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Effects of Caffeine Consumption on Blood Pressure Among Adults at Risk for Increased Intra-ocular Pressure

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Abstract

This study examines the effects of caffeine consumption on blood pressure among adults at risk for increased intraocular pressure attending the Ophthalmic Clinic of a Specialist Teaching Hospital in Nigeria. The study is a retrospective study conducted using questionnaire to obtain information on consumption of caffeinated drinks, coffee, tea and chocolate via the National Health Service semi-quantitative food frequency questionnaire assessment. Subjects who met the criteria and gave informed consent were recruited for blood pressure measurement and the result recorded. Statistical analysis was then carried out and simple descriptive analysis done. The results showed that 388 subjects completed the study with 201 subjects having positive history of caffeine intake. This amounted to a 51.80% prevalence of caffeine consumption among adults attending the Ophthalmic Clinic. Participants positive to caffeine consumption (132.31±16.44/82.41±9.14mmHg) presented significantly higher ($p<0.05$) mean blood pressure than participants negative to caffeine intake (121.11±9.18/77.75±10.32mmHg). Also, age and gender were observed to significantly influence ($p<0.05$) systolic blood pressure in participants positive for caffeine consumption as compared to those negative for caffeine intake. The results suggest that caffeine consumption, female gender and advancing age are risk factors for the development of hypertension in adult population at risk of increased intraocular pressure and vice vasa.

Keywords

Caffeine, Blood Pressure, Increased Intraocular Pressure, Ophthalmic Clinic

1. Introduction

The relationship between coffee, caffeine and cardiovascular health markers has been explored, with emphasis on cardiac arrhythmia, heart rate, serum cholesterol and blood pressure. In a review by Nawrot *et al.*[1], it was concluded that moderate caffeine consumption (400 mg or less, or four or fewer cups of coffee per day) does not adversely affect cardiovascular health. While studies have found that caffeine consumption does not significantly increase the risk of coronary heart disease or stroke [2], randomized controlled trials have found that caffeine consumption increased cardiovascular disease risk factors to some degree, including blood pressure. However, caffeine has been reported to have a protective effect in men 65 years and older and women aged 55-69 years who did not previously have severe hypertension [3]. Another scientific review by James [4] reported that there is strong experimental evidence that blood pressure remains reactive to caffeine in the diet, and that overall epidemiological evidence implicates caffeine as a risk factor for hypertension, however, more recent studies on women have not supported this.

According to the American Heart Association policy on caffeine, "whether high caffeine intake increases the risk of coronary heart disease is still under study" [5] but AHA references two studies of interest; the Nurses' Health Studies I

and II, carried out on approximately 162,000 nurses over 26 years [6], and another long-term study carried out on 128,000 people over 14-20 years in Spain [7] – which offer encouraging results for caffeine. In the study by Lopez-Garcia *et al.* [7], it was reported that coffee consumption was not associated with an increased risk of coronary heart disease. In the Nurses' Health Studies I and II, coffee consumption, even at high levels, appeared to have no effect on blood pressure; however, both regular and diet colas caused a modest increase in blood pressure. This apparent contradiction was thought to be due either to an ingredient other than caffeine or by a protective effect of another component of coffee. This made Winkelmeyer *et al*. [6] to recommend that people already suffering from high blood pressure should consult a physician about their caffeine intake, as they may be more sensitive to the effects of caffeine on blood pressure.

In view of the above, this study was undertaken to investigate the effects of caffeine consumption on blood pressure among at risk adult population of increased intraocular pressure attending the Ophthalmic Clinic. This study was carried out among adult population with increased intraocular pressure because caffeine is reported to acts as stimulant by increasing blood pressure [8, 9] and affecting blood flow at various human body sites such as, decreasing cerebral flow by approximately 15–30% [10], increasing vascular resistance at rest [11] and reducing retinal blood flow by 13% [12]. It is our thinking therefore that blood pressure might have a relationship with intra-ocular pressure and hence the interest among "at risk" adult population of increased intraocular pressure.

2. Materials and Methods

2.1. Study Design and Area

The study is a retrospective study designed for adults attending the Ophthalmic Clinic of Irrua Specialist Teaching Hospital, Irrua Nigeria. And it used questionnaire to obtain information on the ingestion of caffeinated drinks, measurement and documentation of blood pressures.

The Irrua Specialist Teaching Hospital is a tertiary hospital located in Esan Central Local Government Area of Edo State. The hospital is owned by the Federal Government of Nigeria and is a teaching hospital for the Ambrose Alli University College of Medicine, Ekpoma. Esan Central Local Government Area is in Edo State, Nigeria. Its administrative headquarters is in Irrua. It has an area of 253 km² and a population of 105,310 based on the 2006 census. Esan Central is predominantly an agrarian area and has a few industries, hotels, hospitals and factories like the Bendel Feed & Flour Mills Ltd; which is about the single largest factory in Edo State.

2.2. Study Population and Criteria for Inclusion

The study was targeted at all patients referred to and attending the Ophthalmic Clinic of the Department of Ophthalmology, Irrua Specialist Teaching Hospital, Irrua, Edo State -Nigeria.

All patients between 20 and 70 years, both sexes, with no inflammation or rubeotic glaucoma were included. All patients who are ages <20 or > 70 years, have undergone any form of surgical intervention, with history of head injury and with existing infection or inflammation were excluded. Patients who had problem with remembering their history of coffee intake were also excluded.

2.3. Sample Size Determination

Sample size was determined as described by Araoye [13] using the formula below

$$\mathrm{N} = \frac{Z^2 p(1-p)}{d^2}$$

Where N = minimum sample size required; Z = confidence limit of survey at 95% (1.96); p = prevalence of intraocular pressure, which was taken to be 50.0% (0.5) since its prevalence is not known; d = absolute deviation from true value (degree of accuracy) =5% =0.05

$$\mathrm{N} = \frac{1.96^2 \times 0.5(1-0.5)}{0.05^2} = 384.16 = 384$$

Therefore, the minimum sample size estimate for the study was 384. This was approximated to four hundred (400).

2.4. Sampling Procedures and Instrument for Data Collection

The study employed the simple random sampling technique to admit subjects to take part in the study. Subjects included patients who came for clinic visit during the study. This sampling procedure was adopted because of the problem of having the entire population in the same place at the same time.

A structured questionnaire was developed after reviewing existing literatures and was used for data collection. The questionnaire consisted of 2 sections aimed at providing answers to the stated objectives; Section A contained the socio-demographic characteristics/ profile and history of caffeine ingestion and Section B consisted of blood pressure assessments.

Validity of the instrument for data collection was ensured through the development of a draft instrument by consulting relevant literatures and subjecting the draft to independent, peer and expert reviews, particularly expert in ophthalmology and comments from supervisor were used to validate the instruments. Reliability was determined by first subjecting 35 questionnaires (10% of the calculated sample size) to pre-test. The data from the pre-test was coded, entered into the computer and analyzed. Reliability testing was then determined using the Cronbach's Alpha coefficient and a coefficient of 0.773 was obtained and considered reliable since it was greater than 0.5.

2.5. Ethical Consideration

Permission and approval to carry out the study was obtained from the Irrua Specialist Teaching Hospital Health Ethics Review Committee (ADM/PERS/154/VOL.1/92). Consent was

obtained after provision of adequate, clear and complete information and the study was conducted in compliance with the Declaration on the Right of the subject/participant [15].

2.6. Data Collection Procedure

The questionnaire used for the study was interviewer-administered. A questionnaire on dietary recall of the intake of coffee was designed and validated. The questionnaire was piloted on 10 patients attending the Ophthalmic Clinic in Irrua Specialist Teaching Hospital, Irrua Nigeria. A direct face to face interview was conducted by the researchers, one of whom is an Ophthalmologist, with assistance from 2 research assistants that had received training and had previous experience on data collection.

Previously validated semi-quantitative food frequency questionnaire was used to determine about consumption of caffeinated drinks, coffee, tea and chocolate [14]. The questionnaire provided responses with possibilities for intake frequency for each item ranging from "never or less than once per month" to "6 or more times per day." Those who drank caffeinated drinks daily were categorized as frequent drinker and those who claimed to drink caffeinated drinks less than 8 times per month were considered as infrequent drinker.

Blood pressure was measured using a sphygmomanometer and stethoscope. A cuff of appropriate size was fitted and inflated manually by repeatedly squeezing the rubber bulb until the artery was completely occluded. Listening with the stethoscope to the brachial artery at the elbow, the examiner slowly released the pressure in the cuff observing the systolic and diastolic values; the pressure at which the sound was first heard is the systolic blood pressure. The cuff pressure was further released until no sound was heard (diastolic arterial pressure). This was repeated three times and the mean documented as the blood pressure for that subjects.

2.7. Data Analysis

Data analysis was carried out using the Statistical Package for Social Sciences (SPSS) version 20. The data were subjected to descriptive statistic (frequency, percentage and mean ± standard deviation) and inferential statistics (odd ratio, Chi-Square test, t-test and F-test) at a confidence interval of 95% and $p<0.05$ was considered significant.

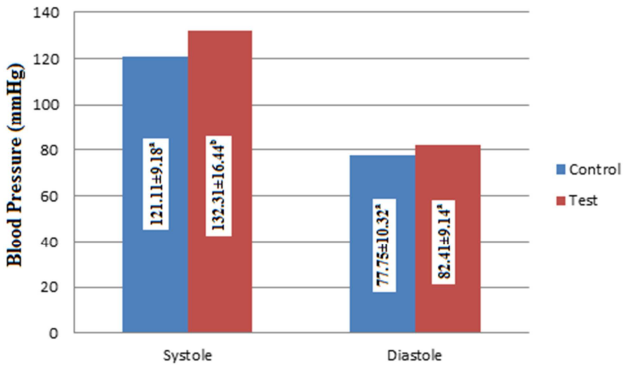


Figure 1. *Compares mean blood pressure among participants positive to caffeine consumption (test) and participants negative to caffeine intake (control).*

3. Results

Table 1 shows the socio-demographic characteristics/ profile and history of caffeine ingestion of the subjects who took part in the study. Overall, 388 adult attending the Ophthalmic Clinic in Irrua Specialist Teaching Hospital, Irrua Nigeria participated in the study with 201 (51.80%) having positive history of caffeine consumption and 187 (48.20%) not having any history of caffeine intake; at least three months before the assessment. There was no significant different ($p>0.05$) in the mean age of participants positive to caffeine consumption (test; 57.08±14.65 years) compared with participants negative to caffeine intake (control; 50.41±18.68 years). Although there were more males than females in the participants positive to caffeine consumption (106 vs. 95) and those negative to caffeine intake (100 vs. 87), the difference in their ages were not significantly different ($p>0.05$) (see table 1).

Table 1. *Socio-demographic characteristics/ profile and history of caffeine ingestion of the subjects who took part in the study.*

Variable	Number of Participants		Mean age of Participants	
	Control	Test	Control	Test
Age (years)	187 (48.20%)	201 (51.80%)	50.41±18.68	57.08±14.65
Sex				
Male	100	106	51.55±20.13	57.51±14.92
Female	87	95	49.27±17.22	56.59±14.41

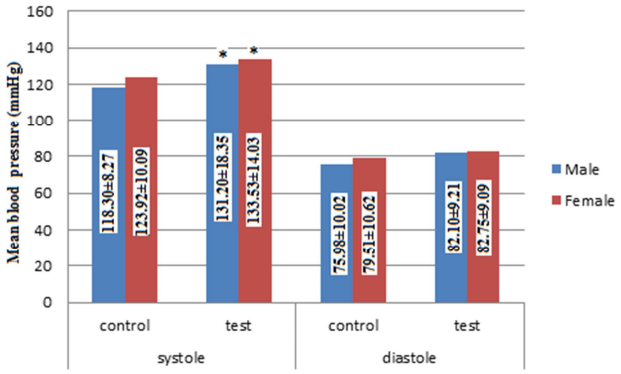
There was no significant different in the means. Participants positive to caffeine consumption represent the test while participants negative to caffeine intake represent the control.

Table 1 shows the mean blood pressure of the sampled population. The mean blood pressure of the studied population was 126.71±12.81/80.08±9.73 mmHg. However, participants positive to caffeine consumption have a mean blood pressure (test; 132.31±16.44/82.41±9.14mmHg) that was significantly higher ($p<0.05$) than participants negative to caffeine intake (control; 121.11±9.18/77.75±10.32mmHg).

Mean with different superscripts are significantly different at $p<0.05$

Figure 2 compares blood pressure with gender in participants positive to caffeine consumption and participants negative to caffeine intake. Females participants positive to caffeine consumption (133.53±14.03 / 82.75±9.09 mmHg) had no significant higher ($p>0.05$) blood pressure compared to male participants positive to caffeine consumption (131.20±18.35 /

82.10±9.21 mmHg). Similarly, female participants negative to caffeine intake (123.92±10.09 / 79.51±10.62 mmHg) had none significantly higher ($p>0.05$) blood pressures compared to male participants negative to caffeine intake (118.30±8.27 / 75.98±10.02 mmHg). However, the mean systolic blood pressure of the male and female participants positive to caffeine consumption were significantly higher ($p<0.05$; *) compared to the systolic blood pressure of the male and female participants negative to caffeine intake.



* indicates significant different at $p<0.05$ compared to control.

Figure 2. *Compares blood pressure with gender in participants positive to caffeine consumption (test) and participants negative to caffeine intake (control).*

Figure 3 compares blood pressure with age in participants positive to caffeine consumption (test) and those negative to caffeine intake (control). Analysis showed that the young adults had lower blood pressure compared to older adults in both participants positive to caffeine consumption (120.81±12.91 / 76.35±8.50 mmHg vs. 136.89±15.45 / 84.82±8.24 mmHg) and in those negative to caffeine intake (120.18±7.19 / 73.91±11.34 mmHg vs. 122.03±11.17 / 81.59±9.30 mmHg). Specifically, there was significantly higher ($p<0.05$) systolic blood pressure in older adult participants positive to caffeine consumption (136.89±15.45mmHg) compared to younger adult participants positive to caffeine consumption (120.81±12.91mmHg).

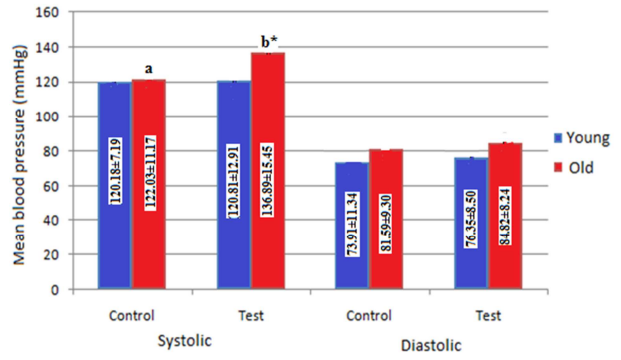


Figure 3. *Compares blood pressure with age in participants positive to caffeine consumption (test) and those negative to caffeine intake (control)*

Means with different superscripts are significant different at $p<0.05$ and * indicates significant different between young and old at $p<0.05$.

4. Discussion

This study showed that caffeine ingestion increase blood pressure, specifically systolic blood pressure. This caffeine effects was observed to be influenced by gender and age with greater impact in the female and the elderly where the effects were significantly increased compared to male counterpart and in young adult. Previous reports suggesting an association between use of caffeine and development of hypertension have been significantly tuned down in view of several epidemiological findings [16]. However, earlier reports have suggested possible transient increase in blood pressure caused by caffeine, especially in persons who are not habitual users [17]. The possible increase in blood pressure with caffeine ingestion was observed in this study and thus correlates with the suggestion by Serafin [17] but disagrees with the study by Lopez-Garcia *et al.*[7] where an association between hypertension and coffee intake could not be established in a population of nurses.

In support of the findings of this study on the association between blood pressure and caffeine intake, studies from several researches have reported acute elevation of SBP and diastolic blood pressure (DBP) at rest and during mental and physical stress following consumption of caffeine and caffeinate drinks and beverages [8, 18 – 26]. The effect of caffeine on blood pressure was reported to be due to thepressor effect on peripheral vascular resistance rather than enhancement of cardiac output [18, 20, 25]. Also, in hypertensive individuals, it has been reported that ambulatory BP increased in coffee drinkers and decreased in abstainers regardless of medication status [27]. Coffee consumption on normotensive individuals, showed elevated BP of 2.4 mm Hg in SBP and 1.2 mm Hg in DBP in the study by Jee *et al.* [28] and 2.0 mm Hg in SBP and 0.7 mm Hg in DBP in the study by Noordzij *et al.* [29] which are lower compared to that observed in this study. Thus the findings of positive association between caffeine intake and blood pressure in this study are in line. This study shows that elevations in BP associated with a greater risk for hypertension are associated with increased caffeine ingestion and suggest that caffeine may exert greater BP effects; at least on SBP, in those with a greater risk of hypertension.

Based on the association between caffeine intake and blood pressure, it was speculated that caffeine intake might also increase intraocular pressure (IOP), considering its hemodynamic effect. In support of this assertion, studies have shown that blood pressure directly and significantly correlates with IOP [30 –36]. In fact, both cross sectional and longitudinal studies have shown a positive association between the systolic BP and a raised IOP [36 – 40].

5. Conclusion

Judging by the findings of this study, it can be concluded that caffeine intake, female gender and advancing age, are risk factor to developing hypertension. By implication, hypertension may also be a risk factor for elevated IOP and can predispose to glaucoma, visual impairment and blindness in the

population either singularly or by interactive combination with caffeine consumption. In view of the findings of this study, it is recommended that a periodic IOP screening be carried out for hypertensive individual and that periodic BP monitoring and abstinence from caffeine intake may be essential for individual with an elevated IOP.

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