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Caffeine ingestion by students at the Brazil faculty of medicine: a prospective observational cross-sectional study

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Abstract

Introduction: In higher education, the consumption of stimulant substances such as coffee is increasing intensely due to the high demand of concentration and disposition of individuals. This occurs mainly among medical students. **Objective:** It was to quantify and analyze caffeine intake and its effects on medical students at the Faculty of Medicine of Catanduva, Centro Universitário Padre Albino (UNIFIPA). **Methods:** This study followed a prospective observational cross-sectional model, following the rules of clinical research of the STROBE. Data collection took place from June 2019, through an objective questionnaire and self-application, which was answered by students from the first to the sixth year of FAMECA who were interested in answering and contributing to the research, which had as objective to quantify and analyze the use of caffeine, in addition to its motivations and side effects on the physiology of these students. This study was analyzed and approved by the Research Ethics Committee according to a substantiated opinion number 5,347,594, and obtaining the Informed Consent Form. For data analysis, a common descriptive analysis was performed, obtaining the values of total N, and statistical percentage (%) for all predictors. The One-Way test (ANOVA) was applied, adopting the α level lower than 0.05, with a statistically significant difference for the 95% CI. **Results and Conclusion:** The results of this study revealed that a very large number of university students ingest caffeine. Most of the students started consumption in the pre-college course and in college, with the aim of compensating for sleep, because they like the taste of energy drinks and improve academic performance, due to the intense routine due to the high workload requires greater attention, in order to to meet the demand for studies. Most students consume moderately caffeine, which is not harmful to health. However, a minority ingest excessive amounts of substances that contain caffeine and side effects are noted. Among these, the ones that stood out were stomach problems, anxiety and tachycardia. Thus, even representing the minority, it is of fundamental importance to carry out more studies on this topic. With this, it will be possible to provide more information to the population so that it is able to assess the impacts of the use of stimulants in clinical practice, in order to minimize possible adverse effects. Finally, the population will be able to use caffeine properly, according to the recommended dose, avoiding major health problems.

Keywords: Medical students. Stimulants. Coffee. Academic achievement. Effects.

Introduction

Over the years, there has been a great increase in the consumption of stimulant substances in order to compensate for the loss of sleep and maintain mental performance. These substances are able to increase alertness, motivation, in addition to improving mood and cognitive performance **[1-3]**. The main stimulants used for these purposes are caffeine, MDMA, methylphenidate, modafinil, piracetam, energy drinks and amphetamines **[4]**.

Caffeine is one of the most consumed psychoactive substances worldwide and can be found in large amounts in coffee seeds, tea leaves, caffeine-based

medicines, cocoa, guarana, soft drinks and yerba mate. **[5-8]**. Chemically, caffeine is a fast-acting alkaloid in the human body, being rapidly absorbed by the gastrointestinal system, as it has almost 100% bioavailability **[10]**.

In the body, it acts by blocking adenosine receptors in the brain and spinal cord, in addition to acting on the release of adrenaline, which stimulates the central nervous system (CNS), reducing the feeling of fatigue in the short term, increasing the ability to perform certain tasks, resulting in great physical and intellectual performance and reducing the reaction time to sensory stimuli **[9-11]**. On the other hand, the consumption of high doses of this substance can cause dependence and tolerance, which can cause anxiety, irritability, tachycardia, tinnitus, nervousness, muscle tremors, as well as negative effects on motor control and sleep quality **[7,12]**.

In higher education, the consumption of stimulant substances is increasing intensely due to the high demand of concentration and disposition of individuals. This occurs mainly among medical students, who have an intense routine due to the high workload of the course and the need to stay alert for longer, in order to meet the demand for studies **[13]**.

Thus, the unbridled use of stimulants by students, without strict nutritional and medical criteria, can directly affect the school performance and health of these individuals. Therefore, considering the above, the present study quantified and analyzed the use of caffeine by medical students, of all periods, from Padre Albino University Center in the city of Catanduva, Sao Paulo, Brazil.

Therefore, the present study aimed to quantify and analyze caffeine intake and its effects on medical students at the Faculty of Medicine of Catanduva, Padre Albino University Center (UNIFIPA).

Methods

Study Design

This study followed a prospective observational cross-sectional model, following the rules of clinical research of the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology), available on: https://www.strobe-statement.org/. A descriptive cross-sectional study was carried out with a qualitative-quantitative and field approach, with medical students from the city of Catanduva, in the interior of the state of Sao Paulo.

Questionnaire

Data collection took place from June 2019, through an objective questionnaire and self-application, which was answered by students from the first to the sixth year of FAMECA who were interested in answering and contributing to the research, which had an objective of quantifying and analyzing the use of caffeine, in addition to its motivations and side effects on the physiology of these students. Data were collected at the institution itself and also through an online questionnaire for students in the last two years, considering the time availability of each class. Specific instructions were given for the survey to be answered correctly, in addition to consent and participation terms.

Ethical Approval

This study was analyzed and approved by the Research Ethics Committee according to a substantiated opinion **number 5.347.594**, and obtaining the Informed Consent Form according to CNS/CONEP Resolution 466/12.

Statistical Analysis

For data analysis, a database was built in a Microsoft Excel spreadsheet that was exported to the Minitab 18® statistical program (version 18, Minitab, LLC, State College, Pennsylvania, USA) (Minitab®) and also to OriginPro® 9 (DPR Group, Inc., Northampton, Massachusetts, USA) (Moberly, Bernards, Waynant, 2018). A common descriptive statistical analysis was performed, obtaining the values of total N, and percentage (%) for all predictors. The One-Way test (ANOVA) was applied, adopting the α level lower than 0.05, with a statistically significant difference for the 95% CI.

Results

The sample consisted only of women, and the total number of responses obtained was 121. Therefore, the sample space consisted of medical students from the Faculty of Medicine of Catanduva whose average age is 21 years and 3 months (max.= 38 years; min.=17 years). Regarding the class, the students who answered the questionnaire belong to classes 45, 46, 47, 48, 49, and 50 (first to the sixth year), with the first year (class 50) being responsible for 42.14% of the answers, the second year (class 49) responsible for 33.88%, the third year (class 48) responsible for 14.04%, the fourth year (class 47) responsible for 5.78%, the fifth year (class 46) responsible for by 3.3%, and the sixth year (class 45) was responsible for 0.82% of the total responses.

In terms of caffeine consumption, 108 women

consume it (89.25%) and 13 do not (10.74%). Regarding the use of haystacks, cigarettes, and the like, 17 people use them (14.05% of the total) and 104 do not (85.95%). As for the pattern of consumption of products containing caffeine, the following were listed: coffee, Coca-Cola, caffeine capsules, energy drink, mate tea, and black tea, with N being the number of people who reported consuming such products. **Table 1** shows these data.

Table 1. Consumption patterns of products containing caffeine were listed: coffee, Coca-Cola, caffeine capsule, energy drink, mate tea, and black tea, adopting the α level lower than 0.05, with a statistically significant difference for the 95% CI.

Consumption pattern of products containing caffeine	*N*	*%*
COFFEE	**93**	**55.35**
COKE	**40**	**23.8**
CAFFEINE CAPSULE	**5**	**2.97**
ENERGETIC	**24**	**14.28**
CAPPUCCINO	**2**	**1.19**
YERBA MATE TEA	**2**	**1.19**
BLACK TEA	**2**	**1.19**
p-value	**p<0.05***	
	*** Between the variable "coffee" and the others**	

The study also related how many days a week individuals used caffeine. **Table 2** below shows how many days a week people ingest caffeine, with N being the number of people who reported consuming such products.

Table 2. Days in the week of caffeine intake, adopting the α level lower than 0.05, with a statistically significant difference for the 95% CI.

Number of days in the week that caffeine consumption occurs	*N*	*%*
1 Day	**6**	**5.55**
2 Days	**12**	**11.11**
3 Days	**12**	**11.11**
4 Days	**18**	**16.66**
5 Days	**18**	**16.66**
6 Days	**11**	**10.18**
7 Days	**31**	**28.7**
p-value	**p<0.05***	
	*** Between the variable "7 Days" and the others**	

The number of times caffeine consumption occurs per day was also addressed, with the number of 57 people (47.1%) who claimed to consume it once a day; 35 people (28.92%) 2 times a day, and 17 people (14.04%) claimed to consume 3 times or more a day. As for the amounts of caffeine, the following information presented in **Table 3** below was collected. Considering N the number of people who reported consuming such products in certain portions.

Table 3. Amount of caffeine ingested, adopting the α level lower than 0.05, with a statistically significant difference for the 95% CI.

Portion of caffeine	*N*	*%*
American Cup	48	36.92
large cup	17	13.07
small cup	46	35.38
Capsule	3	2.3
Tin	16	12.3
p-value	**p<0.05***	
	*** Between the variables "American glass" and "small cup" and the others**	

As for the reasons that led individuals to ingest caffeine, they were listed as cram school, school, college, family, and the internet. N is the number of people who reported consuming products containing caffeine. This is represented in **Table 4**.

Table 4. Reasons leading to caffeine intake, adopting the α level lower than 0.05, with a statistically significant difference for the 95% CI.

What motivated caffeine intake	*N*	*%*
School	2	1.39
Prep school	59	41.25
Faculty	37	25.87
Family	41	28.67
Internet	4	2.79
p-value	**p<0.05***	
	*** Between the variable "Prep school" and the others**	

Regarding the purpose of caffeine use, the following reasons were listed: sleep compensation, liking the taste, reducing exhaustion, improving academic performance, and reducing stress. Considering N the number of people who reported consuming caffeine for this purpose. Such data are shown in **Table 5**.

Table 5. Purpose of caffeine use, adopting the α level lower than 0.05, with a statistically significant difference for the 95% CI.

Purpose of caffeine consumption	*N*	*%*
sleep compensation	64	25.39
like the taste	66	26.19
decrease exhaustion	42	16.66
Improve academic performance	66	26.19
decrease stress	14	5.55
p-value	**p<0.05***	

***Among the variables "Sleep compensation"; "Like the taste"; "Improve academic performance" and others**

The study found a statistically significant association between caffeine consumption and the most common side effects. N is the number of people who reported having such effects. This association is shown in **Table 6**.

Table 6. Caffeine consumption and side effects.

Side effects	*N*	*%*
Insomnia	22	11.16
Headache	27	13.7
Irritation	11	5.58
Anxiety	43	21.82
stomach problems	53	26.9
Tachycardia	37	18.78
None	4	2.03
p-value	**p<0.05***	

***Among the variables "Anxiety"; "Stomach problems" and others**

The effects perceived by individuals after caffeine ingestion were analyzed and quantified, as shown in **Table 7**. N is the number of people who claimed to have had such effects.

Table 7. Perceived effects after caffeine ingestion.

Perceived effects after caffeine ingestion	*N*	*%*
well-being improvement	38	15.26
sleep reduction	88	35.34
Fatigue reduction	48	19.27
improvement of concentration	47	18.87
improvement of reasoning	17	6.82
stress reduction	9	3.61
None	2	0.8
p-value	**p<0.05***	

***Between the variable "Sleep reduction" and the others**

Discussion

From the data collected on the age of the research participants, it can be seen that it is in agreement with the results found by other authors **[1-3]**. On the other hand, a study showed a predominance of the age group above 25 years old **[14]**. Regarding the year in the medical course, the first three classes (50, 49, and 48) are more relevant for the present study, as there was a greater number of responses. The authors Menezes, Nomerg, and Lenz **[14]**, observed that students in the initial periods consumed more caffeine.

Although caffeine has no nutritional value and causes several effects that can be beneficial or not, it is part of the daily routine for many people, which makes it the most used stimulant drug in the world **[15]**. In addition, the lifestyle of medical students contributes to the use of stimulant substances to meet the demand for studies **[16]**. Thus, such data are in agreement with the results found, in which there was a prevalence of women who consume caffeine.

As for the pattern of consumption of products that contain caffeine, those with the highest results were coffee (55.35%) and Coca-Cola (23.8%). Recent studies have shown that regular coffee intake can help fight chronic and degenerative diseases, such as Parkinson's disease and cardiovascular diseases **[17-20]**, in addition to preventing Type 2 Diabetes Mellitus **[21]**. It was also observed that about 14.28% of the students consumed energy drinks, which can present a health risk, since these drinks have high levels of caffeine compared to other substances that compose it, such as taurine, caffeine, guarana, ginseng, glucuronolactone, and vitamins **[22]**.

Consumption of a cup of Brazilian coffee (60 mL) can contain between 85 mg and 125 mg of caffeine, with an average intake of around 50.4 mg. Studies recommend that caffeine be consumed in moderate doses, that is, from 200 to 300 mg/day), as it can induce effects such as increased physical, cognitive, and concentration performance. While doses above 600mg are characterized as excessive consumption, they can cause harmful effects such as nervousness, tremors, and mental confusion, among other actions. Therefore, the results of the present study showed that because most medical students make continuous use of caffeine (7 days), between 1 or 2 times a day, using portions that are equivalent to a cup of coffee or an American

cup (190mL), does not imply a potential health risk, as they consume moderate amounts of caffeine. However, in some students, there may be neutralization of the effects expected by caffeine, as it is possible to infer that there was certain habituation to it since there is chronic ingestion of 100mg/day, which is equivalent to one or two cups of coffee **[15]**.

The main reasons that encouraged the consumption of caffeine were prep courses, family, and college. Similar results were obtained by Plumber et al. 2021 **[23]**, in which family and friends influenced coffee and tea consumption.

Regarding the purpose of using caffeine, the participants evidenced sleep compensation (25.39%), improvement in academic performance 26.19% and the taste of flavor 26.19%. Similar results were observed in the study conducted by the authors O'Connor PJ, Kennedy DO, Stahl, 2021 **[24]**, in which the consumption of energy drinks was aimed at sleep deprivation (38%) because they liked the taste of the drink (32%).

Also, the authors Wikoff et al., 2017 **[25]** reported that caffeine, when ingested by people sensitive to it or consumed in excess, causes several side effects, such as insomnia, headaches, irritation, anxiety, memory impairment, and nausea, gastrointestinal discomforts, muscle tremors, tachycardia, and tinnitus. In addition, caffeine acts by directly stimulating the myocardium, which leads to an increase in the force of contraction, cardiac performance, and especially frequency. Therefore, this action can result in tachycardia. These facts are consistent with the results found in this study, in which stomach problems, anxiety, and tachycardia, respectively, were the most common side effects associated with caffeine consumption. It was possible to observe in other studies adverse effects different from those reported in greater relevance in this project, with insomnia corresponding to the highest percentage, followed by headache, irritation, other symptoms, tachycardia, blurred vision, dry mouth, and nausea.

It was observed that the most perceived effect among the participants was the reduction of sleep (35.34%), followed by Reduction of tiredness 19.27, Improved concentration 18.87%, and well-being 15.26%. A possible explanation for this result lies in the mechanism of action of caffeine, which consists of blocking adenosine receptors. This has a calming effect on neurons, acts to decrease cellular activity, and its receptors are found in various tissues **[26]**. In this way, when caffeine binds to its receptors, it acts oppositely, increasing the action of the sympathetic nervous system and accelerating neural activities.

Still, other authors have confirmed in their article some effects of caffeine, such as increased mental attention, increased concentration, increased release of catecholamines, increased mobilization of free fatty acids, increased use of muscle triglycerides, improved mood and decreased reaction time **[27]**. A similar result was presented in a study with psychostimulants, with an improvement in concentration, 81.2% (n = 91), reduction in sleep, 58.0% (n = 65) reduction in fatigue, 54.0% (n = 60) and improved well-being, 56.1% (n = 59) **[4]**.

Conclusion

This study aimed to quantify and analyze caffeine intake and its effects on medical students at the Faculty of Medicine of Catanduva, Padre Albino University Center. The results of this study allow us to conclude that the number of university students who ingest caffeine is very large. Most of the students started consumption in the pre-college course and college, to compensate for sleep, because they like the taste of energy drinks and to improve academic performance, due to the intense routine due to the high workload requires greater attention, to meet the demand for studies. Most students consume moderate caffeine, which is not harmful to health. However, a minority ingest excessive amounts of substances that contain caffeine, and side effects are noted. Among these, the ones that stood out were stomach problems, anxiety, and tachycardia. Thus, even representing the minority, it is of fundamental importance to carry out more studies on this topic. With this, it will be possible to provide more information to the population so that it can assess the impacts of the use of stimulants in clinical practice, to minimize possible adverse effects. Finally, the population will be able to use caffeine properly, according to the recommended dose, avoiding major health problems.

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Not applicable.

Ethical approval

This study was analyzed and approved by the Research Ethics Committee according to a substantiated opinion number 5.347.594, and obtaining the Informed Consent Form according to CNS/CONEP Resolution 466/12.

Informed consent
The patient signed the consent form.

Data sharing statement
No additional data are available.

Conflict of interest
The authors declare no conflict of interest.

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