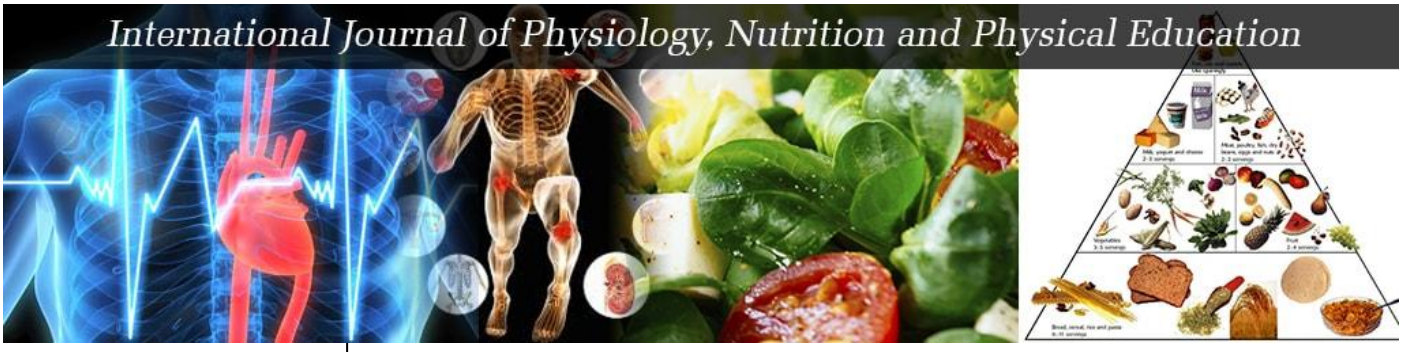

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Effect of caffeine on exercise performance among overweight sedentary medical college students (1st year MBBS) of Jawaharlal Nehru Medical College, Sawangi (Meghe), Wardha, Maharashtra

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Abstract
The purpose of the study was to examine the effect of moderate dose (5mg per kg) of caffeine ingestion on pulse rate, blood pressure(both systolic and diastolic) and energy expenditure (cal) during a steady state exercise period with a standardize power output as well as during a set time period, where participants were required to cycle with maximum effort. Eighteen healthy, overweight, sedentary, male, first year MBBS student of Jawaharlal Nehru Medical college (sawangi, wardha, Maharashtra) completed 15 minutes steady state cycling exercise at a standardized power output equating to 65% of HR max (part-1) followed by 10 min stationary cycling where they were required to cycle with maximum effort after ingestion of caffeine (5mg per kg) 60 min prior to exercise. Same subjects were used as control. Systolic blood pressure was increased after caffeine ingestion but there was no significant change in diastolic blood pressure. Pulse rate decreased with moderate dose of caffeine ingestion during submaximal exercise which indicates decrease in heart rate. After caffeine ingestion energy expenditure in the 2nd part (10 min maximal) of exercise increased in very small amount but it is significantly increased in 1st part of exercise (15 min sub maximal exercise).

Keywords: Sub maximal exercise, Caffeine, Blood pressure, Pulse rate, Energy expenditure

1. Introduction
Use of caffeine and caffeine containing beverages are common among all levels of athletes, hoping to gain ergogenic benefit. To date many studies have demonstrated caffeine to be an ergogenic aid for exercise of varying intensities, duration and modalities in an athletic population [1, 2, 3 4].

Caffeine's cardiovascular effects have also generated much interest. Most of these studies however conducted in resting subjects and have investigated the potential negative health consequences from caffeine induced elevation of blood pressure [5].

Investigations reporting the effect of caffeine on heart rate during exercise are equivocal, with some indicating increases [6], decreases [7], and no effect [8]. Caffeine dose, exercise intensity and caffeine habituation are all factors which differ among the studies. Even though the data is inconclusive, statement will reflect the common notion that caffeine increases heart rate during exercise and this kind of statement often made without reference to dose, intensity of activity or habituation status. Benefits associated with caffeine ingestion includes reduced sensation of pain and exertion [9], delayed feeling of fatigue [10], Increased fatty acid oxidation [11], increased mean power output [12], stimulation of motor activity as well as increase in alertness and ability to concentrate [13].

The inhibition of adenosine receptor including those in the central nervous system is now considered by some to be a more likely mediator of caffeine's ergogenic properties. By attaching adenosine receptors caffeine is able to counteract many of the inhibitory effect of adenosine on neuroexitability [14], neurotransmitter release [15], and arousal [16]. To date majority of the studies in exercise performance following caffeine ingestion involved well trained athletes, whereas the effect may be different in non-athletic population.

Benefits associated with caffeine ingestion i.e. the ability to perform more work and thereby greater calorie expenditure can be used to promote fitness in overweight and sedentary individuals who are prone to weight gain and associated health issue.

Thus the purpose of this study is to evaluate the cardio respiratory effect and energy expenditure of moderate dose of caffeine ingestion(5mg/kg) during bicycle ergometry among overweight sedentary first year MBBS students who are non-habitual caffeine users.

1.1 Aims

To examine the effect of caffeine ingestion(5mg per kg) over pulse rate, blood pressure, energy expenditure, during 15 minutes of stationary cycling at a standardized power output as well as 10 minutes cycling with maximum effort among overweight sedentary first yeas MBBS students of Jawaharlal Nehru Medical College, who are non-habitual caffeine users.

1.2 Objectives

1) To study the effect of caffeine on pulse rate, blood pressure, energy expenditure in two phases of cycling (1st phase-15min sub maximal exercise and 2nd phase-10 min maximal exercise).
2) To achieve performance benefit if any.

2. Materials and Methods

The study was conducted at exercise laboratory of Jawaharlal Nehru medical College with due approval from institutional ethical committee.

40 subjects aged 18 to 25 years, (30males and 10 females) overweight, sedentary, non-habitual caffeine users among first year MBBS students of Jawaharlal Nehru Medical College was included in the study. Regarding selection of overweight candidate WHO criteria (BMI>25) was followed [18].

2.1 Inclusion criteria

Subject should be healthy, normotensive and non-habitual caffeine users.

2.2 Exclusion criteria

Subjects having history of cardiovascular and lung disease were excluded from the study. Chronic smokers and regular caffeine users were also excluded from the study.

Each participant was reported on two separate occasions, once for familiarization session and another for experimental session involving stationary cycling with a bicycle ergo meter (Inco instruments & chemicals private limited with exercise computer JS-154) after administration of caffeine (5mg per kg).

2.3 Study design

A single blind randomized trial was employed in this study.

2.4 Statistics

Data were expressed as mean ± SD. Students paired t test was used for analysis of data. Statistical significance was set at $p<.05$.

2.5 Familiarization session

Participants were explained about the purpose of the study and informed written consent also taken from them.

Participants were instructed 1) to refrain from consuming caffeine or caffeine containing food for 48 hours prior to each testing session, 2) to avoid exercise for 24 hour prior, 3) to keep the time of their last meal consistent between each trial. Trial was separated by at least 48 hours and was conducted at the same time of the day.

2.6 The instructions were applied to all visits

As there is essentially a linear relationship between heart rate and oxygen consumption (VO_2) during increasing intensities of light to relatively heavy aerobic exercise, age predicted maximum heart rate (220-age) was determined from the pulse rate obtained by the software system of bicycle ergo meter (exercise computerJS-154), as heart rate are virtually transmitted as pulse rate unless if there is any pathological condition.

A graded exercise protocol was advocated on a bicycle ergo meter as mentioned, in order to determine the power output required to elicit a target a heart rate equating to 65% of individual age predicted maximum heart rate (220-age).

Percentage of heart rate maximum was chosen instead of vo_2max in an effort to make the study comfortable for the overweight sedentary students.

Procedure involved, a starting workload of grade-1 (as marked in the bicycle ergo meter), increased by every 3 minutes until the target heart rate was achieved. Once the target heart rate was reached, the participants continued to cycle at that power output equated to this heart rate value for a duration of 15 minutes.

To avoid difficulty in coping with longer exercise period, the time periods of 15minutes and 10 minutes were selected. Immediately after completion of each stage of exercise pulse rate and blood pressure were measured.

2.7 Experimental Session

Participants were arrived at exercise laboratory in the morning at 9 am in a fasting state for a previous twelve hour period. Baseline pulse rate and blood pressure were measured.

Then the participants were given powdered caffeine dissolved in 150 ml of milk. Detailed history was taken regarding caffeinated foods or drinks.

2.8 The exercise was divided into two phases

Part-1: which includes 15 minutes stationary cycling at a constant power output equating to 65% of individual age predicted heart rate maximum, determined during familiarization session?

Part-II: After completion of part-1 exercise, participants took rest for 10 minutes and then were advised to cycle for next 10 minutes with maximum effort. Immediately after every stage of exercise, energy expenditure and pulse rate were recorded from software system of bicycle ergo meter (Exercise computer-JS-154). Blood pressure was recorded by sphygmomanometer.

After a brief relaxation participants left the exercise laboratory.

3. Result

Effect of caffeine on total amount of energy expenditure, pulse, systolic and diastolic BP. Values are means ±SD, n= 40.

Parameters	Time	Before Caffeine	After Caffeine	95% confidence interval of the difference		P value
				Lower	Upper	
Energy expenditure	15 min	39.04±.44	44.31±.62	-5.47, -5.06		0.000, S,P<.05
	10 min	32.48±.95	32.68±.87	-.28, -.13		0.000,S,p<.o5
Pulse	15 min	130.72±1.31	129.27±1.01	0.82, 2.06		.067,NS,p>.o5
	10 min	138.27±.82	137.50±2.09	-0.33, 1.89		.159,NS,p>.05
SBP	15min	135.33±4.22	138.66±3.28	-5.35, -1.31		.003, S, p<.05
	10 min	139.55±1.29	139.77±0.94	-.69, 0.24		0.331,NS,p>.05
DBP	15min	84±2.91	83.33±3.06	-1.35, 2.68		.495,NS,p>.05
	10 min	79.77±0.94	80.00±0.00	-.69,.24		.331,NS,p>.05

Part-1 exercise session

Energy expenditure after caffeine ingestion in first 15 minutes exercise session increased which is statistically highly significant. Mean value of pulse rate was decreased though it is not significant. Systolic BP significantly increased during 15 minutes exercise session after caffeine ingestion. No significant change of diastolic BP noted.

Part-2 exercise session

Energy expenditure in part-2 exercise session (10 min max exercise) though shows significant increase by student paired t test, difference of the mean is very less, only 0.20. Pulse rate also decreased but not significant. Rise of systolic BP is very mild and insignificant. No significant change of diastolic BP was noted.

4. Discussion

The result of this investigation provide evidence that caffeine alters the hemodynamic response to exercise, specifically ingestion of 5mg per kg caffeine increases to some extent exercise induced systolic BP. As caffeine increases exercise BP it may be concluded that the effect of exercise were responsible for higher BP observed during exercise, as exercise itself increases systolic BP. The dose of caffeine used in this study (5mg per kg) was selected on the basis of its similarity to doses (3-6mgperkg) previously shown to increase blood pressure at rest or during exercise without provoking side effects like intolerance or decrease in exercise performance or unpleasant wellbeing [5, 21, 22]. The potential tolerance to the effects of caffeine consumption was also controlled for because hemodynamic response to caffeine may be blunted in regular users [19, 20]. In fact tolerance to the caffeine can occur only three consecutive days of use [6, 14]. Consequently all subjects in the present study refrained from consumption of caffeine for at least four days before participating in any of the protocols to desensitize the system to the effects of this drug [20].

The result of this study also evidence that caffeine at dose of 5mg per kg body weight significantly decrease pulse rate during low to moderate intensity cycling exercise which in turn indicates a decrease in heart rate. This finding of lower pulse rate with caffeine use during exercise is in agreement with three previous studies, Sulivan *et al* [7], Gaser and Rich [23], and Turly and crest [24]. All these studies mentioned that low to moderate dose of caffeine significantly decrease heart rate at sub maximal intensity of exercise. These result of pulse rates are in contrast to a number of studies that have reported no effect of caffeine administration 0n exercise heart rate [1, 8, 25]. A possible explanation is that each of the studies used a >5mg per kg dose of caffeine.

Our results are also in direct contrast to some studies which have found higher heart rate with caffeine during exercise. Mcnaughton [6] observed higher heart rate during cycling at work load from 50-300 watts after high dose of caffeine compared with placebo. We speculate that the lower pulse rate observed during exercise after caffeine ingestion would indicate an increased or optimized stroke volume. The most likely mechanism would seem to be either an enhanced contractility or higher preload with caffeine use during exercise [21, 26].

Another possible explanation of a lower pulse rate is due to baroreflex reflexively lowering heart rate in response to elevation of blood pressure in an attempt to reestablish normal blood pressure [27].

Overall results from this study showed that energy expenditure has been increased after ingestion of caffeine during exercise. By applying students paired t test energy expenditure in the second phase of exercise shows mild increase, whereas in the first part of exercise it shows greatly increased which is highly significant. Caffeine's ergogenic benefits have well been established in athletes, not so in case of overweight and sedentary population. Beneficial effect of caffeine i.e. the ability to perform more work without any negative health consequences after ingestion of such moderate dose of caffeine could be used to promote initial exercise performance in overweight and sedentary individuals who are prone to weight gain and associated health issue. This convincing evidence will significantly encourage the overweight, obese and sedentary individual to participate in regular exercise programme.

This results was also surprising considering the convincing evidence for significantly greater work being performed in set times after caffeine ingestion in an athletic population [2]. Lack of significant differences in exercise performance and other physiological variables may be due to the exercise duration (part-1,15min and part-2, 10 min) which were considerably shorter than those undertaken in athletic studies that reported significant performance benefit [4]. This conjuncture is further supported by results from Ahrens *et al*, (2007a) and Ahrens *et al* (2007b) (33, 34) which showed no significant change in heart rate, after caffeine ingestion, during 8 minutes exercise protocol in recreationally fit women. Probably a longer duration of exercise may be needed for better evaluation of caffeine's ergogenic effect. Moreover, % of vo_2 max rather than % of HR max as a guide for exercise intensity during part-1 of the exercise protocol might have resulted in different physiological outcome due to variability associated with heart rate values.

Again it is possible that caffeine ingestion may only have en ergogenic effect in overweight sedentary population when exercise is performed at higher intensity. For instance Engels *et al* [32] reported no significant change of vo_{2max} in sedentary males after caffeine ingestion while walking at intensities equivalent to 30% and 50% of vo_2 max. Of importance, the higher intensity exercise employed by Engles and Haymes in 1992 [32] is similar to the intensity used during steady state cycling in the current study that equated to 65% of individuals HR max which also found a similar result between caffeine and placebo trials. Conversely a review by Graham 2001 [4] that the majority of studies that reported, improvement in

exercise performances in an athletic population following caffeine used exercise intensities between 75 to 85% of vo_2 max. A separate explanation for the result of the study may pertain to participants not being accustomed to regular exercise and consequently being reluctant to extend themselves during second part of exercise session due to fear of injury or lack of confidence. Extra exercise session may boost their confidence, which in turn may result in more work being performed during a set time.

As pulse rate values were decreased to some extent in the current study, it is possible that an increase in stroke volume may have been responsible for the higher energy expenditure reported after caffeine ingestion during part-1 phase of exercise. Other possible mechanism may be the stimulatory effect of caffeine by catecholamine release [4].

5. Conclusion

In the nutshell, the result of the investigation demonstrated that caffeine in moderate dose has got beneficial effect over cardiovascular responses to dynamic exercise. Though caffeine caused mild rise in systolic blood pressure without any unpleasant or adverse effect, the change of diastolic blood pressure is insignificant. Moreover in this study pulse rate was also found decreased during exercise after caffeine intake. The more important aspect of this investigation is caffeine ingestion significantly increased energy expenditure during exercise. Though energy expenditure increased in 10 min maximal exercise session, the finding was very less. The difference of the two means (before caffeine 10 min maximal exercise and after caffeine 10 min maximal exercise) was only. 20, whereas the energy expenditure in 15 min steady state exercise after caffeine ingestion increased which is statistically highly significant. It is possible that initial small improvement seen in the ability to exercise via caffeine ingestion may motivate overweight and sedentary individuals to make exercise a regular habit which in turn could result in positive implications for weight management, fitness and well health.

Further studies investigating the effect of caffeine in overweight and sedentary population should use extra exercise session and longer duration of exercise session.

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