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EFFECT OF CAFFEINE ON EXERCISE PERFORMANCE AMONG UNTRAINED MEDICAL STUDENTS

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ABSTRACT

The purpose of the study was to examine the effect of moderate dose (5mg /kg) of caffeine ingestion on pulse rate, blood pressure and energy expenditure during a steady state e xercise period with a standardized power output as well as during a set time period. In this study participants were required to cycle with maximum effort. Eighteen healthy, overweight, sedentary, male, first year MBBS students of JNMC, completed 15 minutes of steady state of cycling exercise at a standardized power output equating to 65% of HRmax. This was followed by 10 minutes stationary cycling where they were required to cycle with maximum effort after ingestion of caffeine (5mg/kg) 60 min prior to exercise. Same subjects were used as control. The study showed an increase in systolic blood pressure after caffeine ingestion but there was no significant change in diastolic blood pressure. Pulse rate decreased after caffeine ingestion, which indicates decrease in heart rate. After caffeine ingestion energy expenditure in the 2nd part (10 min maximal) of exercise increased but it significantly increased in the 1st part of exercise (15 min submaximal exercise).

INTRODUCTION

Use of caffeine and caffeine containing beverages are commnon 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 (Bell, 2002; Bridge, 2006; Bruce, 2002 and Graham, 2001). Caffeines cardiovascular effects have also generated much interest. Most of this study however conducted in resting subjects and has investigated the potential negative health consequences from caffeine induced elevation of blood pressure (Myers, 1988). Investigations reporting the effect of caffeine on heart rate during exercise are equivocal, with some indicating increases (Bell, 2002 and MCNaughton, 1987), decreases (7), and no effect (Daniels, 1998). Caffeine dose, exercise intensity and caffeine habitation 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 is often made without reference to dose, intensity of activity or habituation status. Benefits associated with caffeine ingestion includes delayed feeling of fatigue (Anselme *et al*., 1992; Jackman, 1996), reduced sensation of pain and exertion (Anselme, 1992), increased fatty acid oxidation (Chad, 1989), increased mean power output (Anderson, 2000), decreased time to complete a set amount of work (Bridge, 2006), stimulation of motor activity as well as increase in alertness and ability to concentrate (Keisler, 2006). 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 to adenosine receptors, caffeine is able to counteract many of the inhibitory effect of adenosine on neuroexitability (14), neurotransmitter release, (Fredholm, 1999), and arousal, (Porkha Heiskanen, 1999). To date majority of the studies in exercise performance following caffeine ingestion involved well trained athlets, 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 calori 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 cardiorespiratory effect of energy expenditure of moderate dose of caffeine ingestion during bicycle ergometry among overweight sedentary first year MBBS students of Jawaharlal Nehru Medical College who are non-habitual caffeine users.

Aims

To examine the effect of caffeine ingestion (5mg per kg) over pulse rate, blood pressure energy expenditure, during 15

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minutes of stationary cycling at a standardised power output as well as 10 minutes cycling with maximum effort among overweight sedentary fist year MBBS students of Jawaharlal Nehru Medical College, who are non-habitual caffeine users.

Objectives

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

MATERIALS AND METHODS

The study was conducted at exercise laboratory of Jawaharlal Nehru Medical College with due approval from institutional ethical committee. 18 male subjects aged 15 to25 year, 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 (WHO).

Inclusion Criteria

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

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

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 food for48 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. The instruction was 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 ergometer (exercise computer JS-154). Heart rate is virtually transmitted as pulse rate unless there is any pathological condition. A graded exercise protocol was advocated on a bicycle ergometer in order to determine the power output, required to elicit a target aof heart rate equating to 65% of individual age predicted maximum heart rate (220-age). Percentage of heart rate maximum was chosen instead of VO_2 max, 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 bicyle ergometer), 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 the 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 15 minutes and 10 minutes were selected. Immediately after completion of each stage of exercise, pulse rate and blood pressure were measured.

Experimental Session

Participants arrived at exercise laboratory in the morning at 9am 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. The exercise was divided into two phases:- Part-1--- which included 15 minutes stationary cycling at a constant power output equating to 65% of individual age predicted heart rate maximum, as determined during familiarization session. 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 ergometer (Exercise computer-JS-154). Blood pressure was recorded by sphygmomanometer. After a brief relaxation, participants left the exercise laboratory.

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	15 min	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	15 min	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

RESULT

Data analysis

Data were expressed as mean± SD. Students paired t test was used for analysis for data. Stastistical significance was set at $p < .05$. Effect of caffeine on total amount of energy expenditure, pulse, systolic and diastolic BP

Values are means ±SD, n=18

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 in diastolic BP was noted.

Part-2 exercise session

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

DISCUSSION

The result of this investigation provide evidence that caffeine alters the haemodynamic response to exercise, specifically ingestion of 5mg per kg caffeine increases exercise induced systolic BP. As caffeine increases both resting and exercise BP it may be concluded that the effect of resting BP were responsible for higher BP observed during exercise, because 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(3-6 mg per kg) 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 (Myers, 1988; Robertson, 1978; Sung , 1990). The potential tolerance to the effects of caffeine consumption was also controlled for because haemodynamic response to caffeine may be blunted in regular users (Casiglia, 1991). In fact tolerance to the caffeine can occur only three consequtive days of use (MCNaughton, 1987 and Kalmar *et al*., 2004). 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 resensitise the system to the effects of this drug (Casiglia, 1991). The result of this study also shows that caffeine at dose of 5mg per kg body weight decreased 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*., Gaser and Rich, (Gasser, 1985), and Turly and Crest, (Turley, 2006). All this studies mentioned that low to moderate dose of caffeine, significantly decreases heart rate at submaximal intensity of exercise. This result of pulse rate are in contrast to a number of studies that have reported no effect of caffeine administration on exercise heart rate (Bell, 2002; Daniels, 1998; Kaminsky, 1998).

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 (MCNaughton, 1978). 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 (Robertson, 1978; Gould, 1973). Another possible explanation of a lower pulse rate is due to baroreflex activity which reflexly lowers heart rate in response to elevation of blood pressure, in an attempt to reestablish normal blood pressure (Mosqueda-garcia, 1990). 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 is greatly increased and this value is highly significant. Caffeines ergogenic benefits have well been established in athlets, 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 (Bridge. 2006). 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 (Graham, 2001). This conjencture is further supported by results from Ahrens *et al*, (2007a) and Ahrens at al, (2007b) 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. Morever % 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*. (1999) reported no significant change of VO_2 in sedentary males after caffeine ingestion while walking at intensities equivalent to 30% and 50% of VO_2 max.

In a review by Graham 2001(Graham, 2001), majority of studies reported, improvement in exercise performances in an athletic population following caffeine use at 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 (Graham, 2001).

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.

REFERENCES

Aherens, J.N, Crixel. S.H. Lloyd. L.K. and Walker. J.L. 2007a. The physiological effects of in women during treadmill walking. *J. of Strength and conditioning Research*. 21(1); 354-1163.

Ahrens, J.N. Lloyd, L.K, Crixell, S.H. and Walker, J.L 2007b. The effects of caffeine in women during aerobic - dance, bench steping. *Int. J. of sports nutrition and exercise metabolism*, 17; 27-34.

Anderson, M.E., Bruce, C.R., Fraser, S.F., Septo, N.K., Klein, R., Hopkins, W.G., and Hawley, J.A. 2000. Improved 2000 meter rowing performance in competitive oarswomen after caffeine ingestion. *Int J of sport nutrition and Exercise Metabolism*. 10(4), 464-475.

Anselme, F., Collomp, P.K., Mercier, B., Ahmardi, S. and Prefot, C. 1992. Caffeine increases maximal anaerobic power and blood lactate concentration. *European J of Applied Physiology and occupational physiology*, 65(2); 188-191.

Bell, D.G. McLellan, T.M. 2002. Exercise endurance in 1,3 and 6 hrs after caffeine ingestion in caffeine users and non users. *J of applied physiology*, 93; 1227-1234.

Bridge, C.A. and Jones, M.A.2006. The effect of caffeine on 8km run performance in a field setting. *J. of sport science,* 24(4), 433-439.

Bruce, C.R., Anderson, M.E., Fraser, S.F., Stepto, N.K., klein. R, Hopkins, W.G., and Hawely, J.A. 2002. Enhancement of 2000m rowing performance after caffeine ingestion. Medicine and science in sports and exercise 32(11); 1958-1963.

Casiglia, E.S., C.D., Paleari, S., Petucco, M., Boni, G., Colangeli, M., Penzo, and A.C. Pessina, 1991. Haemodynamic effect of coffe and caffeine in normal volunteers: A placebo controlclinical study. *J of Intern. Medicine*, 229: 501-504.

Chad, K., and Quigly, B. 1989. The effect of substrate utilization, manipulated by caffeine on post exercise oxygen consumption in untrained female subjects. *Europian J. of Applied Physiology*, 59, 48-54.

Daniels, J.W., Mole, P.A., Shaffrath, J.D., Stebbins, C.L. 1998. Effects of caffeine on blood pressure, heart rate, and fore arm blood flow during dynamic leg exercise. *J Applied Physiology,* 85: 154-159.

Fisher, S.M., R.G. Mcmurray, M. Berry, M.H. Mar, and W.A. Forsythe; 1986. Influence of caffeine on exercise performance in habitual caffeine users. *Int J of Sports Medicine*, 7: 276-280, 1986.

Fredholm, B, Batting, K., Holman, J., Nehlig, A., and Zvartu, E.E. 1999. Action of caffeine in the brain with special reference to factors that contribute to its widespread use; *Pharmacological Reviews*, 51(1),83-133.

Fredholm, B., Battig, K., Holmen, J, Nehlig, A. and Jovartau. E.E. 1999. Action of caffeine in brain with special reference to factors that contributes to its widespread use. *Pharmacological Reviews* 51(1), 83-133.

Gasser, G.A., Rich, R.G., Influence of caffeine on blood lactate response during incremental exercise. *Int J Sports Med* 1985, 6(4): 207-211.

Gould, L., Verkatararaman, K., Goswami, M., Gomprecht, R.M. 1973. The cardiac effect of coffe. Angiology, 24(8):455-463.

Graham, T.E. 2001. Caffeine and exercise, metabolic endurance and performance. *Sports Medicine* 31(11), 1958-1963.

Jackman, M.P., wendling, D., Friars, D. and Graham T.E. 1996. Metabolic, Catecholamine and endurance response to caffeine during intense exercise. *J. of Applied Physiology*, 81(4), 1658-1663.

James, J. 1999. Caffeine and health. Academic Press, London,1-432.

Kalmar, J.M., Caferelli, E. 2004. Caffeine a valuable tole to study central fatigue in human. Exercise and sports science reviews 32(4),143-147.

Kaminsky LA, Martin C.A, Whaley M.H: Caffein consumption habits do not influence the exercise blood pressure response following caffeine ingestion. J. Sports Medicine phys fitness 1998. 38:53-58.

Karen, E., Waltman, K., Jin. W. Goh, and Kym J. Guelfi: Effects of caffeine on exercise performance in sedentary females. *J. of Sports Science and Medicine* (2010)9, 183-189.

Keisler, B.D., and Armesy T.D. 2006. Caffein as an ergogenic aid. *Current sport Medicine Report* 5, 215-219.

Landolt H, dijk J,Gaus S, BorbleY A, 1995: Caffeine reduces low frequency delta activity in the human sleep *EEG. Neuropsyco pharmacology* 12,229-238.

MCNaughton L, Two levels of caffeine Ingestion on blood lactate and free fatty acid responses during incremental exercises. *Res.Quarter*, 1987, 58: 255-259.

Mosqueda-garcia R, Tseng CJ, Biaggioni I, Robertson RM, Robertson D: Effects of caffeine on baroreflex activity in humans. *Clin. Pharmacol Ther,* 1990, 48: 568-574.

Myers. MG: Effect of caffeine on blood pressure. *Arch Intern Med*, 1988, 148: 1189-1193.

Porkha Heiskanen T. 1999. Adenosine in sleep and wakefulness; Annals of Medicine. (31 125-129;)

Robertson.D, J.C. Frolic, R.K. Carr, J.T. Watson, J.W. Hollifield, D.G. Sand, and J.A. Wates. Effects of caffeine on plasma rennin activity, Catacholamines and blood pressure. *N. Engl. J. Med.* 298: 181-186, 1978.

Steven R McClaran, and Thomas J. Wetter; Low dose of caffeine reduce heart rate during submaximal cycle ergometry; *J of the International society of sports nutrion*

Steven. RMcClaran and Thomas J Wetter: Low dose of caffeine reduces heart rate during sub maximal cycle ergometry. *J of the International society of sports nutrition* 2007,4: 11.

Sung B.H, W.R. Lovallo, G.A. Pincomb and M.F. Wilson. Effect of caffeine on blood pressure response during exercise in normotensive healthy young men. *Am. J. Cardiol.*, 65: 909-913.1990.

Turley K.R, Gerst JW: Effects of caffeine on physiological responses to exercise in young boys and girls. *Med sci sports exerc*, 2006, 38: 520-526.

WHO criteria for BMI.

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