any coffee treated thermally including Arabic coffee and tea also [Mohammad RK *et al* 2017]. On the other hand, there are beneficial effects of caffeine, including increased alertness, stimulating the central nervous system and delaying fatigue [Laura A. Smith 2012].

Energy drinks containing more caffeine than coffee and cola can cause attention problems, headache, anxiety, insomnia, overexcitement and hyperactivity and may even fatal when it is excessively taken or drunk with alcohol [Substance Abuse and Mental Health Services Administration 2013; Rath M 2012]. Energy drinks are offered as enhancers of alertness, physical ability and cognitive enhancement [Babu KM *et al* 2008]. Most consumers are teenagers and young adults [Attila S and Cakir B 2011; Malinauskas BM 2007]. University medical, sports and art students are more likely to consume these beverages [Attila S and Cakir B 2011; Reid SD *et al* 2014]. Short-term effects of caffeine consumption include enhanced mood and alertness [Ferré 2008; Kaplan *et al* 1997; Lorist and Tops 2003], improved exercise performance [Doherty and Smith 2004], increased blood pressure [Riksen *et al* 2009], improved ability to remain awake and mentally alert after fatigue [Smit and Rogers 2002], faster information processing speed and reaction time and heightened awareness and attention [Cysneiros *et al* 2007].

A lot of research was done on the association between caffeinated beverages consumption and its effect on academic load and stress [Josué LR *et al* 2013; Alimirzae R *et al* 2014], but there is no data concerning the students of Hail University, especially medical students.

## MATERIALS AND METHODS

### Subject and Study Period:

This study was conducted with medical students (both male and female) at the University of Hail, Saudi Arabia

between 2nd March 2018 and 18th March 2018. Data was collected using a self-reported questionnaire from 258 students. Of them, 69 students who either withdrew the consent or fail to complete all questionnaire were excluded from this study and a total of 189 students were included in the analyses. A relatively balanced sex ratio (47.6% male, 52.4% female) and an age range of 18–29 were observed. The study was approved by College of Medicine, University of Hail. An expert validated questionnaire was developed for this study. The questions included were about demographics (Gender, Height, Weight, Educational level), types and the number of cups per day of caffeine consumption (Type of beverage like Black Coffee, Arabian Coffee, Tea, Hot Chocolate, energy drinks and Soft drinks) and reasons for consuming. In addition to this, participants were then asked to state how frequently they had perceived academic stress and load on a five-point scale (1=Very Low, 2=Below Average, 3=Average, 4=Above Average, 5=Very High), though no clinical evaluations were made. They were also asked the effects and satisfaction of caffeinated beverages.

#### **Statistical Analysis**

Statistical analyses were conducted using IBM SPSS statistical software ver. 23.0 (IBM Co., Armonk, NY, USA). The subjects were divided into 4 groups according to caffeine intake

and BMI. Pearson's chi-square test for nominal variables and analysis of variance test and Scheffe's test for continuous variables were used to compare the characteristics of each group. To evaluate the relationship of caffeine intake with BMI, self-perceived academic load and stress level with 95% confidence interval were calculated using logistic regression analysis. A p-value <0.05 was considered to indicate statistical significance.

### **RESULTS**

Overall, 258 students were solicited and 189 of them completed the questionnaire. The participation rate was 73.26%. The sample included 36 (19%) 1st year students, 32 (16.9%) 2nd year students, 27 (14.3%) 3rd year students, 54 (28.6%) 4th year students, 19 (10.1%) 5th year students and 21 (11.1 %) 6th year students. The subjects were aged between 18 and 29 years. They included 90 male (47.6%) and 99 female (52.4%) students.

Table 1 shows the BMI with age of caffeinated beverages drinking medical students. There is no significant between the age of students with their BMI. At the same time 13 students (46.4%) at the age between 18-21, 14 students (50%) at the age between 22-25 and 1 student (3.6%) at the age between 25-29 shows obese.

**Table 1:** Show the BMI with age of caffeinated beverages drinking medical students (n=189)

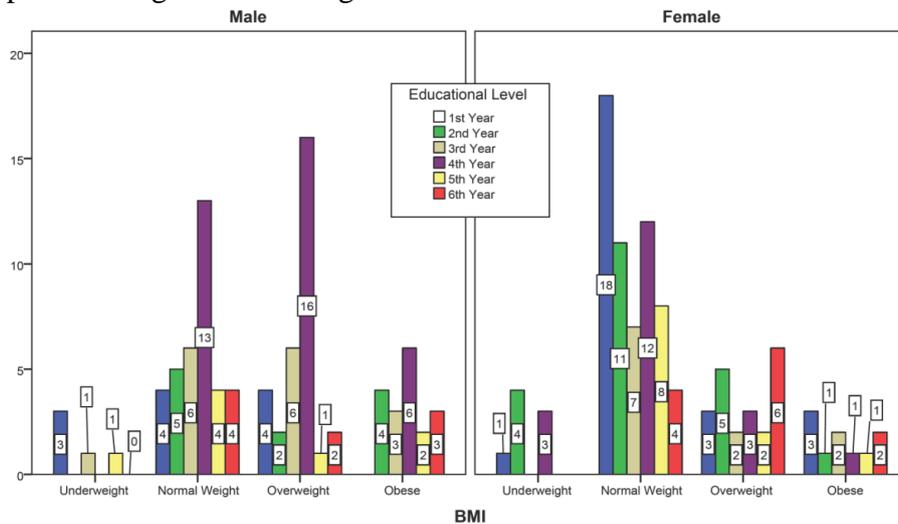
Age	BMI				Total	p-value
	Underweight	Normal Weight	Overweight	Obese		
18-21	7 <sub>a</sub> (53.8%)	59 <sub>a</sub> (61.5%)	24 <sub>a</sub> (46.2%)	13 <sub>a</sub> (46.4%)	103 (54.5%)	0.145
22-25	6 <sub>a</sub> (46.2%)	37 <sub>a</sub> (38.5%)	28 <sub>a</sub> (53.8%)	14 <sub>a</sub> (50.0%)	85 (45.0%)	
25-29	0 <sub>a</sub> (0.0%)	0 <sub>a</sub> (0.0%)	0 <sub>a</sub> (0.0%)	1 <sub>a</sub> (3.6%)	1 (0.5%)	

Each subscript letter denotes a subset of BMI categories whose column proportions do not differ significantly from each other at the 0.05 level; Values are expressed as count (% within BMI).

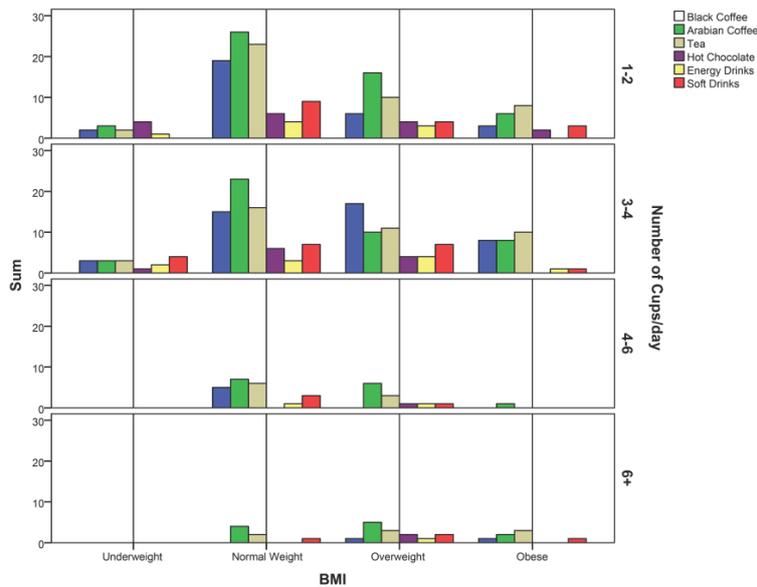
The effects of caffeinated beverages on BMI with their educational level of both male and female students were shown in figure 1. The male medical students were high in number with overweight and obese. They were mixed with all range of their educational levels.

The number of cups of caffeinated beverages/day and BMI with different caffeinated beverages in medical students were depicted in figure 2. Findings from

this cross-sectional studies (figure 2) suggest a positive trend in the relation between the intake of caffeinated beverages and overweight or obesity. Most of the students were drinking 1-2 or 3-4 cups of caffeinated beverages. Comparatively black coffee, Arabian coffee, and tea have more than other types of beverages and also these were high in obese students compare with other caffeinated beverage



**Fig. 1:** Shows the effects of caffeinated beverages on BMI with their educational level of both male and female students



**Fig. 2:** Indicates the number of cups of caffeinated beverages/day and BMI with different caffeinated beverages for medical students.

The levels of self-perceived academic load compared with BMI showed in table 2. Very high academic load (13.8%) were shown in obese students. There was no significant difference in all the range of BMI in

below average students' self-perceived academic load. Overall most of the students' feel their self-perceived academic load were average (45.5%) or above average (29.1%).

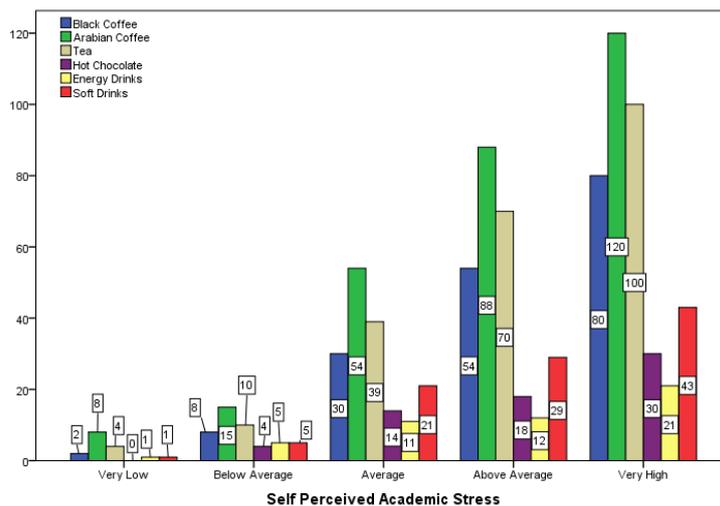
**Table 2:** Shows the levels of students' self-perceived academic load compared with BMI (n=189).

Self-perceived Academic load	BMI				Total	p-value
	Underweight	Normal Weight	Overweight	Obese		
Very Low	2 <sub>a</sub> (15.4%)	3 <sub>b</sub> (3.1%)	2 <sub>a, b</sub> (3.8%)	1 <sub>a, b</sub> (3.6%)	8 (4.2%)	0.477
Below Average	0 <sub>a</sub> (0.0%)	9 <sub>a</sub> (9.4%)	3 <sub>a</sub> (5.8%)	2 <sub>a</sub> (7.1%)	14 (7.4%)	
Average	4 <sub>a</sub> (30.8%)	48 <sub>a</sub> (50.0%)	21 <sub>a</sub> (40.4%)	13 <sub>a</sub> (46.4%)	86 (45.5%)	
Above Average	3 <sub>a</sub> (23.1%)	26 <sub>a</sub> (27.1%)	18 <sub>a</sub> (34.6%)	8 <sub>a</sub> (28.6%)	55 (29.1%)	
Very High	4 <sub>a</sub> (30.8%)	10 <sub>b</sub> (10.4%)	8 <sub>a, b</sub> (15.4%)	4 <sub>a, b</sub> (14.3%)	26 (13.8%)	

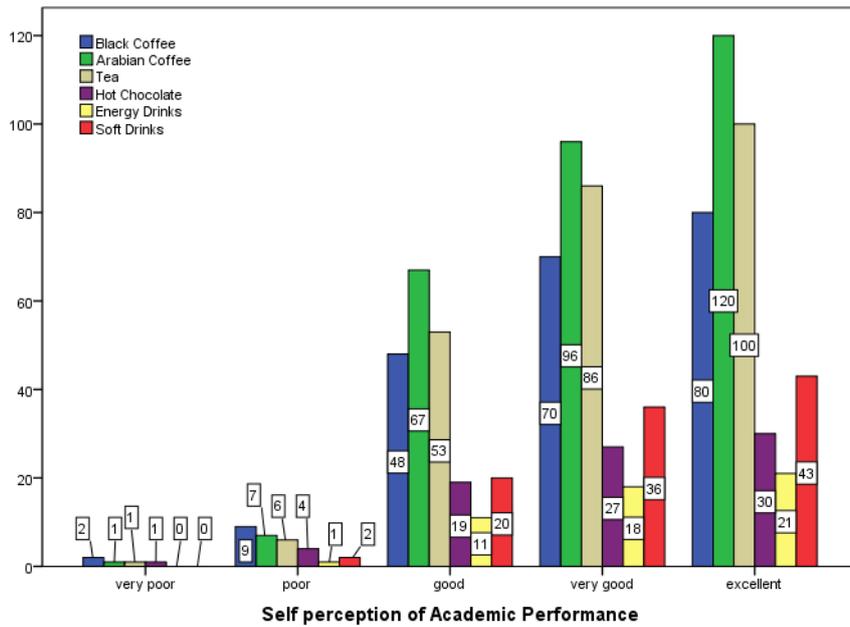
Each subscript letter denotes a subset of BMI categories whose column proportions do not differ significantly from each other at the 0.05 level; Values are expressed as count (% within BMI).

Figure 3 and 4 shows the levels of students' self-perceived academic stress and self-perceived academic performance with caffeinated beverages in medical students. Most of the medical students feel their academic stress were very high which those have drunk more Arabian coffee, tea and black coffee. Soft drinks also showed very high compared with other levels of academic stress.

These results indicate that the academic stress stimulates drinks more caffeinated beverages. Academic stress with drinking more caffeinated beverages were reflected in academic performance. Above average stress and very high academic stress showed very good and excellent academic performance respectively.



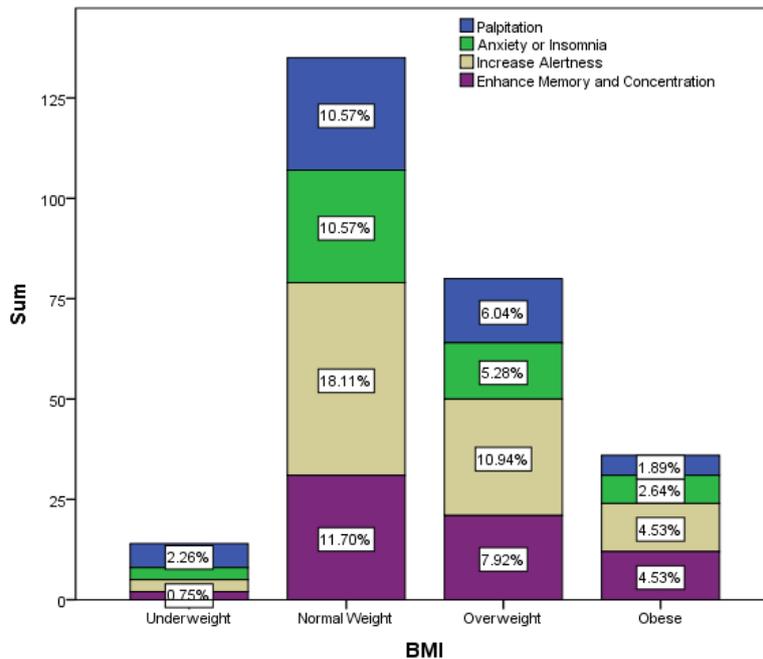
**Fig. 3:** Shows the levels of self-perceived academic stress with caffeinated beverages in medical students.



**Fig. 4:** Shows the levels of self-perceived academic performance with caffeinated beverages in medical students.

The effects of caffeinated beverages in BMI of medical students showed palpitation (10.57%) in normal weight students (Fig. 5). But the obese students showed palpitation (1.89%), anxiety (2.64%), increased alertness (4.53%), and enhanced memory and concentration (4.53%).

(4.53%) and enhance memory and concentration (4.53%). Increased caffeinated beverages drinking showed with increased effects of their anxiety and academic performance.



**Fig. 5:** Showed the effects of caffeinated beverages with their BMI of medical students

## DISCUSSION

The results of the present study were able to associate between caffeinated beverages and students self-perceive their academic loads and stress levels. In addition, this study shows that the consumption of caffeinated beverages is a popular practice among this group of students. The most popular caffeinated beverages among students were black coffee and Arabian coffee and their consumption increased in periods of high stress. Similar results were found in a study conducted at two medical schools in Puerto Rico [Arce M *et al* 2011].

Consumption of caffeinated beverages, mostly black coffee drinks, is common among University students [McIlvain *et al* 2011; Brenda M Malinauskas *et al* 2007] and many have little knowledge of the relative caffeine content of caffeinated beverages [Mackus and Marlou 2016]. Energy-drink consumption was significantly associated with gender, in that men reported a higher consumption of energy drinks than women did. In some cases, positive effects of caffeine have been observed. The low doses have been shown to reduce anxiety and elevate mood [Haskell *et al* 2005; Lieberman *et al* 1987, 2002; Smith 2009a; Smith *et al* 1999]. Smith also reported that caffeine consumption was associated with reduced risk of depression compared with non-consumption in a population study [Smith 2009b].

Negative effects of caffeine on stress and mental health have also been observed. Gilliland and Andress [1981] reported higher anxiety levels in moderate and high caffeine consumers compared with abstainers in a student sample. A possible explanation for the consumption of caffeinated beverages by college students is that they are subject to constant and increasing academic loads and consequently to academic stress

(figure 3, 4) [Diaz Y 2010] and they take advantage of the effects of stimulating beverages to improve academic performance [Arce M *et al* 2011]. Caffeine is the primary constituent responsible for these energizing effects [Smith HJ *et al* 2004].

Caffeine is the main component of these beverages and it is a xanthine, with effects such as GABA inhibition, phosphodiesterase modulation, ryanodine receptor activation and A2 adenosine receptor antagonism [Childs E *et al* 2008; Bodenmann S *et al* 2012] the latter action is most associated with the systemic and local effects of caffeine, such as increased alertness, hypoprosia, wakefulness despite sleep deprivation, irritability, fatigue, headache, hallucinations, seizures, weakness, nausea, vomiting, muscle stiffness, sleep and mood disturbances, bronchial dilatation, cholesterol level increase, gastric acid release stimulation, intraocular pressure increase, tachyarrhythmia and blood pressure increase [Aniței M *et al* 2011].

Another common component of these beverages are taurine and glucuronolactone, taurine plays a significant role in the regulation of the intracellular volume, intracellular calcium and the conjugation of bile salts [Ripps H and Shen W 2012]. Taurine is not a neurotransmitter, but it exhibits hyperpolarizing activity through metabotropic receptors [Schaffer SW *et al* 2010]. Taurine also plays an important role as a neuroprotective factor by reducing glutamate excitotoxicity, which is associated with stress conditions, such as exercise and alcohol intoxication [Wu JY and Prentice H 2010]. Glucuronolactone is a derivative of hepatic glucose metabolism; this component exerts a protective effect on hepatocytes in oxidative stress conditions [Lozano RP *et al* 2007; , Wolk BJ *et al*

2012]. It is worth to note that the content of sugar in energy drinks is also a factor that may affect cardiovascular parameters [Grasser EK *et al* 2014; Brown JJ *et al* 2011; Nguyen S *et al* 2009]. Even more, the interaction of sugar with other components of the energy drinks, mainly caffeine may explain some of the cardiovascular effects of these beverages [Miles-Chan JL *et al* 2015].

A further limitation of the current study is that it utilized a cross-sectional design. This means that all effects observed here were correlational and that causation cannot be inferred. Therefore the possibility of reverse-causation or indeed bidirectionality, cannot be disregarded. For instance, high caffeine consumption may be a cause of high academic stress, but suffering from such conditions may also lead towards the high consumption of caffeinated products as a coping strategy. In our study, the amount of caffeine intake had a significant correlation with very low to very high-stress symptoms and borderline insomnia (figure 5). This result is consistent with previous studies [Gunja N and Brown JA 2012; Carrillo JA and Benitez J 2000; Clark MA *et al* 2012; Kang SH *et al* 2012] and causes daytime sleepiness affecting academic achievement. In addition, persistent caffeine overdose can cause depression and lead to chronic depression as a withdrawal symptom even if caffeine intake is stopped [Seifert SM *et al* 2011; Reissig CJ *et al* 2009].

The abuse of caffeinated beverages, particularly energy drinks, has been linked to many health consequences. For that reason, health-related professionals need to be aware of the consequences of energy-drink consumption and be prepared to provide appropriate community education. Our results also emphasize the need for further studies, particularly longitudinal studies. Future research should identify whether college students recognize the

amounts of caffeine that are present in the wide variety of caffeinated beverages that they are consuming, the amounts of caffeine that they are consuming in various situations and the physical side effects associated with caffeine consumption.

### CONCLUSIONS

The prevalence of caffeinated beverage consumption was high with black coffee and Arabian coffee being the most frequently consumed of the beverages. Caffeinated beverages consumption, particularly, increased in academic stress and were used mainly to academic performance. Caffeinated beverages consumption was significantly higher in men, but no significant associations were found between soft drinks consumption and academic stress or load.

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## ARABIC SUMMARY

العلاقة بين المشروبات التي تحتوي على الكافيين، مؤشر كتلة الجسم والإجهاد الأكاديمي لدى طلاب الطب في جامعة حائل – دراسة مستعرضة استثنائية

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**خلفية:** طلاب الطب معرضون للإجهاد الأكاديمي العالي وكثير من هؤلاء الطلاب يستهلكون مشروبات تحتوي على الكافيين لتحسين أدائهم. تشمل الآثار قصيرة الأجل لإستهلاك الكافيين على تعزيز المزاج واليقظة. أجريت العديد من الأبحاث حول العلاقة بين إستهلاك المشروبات التي تحتوي على الكافيين وتأثيره على الجمل والإجهاد الأكاديمي، لكن لا توجد بيانات تتعلق بطلاب جامعة حائل، وخاصة طلاب الطب. تهدف الدراسة الحالية إلى تقديم بيانات مستعرضة من مختلف المستويات التعليمية للبحث في العلاقة بين المشروبات التي تحتوي على الكافيين، مؤشر كتلة الجسم، والأداء الأكاديمي والإجهاد في طلاب الطب في جامعة حائل.

**المنهجية:** أجريت هذه الدراسة على طلاب الطب (ذكوراً وإناثاً) في جامعة حائل بين ٢-مارس ٢٠١٨ و ١٨ مارس ٢٠١٨. تم جمع البيانات باستخدام إستبيان تقييم ذاتي تم تقديمه لـ ٢٥٨ طالباً. كانت الأسئلة المتضمنة حول التركيبة السكانية، أنواع المشروبات وعدد الأكواب في اليوم الواحد من إستهلاك الكافيين وأسباب هذا الإستهلاك. أسئلة عن الإجهاد والجمل الأكاديمي على مقياس من خمس درجات، وأيضاً عن تأثيرات المشروبات التي تحتوي على الكافينو الرضا عنها.

**النتائج:** كان معدل المشاركة ٧٣,٢٦٪. شملت العينة ٣٦ (١٩٪) و ٣٢ (١٦,٩٪) و ٢٧ (١٤,٣٪) و ٥٤ (٢٨,٦٪) و ١٩ (١٠,١٪) و ٢١ (١١,١٪) من طلاب السنة الأولى، الثانية، الثالثة، الرابعة، الخامسة والسادسة على التوالي. تراوحت أعمار الأشخاص ما بين ١٨ و ٢٩ سنة [٩٠ (٤٧,٦٪) ذكور و ٩٩ (٥٢,٤٪) من الإناث]. القهوة السوداء، القهوة العربية والشاي استهلاكها أكثر مقارنة مع أنواع المشروبات الأخرى، وكانت هذه المشروبات أيضاً عالية في الطلاب الذين يعانون من السمنة مقارنة مع المشروبات الأخرى التي تحتوي على الكافيين.

بشكل عام، معظم الطلاب يشعرون بأن حملهم الأكاديمي المفترض متوسط (٤٥,٥٪) أو أعلى من المتوسط (٢٩,١٪). الإجهاد الأكاديمي مع شرب المزيد من المشروبات التي تحتوي على الكافيين كانا يعكسان الأداء الأكاديمي. زيادة المشروبات التي تحتوي على الكافيين ظهرت مع زيادة في القلق والأداء الأكاديمي.

**الاستنتاج:** كان انتشار إستهلاك المشروبات التي تحتوي على الكافيين عالياً، مع كون القهوة السوداء والقهوة العربية الأكثر استهلاكاً. إستهلاك مشروبات الكافيين، على وجه الخصوص، ازداد مع الإجهاد الأكاديمي وكانت تستخدم بشكل أساسي للأداء الأكاديمي.