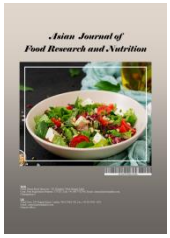

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Effect of Habitual Caffeine Intake on Physical Activity Level in the Students of Selected Bangladeshi University

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Authors' contributions

This work was carried out in collaboration among all authors. Author TAIA designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author SSB supervised the study, managed the statistical analyses and edited the draft copy. Author TAS aided in data analysis and literature searches. Author MM managed the literature searches and data entry. All authors revised and approved the final manuscript.

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ABSTRACT

Background: The psychostimulant that is most often used worldwide is caffeine. It is still unclear how habitual caffeine consumption and physical activity are related. Moreover, research on the relationship between caffeine intake and physical activity have been conducted almost exclusively among trained individuals but little is known about the effects of caffeine on physical activity level in sedentary or lightly active individuals including university going students.
Objectives: To determine the impact of habitual caffeine consumption on levels of physical activity among selected university students in Bangladesh.
Study Design: Cross-sectional observational study.

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Methodology: A total 400 students of Noakhali Science & Technology University, Bangladesh (227 male, 173 female; between the ages of 18 and 28 years old) were included by non-probability convenience sampling method from July 2023 to September 2023. Data was analyzed by SPSS 26.0. Descriptive analyses, Chi-square test and Multinomial logistic regression were performed.
Results: Majority (84.4%) of the participants were observed to consume tea and coffee in a regular weekly basis and most of them were moderately active (71.8%). There was a significant association between the caffeine intake and physical activity level (P<0.001). In multinomial logistic regression it was found that those who did not consume caffeine from coffee & tea and who consume low amount of tea & coffee both were significantly & independently at a higher risk of being sedentary ((aRRR 47.667, 95%CI 37.470 to 65.489, P<0.001 and aRRR 4.037, 95% CI 1.212 to 13.442, P<0.05 respectively) than those who consume moderate amount of caffeine from coffee & tea every week.
Conclusion: The amount of caffeine consumed from tea and coffee by the students were found to have a significant relationship with their level of physical activity. However, for better understanding about caffeine's potential effect on physical activity level, further large scale randomized controlled trial is suggested.

Keywords: Bangladesh; caffeine; physical activity; university students.

ABBREVIATION

ARRR : Adjusted Relative Risk Ratio
BMI : Body Mass Index
FDA : Food and Drug Administration
IPAQ : International Physical Activity Questionnaire
MET : Metabolic Equivalent
NSTU : Noakhali Science and Technology University
URRR : Unadjusted Relative Risk Ratio

1. INTRODUCTION

Caffeine is a type of alkaloid that is found in nature and used as an ingredient in a wide variety of drinks [1]. Many foods and beverages that are frequently consumed contain caffeine. It is found naturally in tea leaves, cacao beans, and coffee beans. Many commercial energy drinks and soft drinks also contain caffeine as well. It has been demonstrated that caffeine intake lessens feelings of weariness and fatigue [2]. Some other benefits include improved alertness and attentiveness, better performance at work, increased vigilance, elevated mood, and delayed sleep onset [3]. As an adenosine A1 and A2A receptor antagonist, caffeine increases the release of dopamine and noradrenaline. Caffeine's effects on alertness and wakefulness as well as its ability to reduce pain and perceived exertion during exercise may be due to this characteristic [4]. It has also been discovered that a light to moderate coffee consumption is linked to a lower risk of death [5] from all causes, including suicide [6].

Use of caffeine-containing products is believed to be associated with individual habits, social behaviors, and biological characteristics related to food [7]. Geographical location can also have an impact on the patterns of caffeine consumption [8]. For example, the United States and Canada consume about three times as much caffeine per person as the rest of the world, but less than half as much as countries like the United Kingdom that consume a lot of tea [4]. In terms of caffeine intake Asia is another region that scores remarkably [9]. Approximately 94% of medical students in India were found to be consuming caffeine in various forms [10]. According to a survey done at the Saudi Arabian medical school, over 95% of the students drink caffeine in one way or another [11]. A study based on Jordan medical students denoted that 84% students consumed caffeine and tea was the most popular beverage followed by coffee [12]. According to a study conducted in Saudi Arabia, female undergraduate students consumed a lot of caffeine [13]. The majority of Bangladeshi students use tea and coffee as a means of recreation or relaxing on a regular basis [14].

College and University students have been observed consuming caffeine in large quantity. Students may use caffeine to help them stay physically active during their hectic class schedule, exam, and presentation periods. Regular work, study, socializing, and activity by students increased their desire for products with caffeine [15]. Studies have shown that the typical student takes in about one cup (or 70 mg) of caffeine per day. Another study found that 40% of adults between the ages of 18 and 24 who attend college on a regular basis drink coffee every day, and between 2012 and 2016, this

percentage increased [16]. Moreover, a recent study that included a large sample of Americans discovered that 88% of participants drank at least one caffeinated beverage on a daily basis [17]. In a similar vein, a significant portion of Pakistani university students (94%) drink coffee [18]. On the other hand, 97% of students in a study of Indian teenagers in classes 9 through 12 reported using caffeine [19].

During the academic years, students also consume caffeinated drinks to relieve stress brought on by social or emotional upheavals, academic pressure, or both [20] as well as a means of staying physically active. Any movement of the body made possible by the skeletal muscles that requires the use of energy is considered physical activity [21]. The World Health Organization recommends that adults between the ages of 18 and 64 engage in aerobic physical activity for at least 150 minutes per week, with 75 minutes of vigorous intensity or less. The aerobic activity should be performed in 10-minute steps [22]. There are many benefits to physical and mental health from physical activity [23]. Frequent exercise can also help one to keep a healthy weight, enhance mood and cognitive abilities, and lessen the symptoms of depression and anxiety [24-27]. The prevalence of non-communicable diseases and the general health of the global population—both in developed and developing countries—are significantly correlated with the rise in physical inactivity. As of right now, estimates put the global prevalence of adult physical inactivity at 31.0% [28,29]. It has been proposed that changes in nutrition and physical activity (PA) patterns could help with this condition, as sedentary behavior and poor diet contribute significantly to mortality [30].

It is still unclear how habitual caffeine consumption and physical activity levels are related; some research point to a positive correlation, while others find none at all or even a negative one [31,32]. Moreover, research on the relationship between caffeine and physical activity have been conducted almost exclusively among trained individuals but little is known about the effects of caffeine on physical activity level in sedentary or lightly active individuals [31].

The current study intends to close a large gap in the existing literature by examining the impact of habitual caffeine consumption on levels of physical activity among selected university students in Bangladesh. This research is expected to provide important insights into the relationship between caffeine consumption and physical activity, and inform recommendations for healthy lifestyle habits among university going students.

2. OBJECTIVES OF THE STUDY

2.1 General Objective

The general objective of the study is to determine the prevalence of caffeine intake from tea and coffee and find the effect of caffeine intake on physical activity level (PAL) among the students of NSTU.

2.2 Specific objectives

i. To find out the association between socio-demographic characteristics (age, sex, academic year) and levels of caffeine consumption among the study subjects.
ii. To determine the Body Mass Index (BMI) and PAL of the participants and explore the relationship between them.

3. METHODOLOGY

3.1 Materials

The present study is a cross-sectional observational study conducted among students of NSTU from July 2023 to September 2023. NSTU is located at the Sonapur region of Noakhali district in Bangladesh. Data collection was conducted from the university dormitory and student hostels located within 1km radius of Noakhali Science and Technology University. The objectives of the study were explained to each participant and informed written consent was obtained. Confidentiality was maintained accordingly and the participants were informed that they had the right to withdraw at any time. Based on availability and study duration a total of 400 students, both male and female, between the ages of 18 and 28, were recruited by non-probability convenience sampling.

3.2 Data Collection

Information regarding age, sex, academic year/semester were collected using self-administered questionnaires. The questionnaire consists of 36 questions divided into three sections (demographic section, physical activity section and caffeine consumption habits section).

Questions 1-6 were about general demographics (name, age, height, weight, gender, academic year/semester). Questions 7-33 assessed the physical activity level of the respondents, whereas questions 34-36 assessed their caffeine use patterns to determine whether they consume caffeine from tea and coffee or not, as well as the number of cups consumed in the previous week.

All the sections of the questionnaire used in the current study were translated into local Bengali language, pretested among 40 individuals for comprehension and readability and later used for final data collection. The same trained personnel involved in pretesting later conducted the study. The questionnaire contained both closed and open-ended questions. It was ensured that the reliability of the required sections of the questionnaire was verified as Cronbach's coefficient alpha value remained greater than 0.700 (α> 0.700) for each.

3.3 Caffeine Consumption Assessment

Caffeine intake from tea and coffee was the exposure variable. Other caffeinated food products or drinks are less available in the study area and were not found to be consumed by a single participant within last one week during pretesting. Therefore, no caffeinated product other than tea and coffee was included in our study. Participants were first asked whether they consumed tea or coffee. If the answer was affirmative, participants were asked how many cups of tea or coffee they had consumed in the previous seven days. Caffeine consumption was categorized into three categories in accordance with a previous study [32]: "No intake", "Low intake" (>0mg/week- ≤350mg/week) and "Moderate intake" (>350 to 2800 mg/week).

The amount of caffeine consumed from these products was calculated based on how much caffeine a cup of tea or coffee contains. In Table 1. caffeine in common substances are provided which was considered for converting the serving size into milligrams (mg) [33].

The Food and Drug Administration (FDA) has cited 400 milligrams a day for healthy adults. As we did not find any participants consuming caffeine from tea or coffee more than 2800mg/week (400mg/day) during data collection, we did not include a high intake category in the current study.

3.4 Physical Activity Assessment

Physical activity is the outcome variable for this study. A field-tested and validated questionnaire of the International Physical Activity Questionnaire (IPAQ) – Long Version was used in the current study to assess the physical activity among the study subjects which is composed of twenty-seven self-reported questions related to weekly performed physical activities performed in a normal basis, estimating the time spent in activities of mild, moderate and vigorous intensity, with a minimum duration of 10 continuous minutes, in different contexts of daily life [34]. The physical activity mentioned in the questionnaire is expressed as Metabolic Equivalent (MET). Total physical activity was later categorized into three levels: Sedentary (<600 MET-minutes/week), moderately active (≥600 to <3000 MET-minutes/ week) and highly active (≥3000 MET-minutes/week).

3.5 Anthropometric Measurements

Body weight of the participants was measured using calibrated portable weighing scale. During measurement nearest 0.1 kg digit was taken with the study subjects wearing minimal clothing and no shoes. In case of height measurement, the participants were standing barefooted in a straight position and the nearest 0.1 cm was taken by a portable stadiometer. Body mass index (BMI) was obtained using the following formula: BMI= Weight in kilograms / (height in meters)^2

3.6 Statistical Analysis

Responses were expressed as frequencies, means and standard deviations (SD). Chi-square tests were performed to find out the association between demographic characteristics and PAL with levels of caffeine consumption among the respondents. Multinomial logistic regression models were established to identify significant factors affecting PAL. IBM SPSS Version 26.0 was used for data entry and analysis. $P \leq 0.05$ was considered statistically significant and all P values were two sided.

3.7 Inclusion Criteria

The selected participants were university students of NSTU, were in good health and between the ages of 18 and 28. All the participants agreed to provide information and were willing to provide a written consent to participate in the study.

Table 1. caffeine in common substances (Burke, 2008)

Food/Drink	Serving	Caffeine (mg)
Instant coffee	250 ml cup	60
Brewed coffee	250 ml cup	80
Espresso shot	1 standard serving	107
Tea	250 ml cup	27

3.8 Exclusion Criteria

Subjects who did not match the inclusion criteria and who had substantial acute or chronic diseases, consumed any other caffeinated food products or beverages other than tea and coffee and those who had made significant lifestyle changes in the past month which could alter physical activity level were eliminated. Pregnant female participants were also excluded.

4. RESULTS AND DISCUSSION

4.1 Socio-demographic Characteristics

A total of 400 students are recruited in the current investigation. The socio-demographic characteristics of this sample were depicted in Table 2. The study sample consisted of 227 male students (56.8%) and 173 female students (43.3%). The mean age of the students was 23.04± 1.86 and the mean BMI was 21.93± 3.03. 44.8% participants were low caffeine consumer while 36.3% participants were moderate caffeine consumer. Majority of the participants were moderately active (71.8%) and only 16% participants were highly active. Among 400 students most of them were from 4th year final (25.8%). The average weekly MET minutes of total physical activity of the respondents was 1321.308± 806.4.

4.2 Association Between Demographic Characteristics & Levels of Caffeine Consumption Among Participants

In this section we established association between the demographic characteristics like gender, academic year, age category as well as levels of physical activity and category of caffeine consumption by Chi-square test.

Table 3. displays association between the measured sample characteristics and the levels of caffeine consumption. Only the physical activity level was significantly associated with the level of caffeine consumption (P <0.001); suggesting that who were highly active they consumed higher amount of caffeine than the students who were sedentary active. Male students, 4th year students, age between (18-23) years old showed slightly higher proportion of caffeine consumption, but no significant association was found (P >0.05).

4.3 Factors Associated with PAL

In this section we tried to investigate the effect of potential factors such as caffeine intake levels and BMI categories on the levels of physical activity of the study subjects by establishing multinomial logistic regression models.

Table 4. indicates the results of multinomial logistic regression model to find out what potential factors were associated with physical activity level, using the physically highly active category as reference. We found those individuals who does not consume caffeine from tea and coffee and also those who consume low amount of caffeine from tea and coffee are both at significantly higher risk of being sedentary compared to those who consume moderate amount of caffeine from tea and coffee (uRRR 11.642, P<0.001 and 4.168, P <0.05 respectively). Additionally, it was found that those who intake low amount of caffeine from tea or coffee are at significantly higher risk of being included in the moderately active category compared to those who consume moderate amount of caffeine from tea and coffee (uRRR 3.124, 95% CI 1.053-9.270, P <0.05). Here, uRRR refers to unadjusted relative risk ratio. The regression model did not find any significant relation between being physically low or moderately active and being included in any specific BMI category.

In Table 5 even after adjusting for a potential confounder (BMI), the multinomial logistic regression model showed that those who did not consume caffeine from tea and coffee and also those who consumed low amount of caffeine from tea and coffee were both significantly and independently at higher risk of being sedentary relative to those who consume moderate amount of caffeine from tea and coffee (aRRR 47.667, 95%CI 37.470 to 65.489, P <0.001 and aRRR 4.037, 95% CI 1.212 to 13.442, P <0.05 respectively). Here, aRRR refers to adjusted relative risk ratio.

Caffeine consumption has soared over the decades, particularly among young adults attending college and university. This study sheds light on the relationship between caffeine consumption and levels of physical activity among selected university students in Bangladesh.

Table 2. Socio-demographic characteristics of the study participants

Variables	Participants, n=400, n (%) / Mean ± SD
Sex	
Male	227 (56.8%)
Female	173 (43.3%)
Academic year	
Master's	60 (15%)
4th year(Final year)	103 (25.8%)
3rd year	78 (19.5%)
2nd year	42 (10.5%)
1st year(2nd semester)	70 (17.5%)
1st year(1st semester)	47 (11.8%)
Physical Activity level	
Sedentary	97 (24.3%)
Moderately Active	287 (71.8%)
Highly Active	16 (4%)
Caffeine Consumption Category(mg/week)	
No intake	76 (19%)
Low intake (>0-≤350) mg/week	179 (44.8%)
Moderate intake (>350 to 2800) mg/week	145 (36.3%)
Age	
BMI	23.04± 1.86
Total Amount of Caffeine In Tea & Coffee	21.93± 3.03
Total Physical Activity	263.69± 244.65
MET min/week	1321.308± 806.41

Table 3. Association between demographic characteristics & levels of caffeine consumption among participants

Variables	Caffeine consumption category (mg/week)			Total	P-value
	No intake	**Low intake (>0-≤350) mg/week**	**Moderateintake (>350) mg/week**		
Gender					
Male	47 (54%)	102 (55%)	78 (60%)	227 (56.8%)	*0.638*
Female	40 (46%)	81 (44.3%)	52 (40%)	173 (43.3%)	
Academic year				60 (15%)	
Master's	12 (13.8%)	28 (15.3%)	20 (15.4%)	103(25.8%)	*0.127*
4thyear (Final year)	17 (19.5%)	53 (29%)	33 (25.4%)	78 (19.5%)	
3rd year	14 (16.1%)	34 (18.6%)	30 (23.1%)	42 (10.5%)	
2nd year	6 (6.9%)	20 (10.9%)	16 (12.3%)	70 (17.5%)	
1styear(2ndsemester)	22 (25.3%)	26 (14.2%)	22 (16.9%)	47 (11.8%)	
1styear (1st semester)	16 (18.4%)	22 (12%)	9 (6.9%)		
Age category					
(18-23) year	57 (65.5%)	98 (53.5%)	66 (50.8%)	221 (53.5%)	*0.083*
(24-28) year	30 (34.5%)	85 (46.4%)	64 (49.2%)	179 (44.8%)	
PhysicalActivityLevel					
Sedentary	42 (48.3%)	45 (51.7%)	0 (0%)	97 (24.3%)	*0.000***
ModeratelyActive	36 (19.7%)	142 (77.6%)	5 (2.7%)	287 (71.8%)	
Highly active	19 (14.6%)	100 (76.9%)	11 (8.5%)	16 (4.0%)	

P-value<0.05 were considered significant & P-value**<0.001 were considered highly significant*

Table 4. Factors associated with PAL (reference: Highly active) in the unadjusted model

PAL				95% Confidence Interval	
Sedentary	**Caffeine Intake Category**	**Unadjusted RRR (95% CI) for PAL**	**P value**	**Lower Bound**	**Upper Bound**
	No intake	11.642	0.000**	5.767	29.194
	Low intake	4.168	0.019*	1.263	13.761
	Moderate intake	Reference			
	BMI Category				
	Underweight	.724	.793	.065	8.054
	Normal	.526	.347	.138	2.009
	Overweight and/or obese	Reference			
Moderately active	**Caffeine Intake Category**				
	No intake	4.833	.811	.234	6.27
	Low intake	3.124	.040*	1.053	9.270
	Moderate intake	Reference			
	BMI Category				
	Underweight	.686	.748	.068	6.882
	Normal	.376	.137	.104	1.365
	Overweight and/or obese	Reference			

P-value<0.05 were considered significant & P-value**<0.001 were considered highly significant*

Table 5. Factors associated with PAL (reference: Highly active) in the adjusted model

PAL				95% Confidence Interval	
Sedentary	**Caffeine Intake Category**	**Adjusted RRR (95% CI) for PAL**	**P value**	**Lower Bound**	**Upper Bound**
	No intake	47.667	.000**	37.470	65.489
	Low intake	4.037	.023*	1.212	13.442
	Moderate intake	Reference			
	BMI Category				
	Underweight	.649	.730	.056	7.567
	Normal	.439	.238	.112	1.724
	Overweight and/or obese	Reference			
Moderately active	**Caffeine Intake Category**				
	No intake	5.112	.096	.729	7.673
	Low intake	3.002	.050	1.001	8.998
	Moderate intake	Reference			
	BMI Category				
	Underweight	.588	.655	.057	6.041
	Normal	.360	.123	.098	1.320
	Overweight and/or obese	Reference			

*P-value *<0.05 were considered significant & P-value **<0.001 were considered highly significant*

In the present study tea and coffee were found to be the most commonly consumed caffeinated drinks. Our research revealed that a significant portion of the participants (84.4%) were ingesting caffeine through tea or coffee on a regular weekly basis. The results indicated that caffeine consumption was common among students. In a similar study conducted at King Saud University reported that coffee was the most commonly consumed caffeinated product, followed by tea [35]. A research study in Bahrain found that approximately 98% of students regularly consume caffeine-containing beverages on a daily basis, mostly from tea, coffee, and soft drinks [36]. In a study of Umm Al-Qura University it was revealed that 80% dental students

consumed caffeine. They consumed caffeine as a symbol of social prestige [37].

The current study did not find any significant association between the level of caffeine consumption & academic year of the students. On the contrary, another study found that compared to students in their later years of study, those in their early university years are likely to consume more caffeine than is advised on a daily basis [38]. There was no significant relationship between the level of caffeine intake and age category among study subjects. However, younger students were seen consuming more caffeine. An inconsistent finding to our study was observed in another a study of Great Britain which shows that compared to younger students, older students consumed more caffeine [39]. Though male participants were found to consume more caffeine, no significant association was found between gender & the level of caffeine consumption. This high consumption among male students could possibly be a result of the distinct habits and social circles compared to their female counterparts in the Noakhali district of Bangladesh. In a similar study conducted among college students of Zayed University, UAE no significant difference was found between gender [40]. This finding is consistent with ours. The present study found a significant association between physical activity level caffeine consumption. A study conducted in the United States found a positive correlation between caffeine consumption and physical activity, meaning that those who drank more caffeine also tended to be more physically active [41]. Based on the findings from a study conducted in Australia, middle-aged women who drink coffee or tea may benefit from physical activity because it lowers barriers to the activity like exhaustion and low energy [42]. These findings are consistent with ours. Our findings indicated that the participants who were either non-consumer as well as consumed low amount of caffeine from tea and coffee were significantly at a risk of being sedentary. This could be resulted from being unexposed or less exposed to the ergogenic effect that caffeine tends to produce. It has been proposed that caffeine consumption influences mood, particularly one's perception of own vigor, which heightens the inclination to engage in physical activity and exercise [43]. Consuming caffeine makes working out easier and more enjoyable than it would be otherwise [44]. In our study, the amount of caffeine consumed from tea and coffee and BMI category did not significantly correlate. Similarly, a prior study that included slender men (BMI ≤25 kg/m^2) did not discover any correlation between four days of coffee consumption and sedentary behavior [45].

Our study has several strengths. A validated questionnaire was used for data collection. We used the long form IPAQ questionnaire to assess physical activity. In another study short form of IPAQ was used where there was no research on sedentary time [46]. The sample analyzed with the short form of the IPAQ was found over-evaluating physical inactivity by 50% compared to the long version. It is not required for the participants to fill out the short form with distinct responses for each category, and some activities may result in disqualification. However, because the three categories of activities—household, work-related, and leisure pursuits—are reported separately, long forms are more accurate than short forms [47]. Therefore, we used the long form of the International Physical Activity Questionnaire (IPAQ), whereas some similar studies used the short form [48,49].

The current study has a few limitations as well. The study was particularly conducted at Noakhali Science and Technology University, so the findings cannot be generalized to other universities or populations and be nationally representative. The cross-sectional nature of this study precluded interpreting the findings in a causally coherent manner. Additionally, the data was self-reported, which can lead to recall bias. Even though the participants were given instructions on how to enter the data correctly, the use of self-reported questionnaires to collect data on caffeine consumption and physical activity level may lead to recall bias. Furthermore, the amount of caffeine in products can vary depending on various factors such as preparation, brand, and serving size, so determining the exact amount of caffeine in products from self-reported data might be misleading to some extent.

6. CONCLUSION

In order to achieve academic success, it is a requisite for a university going student to stay mentally and physically energetic. Based on the findings of the study, it is observed that the amount of caffeine consumed from tea and coffee by participants had a significant relationship with their level of physical activity. Moreover, those who consumed low amount of caffeine from tea and coffee were both

significantly and independently more likely to be sedentary relative to those who consume moderate amount of caffeine from tea and coffee. We did not find any participant consuming high (>2800mg/week or 400mg/day) amount of caffeine from tea and coffee and thus could not establish any relationship between high caffeine intake and physical activity. However, for better understanding about caffeine's potential effect on physical activity level among study subjects, further large scale randomized controlled trial is required. This could help to establish a dose-response relationship by controlling the actual amount of caffeine consumption from tea and coffee among participants.

CONSENT AND ETHICAL APPROVAL

Participants provided their written informed consent prior to the study, and ethical approval was granted by the Human Research Ethics Committee of Noakhali Science & Technology University.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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