ORIGINAL ARTICLE

Caffeine Intake and Its Association with Mental Health Status among Pharmacy Students at UiTM Puncak Alam

Nurul Atikah Annuar[1], John Kwong Siew Shia[2], Noor Jannah Yob[2], Yuslina Zakaria[2,3], Siti Nooraishah Hussin[2]

[1] Faculty of Pharmacy, Universiti Teknologi MARA (UiTM) Selangor Branch, Puncak Alam Campus, 42300 Bandar Puncak Alam, Selangor, Malaysia.
[2] Department of Pharmaceutical Life Sciences, Faculty of Pharmacy, Universiti Teknologi MARA (UiTM) Selangor Branch, Puncak Alam Campus, 42300 Bandar Puncak Alam, Selangor, Malaysia.
[3] Accounting Research Institute (ARI), Universiti Teknologi MARA (UiTM), 40450 Shah Alam, Selangor, Malaysia

ABSTRACT

Introduction: Caffeine is a psychoactive substance widely consumed over the past decades. The effect of caffeine can be either beneficial or harmful. It increases cognitive performances, including attention, alertness and concentration. However, high caffeine intake may also induce an anxiogenic effect, causing symptoms such as rapid heart rate, restlessness and nervousness. This study aimed to determine the association between caffeine intake and mental health disorders such as anxiety and depression among undergraduate pharmacy students at UiTM Puncak Alam. **Methods:** This was a cross-sectional study with stratified random convenience sampling. A total of 270 undergraduate pharmacy students in UiTM Puncak Alam, Selangor participated in this study. A set of questionnaires was distributed using the Google Form platform. Standard General Anxiety Disorder (GAD-7) and Patient Health Questionnaire (PHQ-9) scoring were used to assess the level of anxiety and depression among the respondents, respectively. SPSS version 27.0 was used to analyse the data. **Results:** About 70.4% of the students consumed caffeine, while 29.6% of the students did not consume caffeine. No significant association was found between caffeine status and the mental health scoring of GAD-7 (χ^2=4.639, p=0.200) and PHQ-9 (χ^2=5.256, p=0.262). **Conclusion:** Non-daily consumption and a low dose of caffeine intake patterns are good practises to prevent the development of anxiety or depression conditions, although the associations were not significant. Public awareness on possible anxiogenic effect and mental related disorders due to caffeine consumption need to be initiated, as nowadays, the caffeine intake behaviour has become a trendy lifestyle among the young adults.
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Keywords: Caffeine intake, Anxiety disorder, Depression, Mental health status

Corresponding Author:
Siti Nooraishah Binti Hussin, PhD
Email: nooraishah0352@uitm.edu.my
Tel: +6016-6275436

INTRODUCTION

Caffeine is an alkaloid that acts primarily in the central nervous system and has been widely consumed over the past decades (1). It can be found in various types of natural products such as coffee beans, cocoa beans, tea leaves and guarana plants (2). Eighty-nine per cent of the United States population has been reported consuming caffeine, where coffee is the primary source of caffeine, followed by tea, soft drinks and energy drinks (3). Malaysia is among the top 50 countries with the highest caffeine intake, approximately 1.3 kg per capita (4). A study in Ipoh, Perak involving 300 participants aged 40 and above, discovered that 74% of the subjects used caffeine, and the majority of them took caffeine daily for over 20 years (5).

Depending on population groups, the main purpose of caffeine intake varies. A study among 540 surgeons reported that 54.3% of them consumed caffeine during long working hours and night shifts did reduce fatigue (6). In addition, a study conducted at a private medical school in Malaysia found that college students used caffeinated products to stay awake (7).

According to the Food and Drug Administration (FDA), 400 milligrams of caffeine per day, equivalent to 4 to 5 cups of coffee, is generally safe for healthy adults (8). Depending on individual sensitivity, consuming a low dose of caffeine has beneficial effects. Caffeine is a cognitive enhancer as it exerts stimulant effect on the central nervous system, by competitively blocking the inhibitory neurotransmitter (adenosine) from its

receptors. The antagonistic properties of caffeine on A1 and A2A adenosine receptor subtypes in the brain result in increased cognitive performances, including attention, alertness and concentration (9). In addition, caffeine also significantly impacts physical performance (9).

On the other hand, high caffeine intake can also be harmful. High doses of caffeine reverse the action of adenosine on its receptor and subsequently increase the release of adrenaline. The binding of adrenaline neurotransmitters leads to the activation of β1 adrenoceptors in the heart, resulting in positive inotropic and chronotropic effects (10). Moreover, excessive caffeine consumption will lead to insomnia. A study conducted among Australian adults suggested that caffeine intake strongly influences total sleeping time by increasing the time it takes to fall asleep (11).

The effects of caffeine vary from person to person. For instance, high doses of caffeine increased anxiety level among college students in Florida (12). In placing more emphasis, the anxiolytic effect of caffeine also differs between genders (13). Nunez et al. (2015) reported that caffeine is less responsive in women, while men are more likely to experience anxiety due to the more significant stimulant effect of caffeine (14).

A study conducted among middle school students in Korea suggested that caffeine intake significantly associated with depression (15). In contrast, Turnbull et al. (2016) reported no association between the consumption of 100 mg of caffeine on anxiety or depression (16). Meanwhile, a study by Kim (2018) revealed that caffeine reduced the risk of depression in the Korean population (17) which might be due to the property that caffeine acts as an antioxidant (18) that prevents the oxidative stress condition in depression (19).

Nowadays, young adults tend to consume caffeine and many have made it essential in their life. Stress and pressure experienced by students to cope with the hectic academic workload and to maintain study-life balance might increase their tendency to consume more caffeine, subsequently making them more sensitive to caffeine's anxiogenic effect. The lack of information on students' patterns of caffeine consumption has led us to further determine the association between caffeine intake and mental health status among undergraduate pharmacy students in UiTM, Puncak Alam. In addition, this research served as a medium to report respondents' attitudes and perceptions towards the related caffeine intake behaviour.

MATERIALS AND METHODS

Ethics Approval

Ethics approval for conducting the research study was obtained from the Human Research Ethics Committee (REC) of Universiti Teknologi MARA (UiTM) (REC (PH)/010/2022).

Study Design and Recruitment of Respondents

This was a cross-sectional study with a stratified random convenience sampling. The target respondents were among the undergraduate pharmacy students from first- to fourth-year batches in UiTM Puncak Alam, Selangor. The sample size was calculated using the Raosoft sample size calculator; at 95% confidence interval, 5% margin of error, and 50% response distribution. A total of 270 out of 696 pharmacy students were recruited for this study. Informed consent was obtained electronically before data were collected from the respondents.

Questionnaires

The research was structured to gather the respondents' information via bilingual questionnaires in English and Malay (20,21). Respondents responded according to their preferred language.

Section A consisted of five questions related to the sociodemographic data of the respondents. Section B comprised questions related to the pattern of caffeine intake. The mental health status scoring in Section C contained the Generalised Anxiety Disorder (GAD-7) and the Patient Health Questionnaire (PHQ-9) (22). The GAD-7 measures the severity of generalised anxiety disorder. In comparison, the PHQ-9 assesses the severity of depression. This section is a Likert-type with four options to measure frequency: 0 (Not at all), 1 (Several days), 2 (More than half the days) and 3 (Nearly every day).

Section D consisted of nine items related to attitude statements toward caffeine (Poor attitude = 9 to 19, Moderate attitude = 20 to 32, Good attitude = 33 to 45). Lastly, section E was related to perception towards caffeine with six items. From Section D to E, all items were measured using a five-point Likert scale (1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree).

The Google Forms platform was used to construct and publish the online questionnaires before being disseminated to the respondents via WhatsApp. The sampling process was conducted from April to July 2022. Prior to the statistical analyses, preliminary tests using Cronbach's alpha were conducted to check for the reliability of the data, particularly in section D and E.

Data analysis

The Statistical Package for the Social Science (SPSS) software version 27.0 was used for the statistical analyses in this study. The Kolmogorov-Smirnov test of normality was performed to test for normality. Descriptive statistics were used to describe the demographic profile of respondents, while inferential statistical analysis such as

Pearson's Chi-Square test was conducted to associate the caffeine intake status with sociodemographic variables and mental health scoring among the respondents. The mean differences in attitude and perception among the consumed and non-consumed respondents were determined by an independent T-test. The level of significance for all analyses was set to $p<0.05$.

RESULTS

A total of 270 undergraduate pharmacy students of UiTM Puncak Alam, with a mean age of 22.10 ± 1.50 years, voluntarily participated in this study. They comprised 65 first-year students (24.1%), 72 second-year students (26.7%), 68 third-year students (25.2%) and 65 fourth-year students (24.1%). Respondents reported on their sociodemographic data, including the information on caffeine consumption (purpose, type of caffeinated beverages, frequency and the factors influencing the caffeine intake).

Regarding gender composition, 33 were male students (12.2%), and 237 were female students (87.8%). About 23% of male students from the total population of male pharmacy undergraduate students (33/144) have responded to the questionnaire, while approximately 43% (237/552) were the female respondents. The ratio of male to female students in the faculty was approximately equivalent to 1:3. It was discovered that 70.4% of the respondents consumed caffeine, while 29.6% did not consume caffeine. In comparison, Pearson's Chi-Square test indicated a significant difference in caffeine status between respondents' years of study (χ^2=7.955, p=0.047). There were no statistical differences in the areas of living, gender and age between consumed and non-consumed caffeine respondents (Table I).

As shown in Fig. 1, coffee (49.6%) was reported to be the most caffeinated product type consumed by undergraduate pharmacy students, followed by tea (25.9%) and chocolate drinks (17.8%). On the other hand, energy drinks (0.4%) were the least preferred. The remaining 6.3% of respondents reported not consuming any caffeinated products.

Further analysis also found a significant association in the type of caffeinated products and years of study (χ^2=24.509, p=0.017). It was discovered that second-year pharmacy students consumed coffee as the primary caffeine source (31.3%). In contrast, chocolate drinks (35.4%) and tea (30%) were the primary caffeine sources among the third-year batch.

The non-consumed respondents were further divided into previously consumed and never consumed categories. About 50.5% of respondents who consumed caffeine and 77.8% who previously consumed caffeine, did not consume caffeine daily. The association between the caffeine status categories and the frequency of caffeine intake among the respondents was also significant (χ^2=288.018, p<0.000) (Table II). From a total of 190 consumed respondents, 86.3% of them represented the categories of taking only one serving per day and not on a daily basis.

Moreover, it was found that only four respondents who consumed caffeine (2.1%) and one respondent who previously consumed caffeine (1.6%) took more than two servings per day. The reason for caffeine intake

Table I: Sociodemographic characteristics of the respondents

	n (%)		χ^2	p-value
	Consumed (N = 190)	Not consumed (N = 80)		
Area of Living			0.658[a]	0.720
Urban	89 (46.8)	39 (48.8)		
Sub-Urban	57 (30.0)	26 (32.5)		
Rural	44 (23.2)	15 (18.8)		
Gender			1.719[a]	0.190
Male	20 (10.5)	13 (16.2)		
Female	170 (89.5)	67 (83.8)		
Year of Study			7.955[a]	0.047*
1	38 (20.0)	27 (33.8)		
2	55 (28.9)	17 (21.2)		
3	46 (24.2)	22 (27.5)		
4	51 (26.8)	14 (17.5)		
Age (mean ± SD)	22.10 ± 1.50		11.972[a]	0.101
19 years old	0 (0)	1 (1.2)		
20 years old	27 (14.2)	22 (27.5)		
21 years old	42 (22.1)	11 (13.8)		
22 years old	37 (19.5)	17 (21.2)		
23 years old	48 (25.3)	16 (20.0)		
24 years old	22 (11.6)	10 (12.5)		
25 years old	13 (6.8)	3 (3.8)		
26 years old	1 (0.5)	0 (0)		

[a]Based on Pearson's Chi Square
*Statistically significant at p-value < 0.05

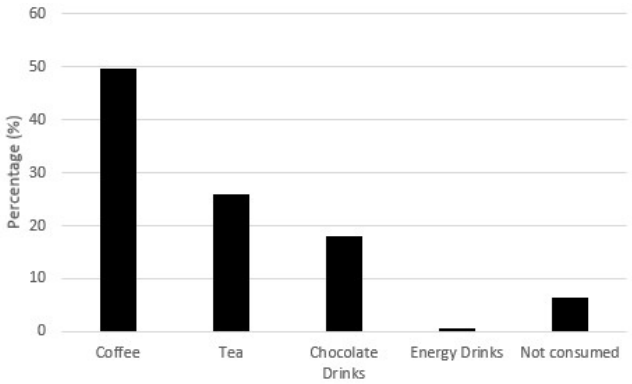

Figure 1: Pattern of caffeinated products consumed among undergraduate pharmacy students. The bar graph shows the frequency (%) of caffeinated products that is consumed by the respondents.

Table II: Frequency of caffeine intake among undergraduate pharmacy students

	Consumed n (%)	Not Consumed n (%)		χ^2	p-value
		Previously consumed	Never consumed		
				288.018[a]	<0.000
No intake at all	0 (0)	0 (0)	17 (100)		
One serving per day	68 (35.8)	13 (20.6)	0 (0)		
Two servings per day	22 (11.6)	0 (0)	0 (0)		
More than two servings per day	4 (2.1)	1 (1.6)	0 (0)		
Not everyday	96 (50.5)	49 (77.8)	0 (0)		

[a]Based on Pearson's Chi Square
*Statistically significant at p-value < 0.05

among undergraduate pharmacy students varies. The majority of the respondents stated that their main reason for taking caffeine was to enjoy the taste of caffeine (51.1%), followed by to help them to stay awake (23%), to improve alertness (14.4%), to improve physical performance (3%) and social interaction (2.2%). As shown in Table III, there was a significant difference between caffeine status and the purpose of caffeine intake (χ^2=278.923, p=0.000).

Table III: Purpose of caffeine intake among undergraduate pharmacy students

	Consumed n (%)	Previously consumed n (%)	χ^2	p-value
			278.923[a]	0.000*
Enjoy the taste of caffeine	108 (56.8)	30 (47.6)		
Stay awake	40 (21.1)	22 (34.9)		
Improve alertness	33 (17.4)	6 (9.5)		
Improve physical performance	6 (3.2)	2 (3.2)		
Social interaction	3 (1.6)	3 (4.8)		

[a]Based on Pearson's Chi Square
*Statistically significant at p-value < 0.05

The present study also investigated the factors influencing caffeine intake among undergraduate pharmacy students. It was shown that lifestyle was the highest factor that motivated caffeine intake among respondents (45.9%). Respondents also reported other factors that influence them on caffeine taking, including habit (27%), dependency (16.3%), withdrawal symptoms (2.6%) and financial (1.9%).

The attitudes toward caffeine among undergraduate Pharmacy students were also investigated. The majority of the respondents have a moderate attitude towards caffeine intake (59.6%), followed by a good attitude (37%) and a poor attitude (3.3%). Pearson's Chi-Square also indicated a significant association between caffeine intake status and attitude levels (χ^2=7.445, p=0.024).

Table IV showed the overall mean of responses from different caffeine statuses toward attitude statements provided in the questionnaires. The majority of caffeine consumers agreed about the effect of caffeine on the human body, including positive lifestyle (p<0.001), trendy (p=0.013), improved physical performance (p<0.001), increased mental alertness (p<0.001), improved mood (p<0.001) and increased urination (p=0.003). In contrast, the non-consumed respondents showed a higher mean value than the consumed respondents, indicating that caffeine caused increased heart rate and dehydration, although no significant differences were found (p>0.05).

Table V reported the respondents' means and standard deviations of perception responses. The consumed respondents agreed that caffeine produced health benefits, which was significantly different from the non-consumed respondents (t=3.044, p = 0.003). Another

Table IV: Attitudes toward caffeine intake among undergraduate pharmacy students

	Mean ± SD		t-value	p-value
	Consumed	Not consumed		
Caffeine contributes to a positive lifestyle	3.15 ± 0.783	2.69 ± 0.739	4.479[a]	0.000**
Caffeine is trendy	3.51 ± 0.985	3.16 ± 1.130	2.497[a]	0.013*
Caffeine improves physical performance	3.31 ± 0.972	2.56 ± 0.939	5.830[a]	0.000**
Caffeine increases mental alertness	3.49 ± 0.953	2.89 ± 1.079	4.555[a]	0.000**
Caffeine improves mood	3.52 ± 1.022	2.76 ± 0.997	5.609[a]	0.000**
Caffeine increases heart rate	3.72 ± 0.938	3.76 ± 0.984	-0.327[a]	0.744
Caffeine increases urination	3.92 ± 0.986	3.53 ± 1.055	2.951[a]	0.003*
Caffeine causes dehydration	3.40 ± 1.053	3.45 ± 1.018	-0.360[a]	0.719
Caffeine causes headaches	3.20 ± 1.123	3.76 ± 1.009	-3.869[a]	0.000**

[a]Based on Independent T-Test
*Statistically significant at p-value <0.05
**Statistically significant at p-value <0.001

Table V: Perceptions toward caffeine intake among undergraduate pharmacy students

	Mean ± SD		t-value	p-value
	Consumed	Not consumed		
I believe caffeine has health benefits	3.87 ± 0.845	3.49 ± 0.994	3.044[a]	0.003*
I believe caffeine has short- and long-term effects	4.19 ± 0.682	4.05 ± 0.727	1.562[a]	0.120
I believe caffeine causes caffeine tolerance	4.23 ± 0.656	3.91 ± 0.814	3.334[a]	0.001*
I believe caffeine causes addiction	4.14 ± 0.824	4.11 ± 0.729	0.229[a]	0.819
I believe caffeine causes cancer	2.47 ± 0.871	2.58 ± 0.883	-0.915[a]	0.361
I believe over caffeine usage leads to toxicity	3.68 ± 0.946	3.53 ± 1.113	1.120[a]	0.265

[a]Based on Independent T-Test
*Statistically significant at p-value <0.05

strongly approved perception among the consumed respondents was the caffeine tolerance effect (t=0.334, p=0.001).

This study also focused on the association between caffeine intake and mental health status, particularly anxiety disorder and depression. In general, responses from the GAD-7 survey discovered that 130 pharmacy students (48.1%) had no anxiety disorder. Meanwhile, 34.1% and 12.2% of the respondents experienced mild and moderate anxiety, respectively. Besides, the major concern was that 15 subjects (5.6%) had a severe anxiety disorder (Table VI).

Concerning depression, the PHQ-9 questionnaire detected that 33.7% of respondents suffered from mild depression, followed by 30% classified as normal, 18.9% as moderate, 11.1% as moderately severe and 6.3% as severely depressed. Pearson's Chi-Square was performed to assess the association between caffeine status and the mental health scoring of the GAD-7 and PHQ-9. The result showed no significant association between the caffeine status and the mental health scoring of GAD-7 (χ^2=4.639, p=0.200) and PHQ-9 (χ^2=5.256, p=0.262).

DISCUSSION

Most pharmacy students who participated in this study consumed caffeine, with a higher prevalence among female students. This data was in line with the previous study by Mahoney et al. (2019), who conducted research among undergraduate students at five universities in the United States (23). Although the numbers of participants from the male students were low, it was in accordance with their small population numbers in comparison to the total numbers of the female pharmacy undergraduate students. Furthermore, female respondents were found to be more responsive to online survey research (24).

In the present study, coffee was the primary source of caffeine for the respondents, followed by tea and chocolate drinks. In contrast, college students in Lahore mostly took tea as their primary caffeine source, followed by soft drinks and coffee (24). Interestingly, caffeinated energy drinks were the least consumed, unlike other sources of caffeine. In accordance, several studies asserted the most prominent concern over energy drinks consumption with the risk of supraventricular arrhythmias. The underlying mechanism of this condition is related to the sensitisation of dopamine receptors due to the increased release of catecholamine triggered by caffeine (25). Moreover, excessive consumption of energy drinks increases the incidence of atrial fibrillation, a heart condition with an irregular and rapid heartbeat (26,27). Hence, the public should be aware of the potential harmful consequences of consuming caffeinated energy drinks.

In addition, only 94 students from the total number of respondents in the current research consumed caffeine on daily basis. This ratio was rather low (35%) in comparison to previous findings by Samoggia and Rezzaghi (2021) who reported that 80% of the world population consumed caffeine every day (28). In placing more emphasis, the second-year students were recorded to consume caffeinated products most frequently compared to the other batches. As to the purpose connected with the consumption of caffeine products, the most important reason was the enjoyment of the taste, followed by the intention to stay awake and improve alertness. Kharaba et al. (2022) reported similar findings that out of 467 students from different universities in the UAE, 59.4% of them also consumed caffeine to stay awake and to facilitate learning (29). Moreover, a recent systematic review of 58 studies by Booker et al. (2018) concluded that the significant reason for caffeine intake among healthcare workers, including nurses and midwives, was to stay awake to cope with poor and inadequate sleep (30).

In the current study, lifestyle was also found as one of the reasons for caffeine consumption. Lifestyle is a vital factor in health and quality of life, which refers to the characteristics of individuals, including their daily activities, behaviour, diet and sleep patterns (31). The hectic academic schedules and the struggle to balance studies and personal life could increase the respondents' tendency to consume more caffeine. Hence, the respondents may include caffeine in their routine dietary plan for various purposes.

Furthermore, the pharmacy students' attitudes toward caffeine were classified into three categories: good, moderate and poor. A good attitude is resulted from a positive psychological and physical expression of situations or interactions with things, whereas a poor attitude is the opposite. In the current study, the consumed respondents agreed on the caffeine's role in improving physical performance, as it was also supported by Talanian et al. (2016) (32).

The research findings also supported that pharmacy students who consumed and previously consumed caffeine had a strong understanding and awareness towards caffeine intake. They showed high agreement with improving mood as one of the positive effects of caffeine consumption. The effect of caffeine on mood has been widely reported in the literature, including by Wilhelmus et al. (2017). They claimed that the stimulant effect of 60 mg of caffeine in healthy adults boosts contentment, overall mood, and relaxation (33). A double-blind, placebo-controlled study was conducted among 17 male adults in Germany to investigate the potential effect of caffeine and glucose on mood. The findings showed that caffeine, unlike glucose and placebo, resulted in mood changes, with participants

feeling more energetic after caffeine consumption (34). In addition, the potency effect of caffeine on mood has also been reported by Haskell-Ramsay et al. (2018). In the study, 56 participants were asked to consume either regular coffee containing 100 mg of caffeine, decaffeinated coffee or a placebo, and regular caffeine was found to elevate the overall mood (35).

Majority of the respondents in the current study agreed that caffeine has short- and long-term effects. Therefore, the students were more careful in their consumption. It has been reported that short-term caffeine effects include mood alleviation and irregular heartbeats, usually occurring within 5 to 30 minutes and lasting up to 12 hours. Although the FDA has set 400 milligrams of caffeine per day, equivalent to 4 to 5 cups of coffee, as an amount that is not generally associated with negative effects nor dangerous, there is a wide and varied sensitivity among individuals that contributes to different metabolising effects. Interindividual genetic variability could produce different pharmacokinetic and pharmacodynamic effects after a certain amount and duration of caffeine consumption (36). Hence, as a precaution, it can be seen that most of the consumed respondents in the current study did not take caffeine daily.

Meanwhile, most of the respondents in the current study disagreed that caffeine causes cancer. A study by Cui et al. (2020) reported on increased incidence of several cancers, such as childhood acute lymphocytic leukaemia and bladder cancers following caffeine intake (37). In contrast, a systematic review by Zhoa et al. (2020) reported various findings on cancer progression and suppression in relation to different caffeine sources (38). Thus, the respondents need to be educated to gain more comprehensive understanding on the type and source of caffeine they consumed.

The respondents in the present study also agreed that tolerance and addiction are the effects of caffeine consumption. Caffeine tolerance is developed with regular caffeine intake, which is associated with the individual's response to a dose of caffeine over time. The tolerance effect of caffeine consumption can be observed in the alteration of physical performance (39). In placing more emphasis, the possible mechanism of caffeine tolerance development was associated with increased expression of adenosine receptors in the brain after chronic caffeine consumption (40). Caffeine intake makes individuals more susceptible to developing dependence, also known as caffeine addiction. It is characterised as a persistent desire and inability to control caffeine consumption regardless of its effects on the human body (41). Withdrawal symptoms such as drowsiness, craving and lethargies have been diagnosed with caffeine dependence syndrome. These are among the post-effect perceptions that need to be considered by the respondents when they consume caffeine.

Our study found no significant association between caffeine status and anxiety disorder among the undergraduate pharmacy students. Even though the evidence was lacking in the recent study, several studies were able to link a physiological effect of caffeine consumption. A study involving 49 California University students aged between 18 and 45 years with no history of mental illness was conducted. The respondents consumed 450 mg of caffeine daily for five days and discovered that caffeine had the strongest effect on anxiety and indirectly reduced their health-related quality of life (42). A recent systematic review on the incidence of anxiety associated with caffeine consumption concluded that high caffeine intake increases the risk of anxiety. Moreover, the result showed that the anxiogenic effect of caffeine is more pronounced in men than women (43). Conversely, an animal study to determine anxiety-related behaviour as a caffeine withdrawal symptom in mice was conducted by Sweeney and colleagues. The result showed no anxiety-related behaviour in mice after receiving 20 mg/kg of caffeine (44).

Although caffeine is related to many health benefits, depending on the individual's sensitivity, caffeine consumption can indirectly increase the incidence of depression. Li et al. (2016) conducted a meta-analysis and suggested that insomnia is a risk factor contributing to an increase in the prevalence of depression (45). This is supported by a study conducted by Julia et al., who found that caffeine's stimulating effect did increase the prevalence of insomnia, where 17.9% of participants have caffeine-induced insomnia with poor sleep quality and latency (46). Thus, it showed that the harmful effect of caffeine on sleep patterns increases the incidence of depression in certain individuals.

In contrast, Navarro et al. (2018) suggested that consuming 4 cups of coffee daily lowers the incidence of depression (47). Coffee contains antioxidant properties including flavonoids, melanoidins, and various lipid-soluble compounds such as furans, pyrroles, and maltol that beneficially prevent the oxidative stress condition in depression (48). Besides that, the roles of caffeine in reducing depression have been connected to its involvement as a stimulant which increases psychomotor and dopaminergic activity. Moreover, caffeine also acts in anti-inflammatory activity due to the presence of polyphenols such as trigonelline and chlorogenic acid (49).

It is worth mentioning that the current study revealed the percentage of students who suffered from mental illnesses such as severe anxious (5.6%) and severe depressed (6.3%). Although minority of them were involved, planned actions such as early counselling and pharmacological intervention can be initiated among the targeted respondents.

Although no significant association was found between caffeine intake and the mental health status among the undergraduate pharmacy students, non-daily consumption and a low dose of caffeine intake patterns were observed. Thus, it can be suggested as good practises to prevent the development of anxiety or depression. However, the extent to which doses of caffeine are anxiogenic is still not clear. Therefore, more studies should be carried out to provide a more consistent picture.

Future studies should be continued on other target respondents of different ethnicity and economic backgrounds. Further research may also aim to compare the school children and old generations' caffeine intake patterns and their implications. A validated food-frequency questionnaire (FFQ) should also be used to provide an overall dietary pattern and to control confounder element.

CONCLUSION

In conclusion, non-daily consumption and a low dose of caffeine intake patterns are suggested as good practises to prevent the development of anxiety or depression conditions, although the associations were not significant. The current research findings provide some of the initial evidence that consuming caffeine products has become a part of young adults' lifestyle. A proactive measure should be idealised by communicating to the public about the possible anxiogenic effect to control excess caffeine consumption behaviour early.

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REFERENCES

1. Magalhres R, Picy-Pérez M, Esteves M, Vieira R, Castanho TC, Amorim L, et al. Habitual coffee drinkers display a distinct pattern of brain functional connectivity. Mol Psychiatry. 2021; 26(11): 6589–98. doi: 10.1038/s41380-021-01075-4.
2. Mejia EGD, Ramirez-Mares MV. Impact of caffeine and coffee on our health. Trends Endocrinol & Metabolism 2014;25(10):489–92. doi: 10.1016/j.tem.2014.07.003.
3. Fulgoni, V. L., Keast, D. R., & Lieberman HR. Trends in intake and sources of caffeine in the diets of US adults: 2001-2010. Am J Clin Nutr. 2015;101(5):1081–7. doi: 10.3945/AJCN.113.080077.
4. Foster J. Caffeine (Coffee) Consumption By Country [Internet]. 2021 [cited 2021 Dec 4]. Available from: https://www. caffeineinformer.com/caffeine-what-the-world-drinks.
5. Haque ATME, Mohammed Hashim NB, Binti Ruslan NA, Haque M. Lifestyle diseases and their association with coffee consumption at Ipoh, Malaysia. Res J Pharm Technol. 2015 Mar 1;8(3):285–91. doi: 10.5958/0974-360X.2015.00048.7.
6. Franke AG, Bagusat C, McFarlane C, Tassone-Steiger T, Kneist W, Lieb K. The use of caffeinated substances by surgeons for cognitive enhancement. Ann Surg. 2015;261(6):1091–5. doi: 10.1097/SLA.0000000000000830.
7. Ching CS, Ling TS. Caffeine Consumption And Knowledge Among First Year Medical Students In A Malaysian Private Medical School. Asian J Med Heal Sci. 2021;4:119-27. doi: https://doi.org/10.37268/mjphm/vol.21/no.2/art.626
8. Davis CF. How Much Is Too Much Caffeine? Effects & Symptoms [Internet]. Available from:https://www.medicinenet.com/how_much_caffeine_is_too_much_caffeine/views.htm. [Accessed on 4 Dec 2021].
9. Cappelletti S, Daria P, Sani G, Aromatario M. Caffeine: cognitive and physical performance enhancer or psychoactive drug? Curr Neuropharmacol 2015 Dec 10;13(1):71–88. doi: 10.2174/ 1570159x13666141210215655.
10. Motiejunaite J, Amar L, Vidal-Petiot E. Adrenergic receptors and cardiovascular effects of catecholamines. InAnnales d'Endocrinologie 2021 Jun 1 (Vol. 82, No. 3-4, pp. 193-197). https://doi.org/10.1016/j.ando.2020.03.012
11. Watson EJ, Coates AM, Kohler M, Banks S. Caffeine Consumption and Sleep Quality in Australian Adults. Nutrients. 2016 Aug 4];8(8). doi:103390/NU8080479.
12. Bertasi RAO, Humeda Y, Bertasi TGO, Zins Z, Kimsey J, Pujalte G. Caffeine Intake and Mental Health in College Students. Cureus. 2021;13(4) doi: 10.7759/cureus. 14313
13. Richards G, Smith A. Caffeine consumption and self-assessed stress, anxiety, and depression in secondary school children. J Psychopharmacol. 2015;29:12. doi:10.1177/0269881115612404.
14. Núcez C, Stephan-Otto C, Cuevas-Esteban J, Maria Haro J, Huerta-Ramos E, Ochoa S, et al. Effects of caffeine intake and smoking on neurocognition in schizophrenia. Psychiatry Res. 2015 Dec 30;230(3):924–31. doi: 10.106/j.psychres.2015.11.022
15. Jin M-J, Yoon C-H, Ko H-J, Kim H-M, Kim A-S, Moon H-N, et al. The Relationship of Caffeine Intake with Depression, Anxiety, Stress, and Sleep in Korean Adolescents. J Fam Med 2016;37:111–6. doi: 10.4082%2Fkjfm.2016.37.2.111.
16. Turnbull D, Rodricks J V., Mariano GF. Neurobehavioral hazard identification and characterization for caffeine. Regul Toxicol

Pharmacol. 2016 Feb 1;74:81–92. doi: 10.1016/j.yrtph.2015.12.002
17. Kim, J. Green Tea, Coffee, and Caffeine Consumption Are Inversely Associated with Self-Report Lifetime Depression in the Korean Population. Nutr 2018 Sep 1;10(9):1201. doi: 10.3390/ nu10091201.
18. Pham NM, Nanri A, Kurotani K, Kuwahara K, Kume A, Sato M, et al. Green tea and coffee consumption is inversely associated with depressive symptoms in a Japanese working population. Public Health Nutr. 2013;17(3):625–33. doi: 10.1017/S1368980013000360
19. Pizzino G, Irrera N, Cucinotta M, Pallio G, Mannino F, Arcoraci V, et al. Oxidative Stress: Harms and Benefits for Human Health. Oxid Med Cell Longev. 2017:8416763. doi: 10.1155/2017/8416763
20. Sherina MS, Arroll B, Goodyear-Smith F. Criterion Validity of the PHQ-9 (Malay Version) in a Primary Care Clinic in Malaysia. Med J Malaysia. 2012;67(3):309–15. PMID:23082424
21. Sidik SM, Arroll B, Goodyear-Smith F. Validation of the GAD-7 (Malay version) among women attending a primary care clinic in Malaysia. J Prim Health Care. 2012;4(1):5–11. PMID: 22377544
22. Stocker R, Tran T, Hammarberg K, Nguyen H, Rowe H, Fisher J. Patient Health Questionnaire 9 (PHQ-9) and General Anxiety Disorder 7 (GAD-7) data contributed by 13,829 respondents to a national survey about COVID-19 restrictions in Australia. Psychiatry Res. 2021 Apr 1;298:113792. doi:10.1016/ j.psychres.2021.113792.
23. Mahoney CR, Giles GE, Marriott BP, Judelson DA, Glickman EL, Geiselman PJ, et al. Intake of caffeine from all sources and reasons for use by college students. Clin Nutr. 2019 Apr 1;38(2):668–75. doi: 10.1016/j.clnu.2018.04. 004
24. Bucher J, Fitzpatrick D, Swanson AG, Abraham SP. Caffeine Intake Habits and the Perception of Its Effects on Health among College Students. Health Care Manag (Frederick). 2019;38(1):44–9. doi: 10.1097/HCM.0000000000000240
25. Mangi MA, Rehman H, Rafique M, Illovsky M. Energy Drinks and the Risk of Cardiovascular Disease: A Review of Current Literature. Cureus. 2017 Jun 7;9(6). doi: 10.7759/cureus.1322.
26. Sanchis-Gomar F, Pareja-Galeano H, Cervellin G, Lippi G, Earnest CP. Energy Drink Overconsumption in Adolescents: Implications for Arrhythmias and Other Cardiovascular Events. Can J Cardiol. 2015 May 1;31(5):572–5. doi: 10.1016/j.cjca.2014.12.019
27. Hanif M, Saleem S, Naz S, Sundas F. Energy Drinks and Atrial Fibrillation: An Unusual Case of Caution. Cureus. 2020 Oct 5;12(10).doi:10.7759/cureus.10807
28. Samoggia A, Rezzaghi T. The Consumption of Caffeine-Containing Products to Enhance Sports Performance: An Application of an Extended Model of the Theory of Planned Behavior. Nutrients. 2021; 13(2):344. doi: 10.3390/nu13020344.
29. Kharaba Z, Sammani N, Ashour S, Ghemrawi R, Al Meslamani AZ, Al-Azayzih A, et al. Caffeine Consumption among Various University Students in the UAE, Exploring the Frequencies, Different Sources and Reporting Adverse Effects and Withdrawal Symptoms. J Nutr Metab. 2022 May 18;2022:1–7. doi:10.1155/ 2022/5762299
30. Booker LA, Magee M, Rajaratnam SMW, Sletten TL, Howard ME. Individual vulnerability to insomnia, excessive sleepiness and shift work disorder amongst healthcare shift workers. A systematic review. Sleep Med Rev. 2018 Oct 1;41:220–33. https://psycnet.apa.org/doi/10.1016/j.smrv.2018.03.005
31. Farhud DD. Impact of Lifestyle on Health. Iran J Public Health. 2015 Nov 1;44(11):1442.
32. Talanian JL, Spriet LL. Low and moderate doses of caffeine late in exercise improve performance in trained cyclists. Applied physiology, nutrition, and metabolism = Physiologie appliquee, nutrition et metabolisme. 2016 Apr 8;41(8):850–5. doi: 10.1139/apnm-2016-0053.
33. Wilhelmus MMM, Hay JL, Zuiker RGJA, Okkerse P, Perdrieu C, Sauser J, et al. Effects of a single, oral 60 mg caffeine dose on attention in healthy adult subjects. J Psychopharmacol. 2017 Feb 1;31(2):222–32. doi: 10.1177/ 0269881116668593.
34. Ullrich S, de Vries YC, Кьhn S, Repantis D, Dresler M, Ohla K. Feeling smart: Effects of caffeine and glucose on cognition, mood and self-judgment. Physiol Behav. 2015 Nov 1 ;151:629–37. doi: 10.1016/j.physbeh.2015.08.028.
35. Haskell-Ramsay CF, Jackson PA, Forster JS, Dodd FL, Bowerbank SL, Kennedy DO. The Acute Effects of Caffeinated Black Coffee on Cognition and Mood in Healthy Young and Older Adults. Nutrients. 2018 Oct 1;10(10). doi: https:// doi.org/10.3390/nu10101386.
36. Nehlig A. Interindividual Differences in Caffeine Metabolism and Factors Driving Caffeine Consumption. Pharmacol Rev. 2018 Apr 1;70(2):384–411. doi:10.1124/pr.117.014407
37. Cui WQ, Wang ST, Pan D, Chang B, Sang LX. Caffeine and its main targets of colorectal cancer. World J Gastrointest Oncol. 2020 Feb 2;12(2):149. doi: 10.4251/wigo. v12.j2.149
38. Zhao LG, Li ZY, Feng GS, Ji XW, Tan YT, Li HL, et al. Coffee drinking and cancer risk: An umbrella review of meta-analyses of observational studies. BMC Cancer. 2020 Feb 5;20(1):1–12. doi: 10.1186/s12885-020-6561-9
39. Caffeine Tolerance: Fact or Fiction? [Internet]. Available from: https://www.healthline.com/nutrition/caffeine-tolerance# development. [Accessed on 11 July 2022]
40. Beaumont R, Cordery P, Funnell M, Mears S, James L, Watson P. Chronic ingestion of a low dose of caffeine induces tolerance to the performance

benefits of caffeine. Journal of sports sciences. 2016 Oct 2;35(19):1920–7. doi: 101080/ 0264041420161241421.
41. Jain S, Srivastava AS, Verma RP, Maggu G. Caffeine addiction: Need for awareness and research and regulatory measures. Asian J Psychiatr. 2019 Mar 1;41:73–5. doi: 10.1016/j.ajp.2017.01.008.
42. Distelberg BJ, Staack A, Elsen KD, Sabatй J. The Effect of Coffee and Caffeine on Mood, Sleep, and Health-Related Quality of Life. Journal of Caffeine Research. 2017 Jun 1;7(2):59–70. doi: 10.1089/ jcr.2016.0023.
43. Jee HJ, Lee SG, Bormate KJ, Jung YS. Effect of Caffeine Consumption on the Risk for Neurological and Psychiatric Disorders: Sex Differences in Human. Nutr, 2020 Oct 9;12(10):3080. doi: 10.3390/ nu12103080
44. Sweeney P, Levack R, Watters J, Xu Z, Yang Y. Caffeine increases food intake while reducing anxiety-related behaviors. Appetite. 2016 Jun 1;101:171–7. doi: /10.1016/ j.appet.2016.03.013
45. Li L, Wu C, Gan Y, Qu X, Lu Z. Insomnia and the risk of depression: A meta-analysis of prospective cohort studies. BMC Psychiatry. 2016 Nov 5;16(1):1–16. doi: 10.1186/s12888-016-1075-3.
46. Frozi J, de Carvalho HW, Ottoni GL, Cunha RA, Lara DR. Distinct sensitivity to caffeine-induced insomnia related to age. J Psychopharmacol. 2018 Jan 1;32(1):89–95. doi: 10.1177/ 0269881117722997.
47. Navarro AM, Abasheva D, Martнnez-Gonzбlez M, Ruiz-Estigarribia L, Martнn-Calvo N, Sбnchez-Villegas A, et al. Coffee Consumption and the Risk of Depression in a Middle-Aged Cohort: The SUN Project. Nutr. 2018 Sep 19;10(9):1333. doi: 10.3390/nu10091333.
48. Godos J, Pluchinotta FR, Marventano S, Buscemi S, Volti GL, Galvano F, et al. Coffee components and cardiovascular risk: beneficial and detrimental effects. Inter Journal of Food Sciences and Nutrition, 65:8, 925-936, doi: 10.3109/09637486.2014.940287
49. Rojas-González, A, Figueroa-Hernández CY, González-Rios O, Suárez-Quiroz ML, González-Amaro RM, Hernández-Estrada ZJ, Rayas-Duarte P. Coffee Chlorogenic Acids Incorporation for Bioactivity Enhancement of Foods: A Review. Molecules 2022; 27, 3400. https://doi.org/10.3390/ molecules27113400