JMBR: A Peer-review Journal of Biomedical Sciences
June 2012, Vol. 11 No.1 pp 78-87

CHANGES IN PEAK EXPIRATORY FLOW RATE, BLOOD PRESSURE AND PULSE RATE FOLLOWING INGESTION OF INCREASED COFFEE CONCENTRATIONS IN HEALTHY MALE ADULTS

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ABSTRACT

We studied the effect of different concentrations of coffee on peak expiratory flow rate (PEFR), blood pressure and pulse rate in an attempt to determine some physiological effects of coffee intake. 18 apparently healthy adult males, age range 20 to 30 years, were recruited for the study over a three day period. Varying concentrations (2g, 4g and 6g) of Nescafe Instant Coffee were administered. 2g coffee concentration was given on the first day, 4g on the second day and 6g on the third. The control measurements were taken on the first day of the experimental procedure in all subjects. The PEFR readings after coffee administration increased significantly when compared with control readings ($P<0.05$) 4g and 6g readings also increased significantly when compared with 2g readings ($P<0.05$), but there was no significant change between the 4g and 6g readings.

Using 2g, no significant change in systolic blood pressure (SBP) was observed when compared with controls. SBP increased significantly at 4g and 6g when compared with the control ($P<0.05$). Diastolic blood pressure (DBP) increased significantly in all categories when compared with the control, but there was no significant change in DBP when the 3 coffee doses were compared. There was significant decrease in PR in all the 3 experimental doses when compared with the control reading ($P<0.05$), 2g decreased significantly when compared with 4g, but no significant change when 4g was compared to 6g.

This study suggests that 2g of coffee does not give maximum cardio-respiratory effects. The peak effect that coffee can exhibit on PEFR and cardiovascular system was seen from 4g coffee concentration; but there was no significant difference when compared with 6g concentration. Only in DBP and PR were significant changes observed when 2g concentration was administered. It further indicates that, mild doses of coffee confer benefits on airflow in the lungs. While higher doses are also beneficial in improving airflow in the airway, such doses have the disadvantage of increasing BP.

Introduction

Coffee is a brewed drink prepared from roasted seeds, commonly called coffee beans, of the coffee plant. Due to its caffeine content, coffee can have a stimulating effect in humans. Today, coffee is one of the most popular and most consumed beverages worldwide (Villanueva et al., 2006). In the United States that researchers found 43% of coffee drinkers say they're less productive if they don't drink coffee on the job; workers say they drink two or more cups of coffee during their normal workday[1].

Euromonitor International in an article "Coffee in Nigeria", reported that Coffee

KEY WORDS: *Peak expiratory flow rate, blood pressure, pulse rate and coffee*

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drinking continued to increase in 2009 especially among working Nigerians, who consumed it to remain alert in stressful working environments; that many now rely on coffee to ward off drowsiness and restore alertness during the working day[2]. Coffee is also consumed before going home to ward off tiredness in the huge 'traffic jams'. Coffee is served in most offices during breaks, at conferences and at other formal business gatherings. It is also popular among students during school sessions and most especially in the examination or test periods.

There are many compounds in coffee that are often thought to have implications upon human health; these include Caffeine, Micronutrients, LDL Cholesterols and Chlorogenic acid. The major physiologically active substance in coffee is the alkaloid caffeine ($C_8H_{10}O_2N_4.H_2O$), also called guaranine or methyltheobromine, which acts as a mild stimulant (a central nervous system (CNS) stimulant). Caffeine has been shown to interfere with the enzyme phosphodiesterase which inactivates cAMP, an intracellular messenger[3]. It has also been shown to be a respiratory stimulant; it is capable of improving airflow in the lungs and reducing the respiratory depression normally associated with morphine and codeine [4, 5].

This study examines the effect of coffee at "different concentration levels" on Peak Expiratory Flow Rate (PEFR) in young Nigerians. This is essential in order to moderate coffee intake, especially for those who employ coffee drinking for therapeutic measures or performance enhancement.

Peak expiratory flow rate (PEFR) is generally considered as a sensitive indicator for changes in elastic recoil pressure and/or the resistance to airflow in medium and small airways[6]. Systolic blood pressure (SBP), diastolic blood pressure (DBP) and Pulse rate (PR) were also measured.

Materials and Methods

The subjects used for this study were male undergraduate students of the University of Ilorin, who volunteered to participate; ages ranged from 20 – 30 years. All subjects were apparently healthy, non-habitual coffee users, non-smokers and had no history of cardiopulmonary diseases. The studies were carried out between 9 a.m. and 12 p.m. Each subject participated for a three-day consecutive period, with their anthropometric data obtained the first day together with the control measurements. Also, on the first day, 2g-coffee was administered to the subject, 4g-coffee coffee administration on day-two and 6g coffee on the third day, making a four-grouped reading which were: control, 2g, 4g and 6g groups. All coffee concentrations (2g, 4g and 6g) were dissolved in 150ml of warm water of about 40°C. [2g coffee is the supposed amount in a 7oz cup of coffee (Nescafe Instant Coffee) with approximately 65mg caffeine content[7].

On the first day, subjects were requested to come to the laboratory for the test having had their last meal the previous day not later than 6p.m. On arrival (on the first day), subjects were made to have a 15mins rest after which their control blood pressure readings were obtained using a mercurial sphygmomanometer (Yamasu, Japan). After 5mins, control peak expiratory flow rate measurements were also taken using the standard Wright's Peak Flow meter. 2g-coffee was then administered. 60mins after of administration, the experimental readings were taken; blood pressure level measurements and pulse rate, and PEFR followed 5mins afterwards. [A period of 60mins was preferred using the study "Time Course and Bronchodilator Effect of Caffeine in Young Nigerians", as a reference, which provided the evidence that maximum bronchodilator effect of caffeine on the airway was attained in 60mins, and that no significant bronchodilation occurs after this period][5]. The second and third day procedures commenced with 4g and 6g respectively. All measurements were done with subjects in the sitting position.

RESULTS

Table 1: **Mean Values of Anthropometric Data for all 18 Subjects**

Variable	Means
Age (yrs)	23.23±0.34
Weight (kg)	63.85±1.44
Height (m)	1.75±0.01
Body Mass Index (kgm^{-1})	20.72±0.34
Chest Circumference (cm)	83.25±1.98

The results are represented with bar charts.

Peak Expiratory Flow Rate (PEFR) $L.min^{-1}$

Figure 1 shows changes in PEFR in relation to coffee concentrations. There was no significant change in PEFR between the control mean (532±8.61) and the 2g concentration coffee mean (545±5.37). PEFR values increased significantly following the ingestion of 4g (587±9.64) and 6g (596±7.98) when compared to the 2g (545±5.37) and control (532±8.615) ($P<0.05$). There were no significant changes in PEFR of the 4g (587±9.64) and 6g (596±7.98) coffee concentrations.

SYSTOLIC BLOOD PRESSURE (SBP) mmHg

Figure 2 shows changes in SBP with respect to coffee concentrations. There was no significant change between the control SBP (109.00±1.95) and the SBP for 2g (110.83±1.77), but SBP for 4g (114.89±1.67) and 6g (113.06±1.19)

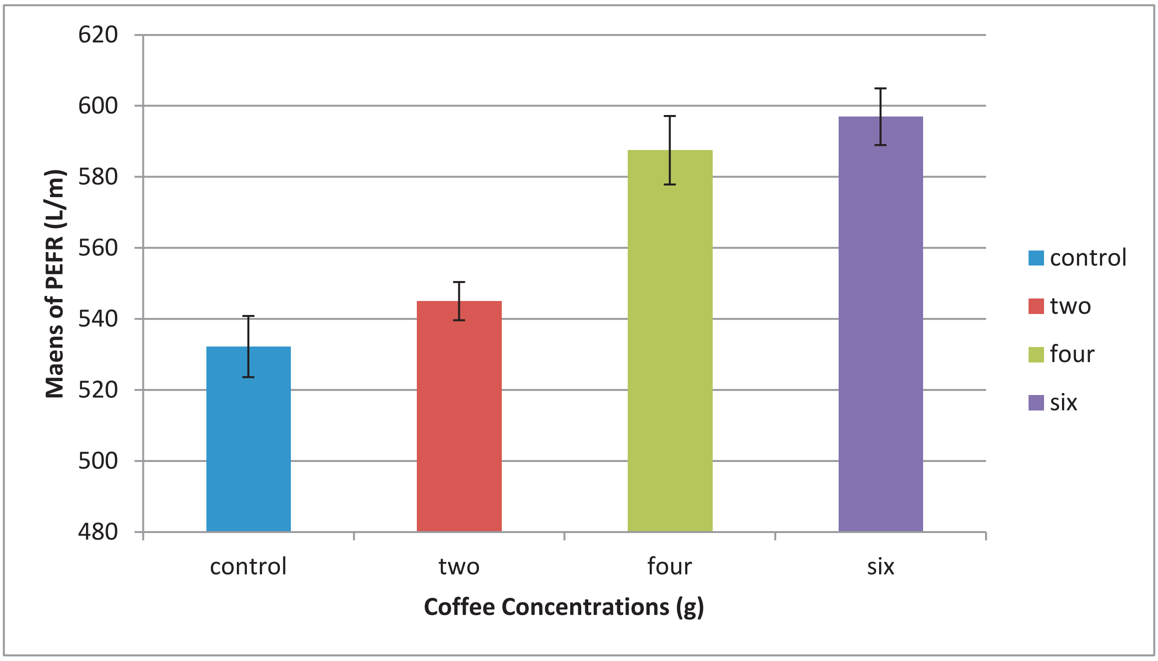

Figure 1: Bar Chart Representing Changes in PEFR with Respect to Coffee Concentrations

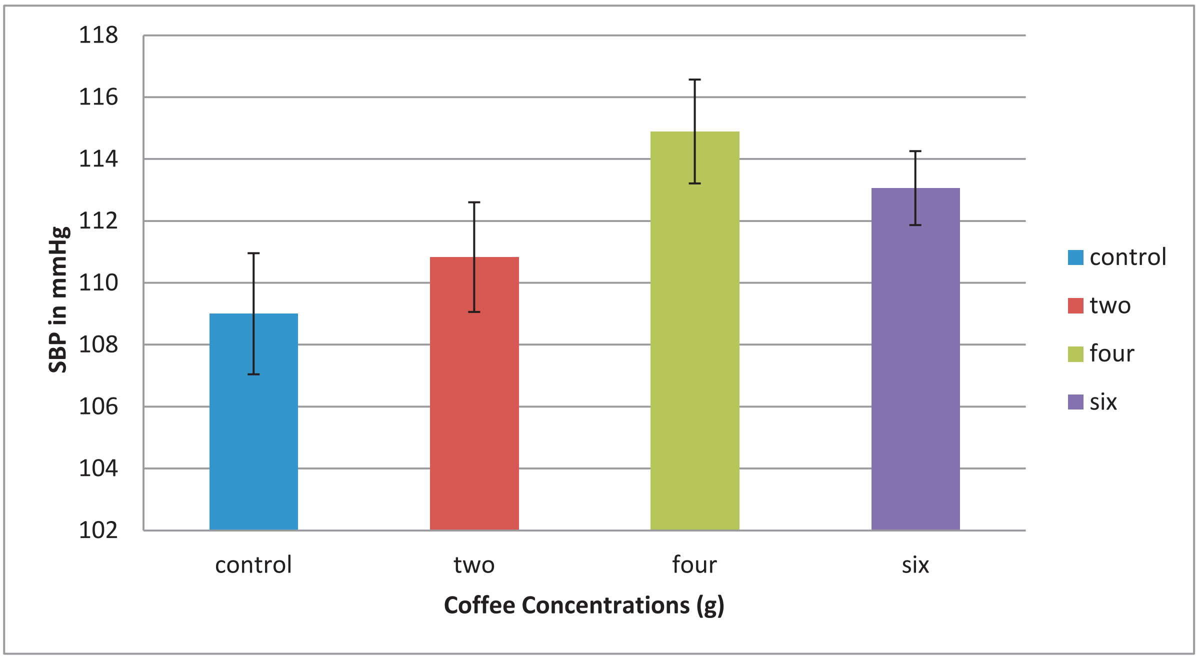

Figure 2: Bar Chart Representing Changes in SBP with Respect to Coffee Concentrations

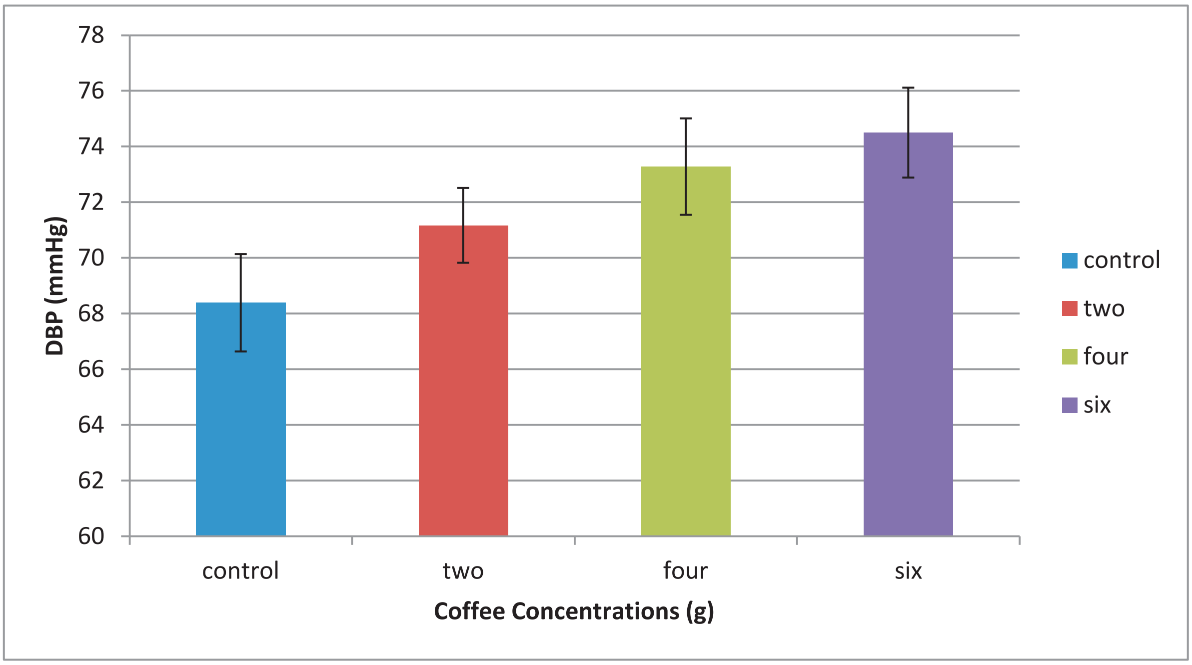

Figure 3: Bar Chart Representing Changes in DBP with Respect to Coffee Concentrations

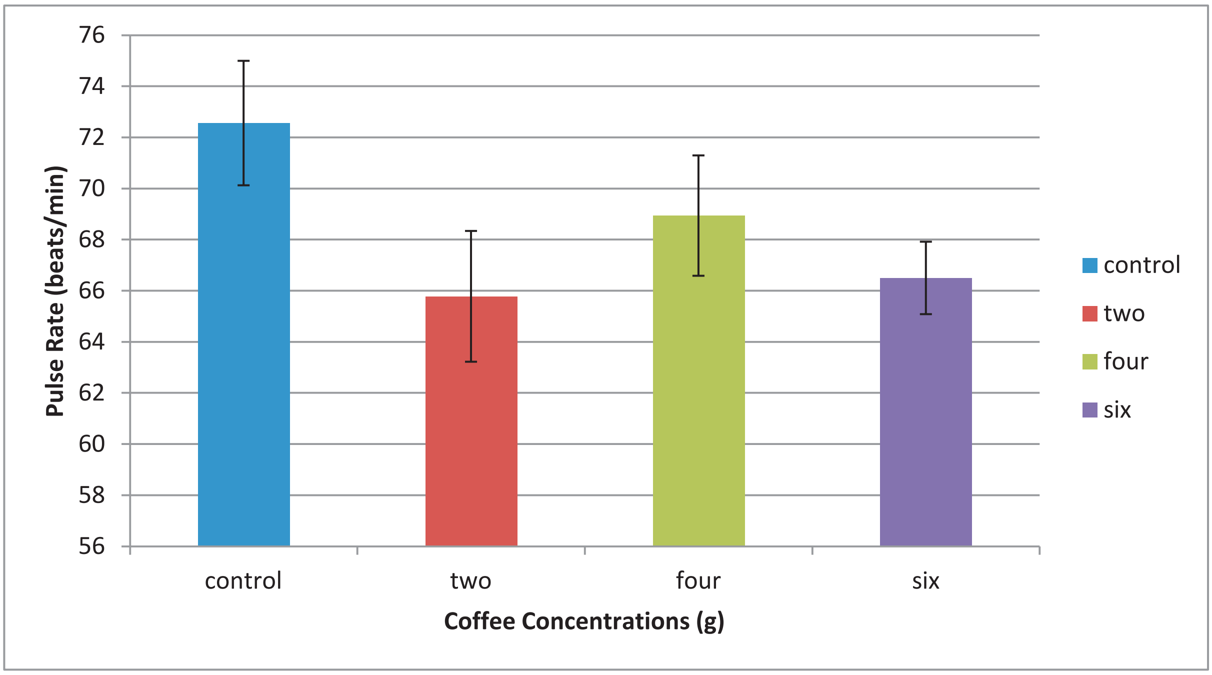

Figure 4: Bar Chart Representing Changes in PR with Respect to Coffee Concentrations

Peak Expiratory Flow Rate (PEFR)

Table 1: Means, SD, SEM and Paired Statistics of PEFR

	Mean	Standard Error of Mean (SEM)	P-value (two-tailed)
Control	532.22	8.615	-
2g	545.00	5.378	-
4g	587.50	9.644	-
6g	596.94	7.984	-
Control—2g	-12.778	7.267	0.097
Control—4g	-55.278	7.337	0.000*
Control—6g	-64.722	6.176	0.000*
2g—4g	-42.500	7.423	0.000*
2g—6g	-51.944	6.980	0.000*
4g—6g	-9.444	5.541	0.106

*Significant at 0.05 level (2-tailed)

SYSTOLIC BLOOD PRESSURE (SBP)

Table 2: Means, SEM and Paired Statistics of SBP

	Mean	Standard Error of Mean (SEM)	P-value (two-tailed)
Control	109.00	1.957	-
2g	110.83	1.772	-
4g	114.89	1.678	-
6g	113.06	1.195	-
Control—2g	-1.833	1.172	0.136
Control—4g	-5.889	1.592	0.002*
Control—6g	-4.167	1.576	0.017*
2g—4g	-4.056	1.670	0.027*
2g—6g	-2.333	1.486	0.135
4g—6g	1.722	1.134	0.147

*Significant at 0.05 level (2-tailed)

DIASTOLIC BLOOD PRESSURE (DBP)

Table 3: Means, SEM and Paired Statistics of DBP

	Mean	Standard Error of Mean (SEM)	P-value (two-tailed)
Control	63.39	1.749	-
2g	71.17	1.344	-
4g	73.28	1.732	-
6g	74.50	1.615	-
Control—2g	-2.778	1.217	0.036*
Control—4g	-4.889	1.338	0.002*
Control—6g	-6.111	2.395	0.021*
2g—4g	-2.111	1.405	0.151
2g—6g	-3.333	2.080	0.127
4g—6g	-1.222	2.489	0.630

*Significant at 0.05 level (2-tailed)

PULSE RATE (PR)

Table 4: Means, SEM and Paired Statistics of PR

	Mean	Standard Error of Mean (SEM)	P-value (two-tailed)
Control	72.56	2.435	-
2g	65.78	2.559	-
4g	68.94	2.355	-
6g	66.50	1.417	-
Control—2g	6.778	1.556	0.000*
Control—4g	3.611	1.538	0.031*
Control—6g	6.056	1.356	0.000*
2g—4g	-3.167	1.197	0.017*
2g—6g	-0.722	1.475	0.631
4g—6g	2.444	1.227	0.063

*Significant at 0.05 level (2-tailed)

increased significantly when compared to the control mean (109.00±1.95) ($P<0.05$). The 4g (114.89±1.67) increased significantly when compared with the 2g (110.83±1.77) ($P<0.05$), but there was significant change in the mean SBP of 2g (110.83±1.77) and 6g (113.06±1.19) ($P<0.05$). There were no significant changes in the mean SBP for 4g (114.89±1.67) and 6g (113.06±1.19).

DIASTOLIC BLOOD PRESSURE (DBP) mmHg

Figure 3 shows changes in DBP with respect to coffee concentrations. There was significant increase in DBP with increase in coffee concentration i.e. 2g (71.17±1.34), 4g (73.28±1.73), and 6g (74.50±1.615) when compared with the control DBP (68.39±1.75) ($P<0.05$). There were no significant changes in DBPs when readings for different coffee concentrations were compared.

PULSE RATE (PR) – min^{-1}

Figure 4 shows changes in PR with respect to coffee concentrations. There was significant decrease in PR with increase in coffee concentration i.e. 2g (65.78±2.56), 4g (68.94±2.36), and 6g (66.50±1.41) when compared with the control mean (72.56±2.44). The PR for 4g (68.94±2.36) increased significantly when compared with the PR for 2g (65.78±2.56) ($P<0.05$), but there was significant change in the mean PR for 2g (65.78±2.56) and 6g (66.50±1.41). There were no significant change in the mean PR for 4g (68.94±2.36) and 6g (66.50±1.41).

Discussion

Caffeine is presently the worlds most widely consumed psychoactive substance; but unlike many other psychoactive substances, it is legal and unregulated in nearly all jurisdictions.

From the present study, the full physiologic effect of coffee on the air passage ways is recorded at 4g coffee concentration (approx: two cups of coffee). This agrees with Iyawe et al.[5], that there were no significant differences between the response to 260mg and 520mg of caffeine (in a cup of Instant coffee) in non-caffeine users.

Systolic blood pressure (SBP) increased significantly at high levels of coffee consumption. Diastolic blood pressure (DBP) increased significantly in all the experimental readings when compared with the control, but there was no significant change in the comparisons of the experimental values. These findings support studies like Klag et al.[8], which associated coffee drinking with small increases in blood pressure, and also Nurminen et al.[9], which reported that acute intake of coffee and caffeine increases blood pressure.

Pulse rate decreased generally with the consumption of coffee. This finding is in conformity with Rachima-Moaz et al.[10], which discovered marked decrease in heart rate of both habitual and non-habitual coffee takers after one hour of 250mg caffeine ingestion.

Decrease in heart rate associated with coffee ingestion can be noticed even at 2g coffee concentration, and subsequent increase in dosage might initiate little or no further changes in pulse rate.

The possible mechanism of action of coffee/caffeine is the blocking of adenosine receptors and inhibition of the enzyme phosphodiesterase[3,8,9,11]. Phosphodiesterase inactivates cyclic adenosine monophosphate (cAMP). In the absence of phosphodiesterase, there is a build up of cAMP. Since cAMP is in a dynamic steady state relation with its intracellular pool, an increase in vascular smooth muscle cell cAMP may thus result. Such a rise in cAMP level would stimulate increased Ca^{2+} sequestration, and cause relaxation, as has been reported for other smooth muscles[11]. Also, it is well known that caffeine influences contractile mechanisms in striated muscle fibres and facilitates the contraction of skeletal muscle, before and after fatigue; it improves metabolism and exercise performance[12]. Furthermore, caffeine has been shown to readily pass through the blood/brain barrier and so can affect the central nervous system (CNS) directly, including the respiratory centers.

This study suggests that the peak effect that coffee can exhibit on PEFR and cardiovascular system occur around 4g coffee concentration since there was no significant difference when compared with values of 6g concentration. Only in DBP and PR were significant changes observed when 2g concentrations were administered. It further indicates that, mild doses of coffee confer benefits on airflow in the lungs. Although higher doses may still be beneficial to airway mechanics, they have the disadvantage of increasing BP. The effect of repeated consumption of coffee in the day or addiction needs further elucidation.

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