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Assessment of the Effect of Caffeine on Intraocular Pressure Among Adults Attending the Ophthalmic Clinics of Irrua Specialist Teaching Hospital

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Abstract
This study determines the effect of caffeine on the intraocular pressure of adults. It is a retrospective study carried out on adults attending the ophthalmic clinic in Irrua Specialist Teaching Hospital (ISTH), Irrua Nigeria. The study was conducted using questionnaire to obtain information on consumption of caffeinated drinks, 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 ocular examination and intraocular pressure (IOP) measurement using the standard Goldman applanation tonometer. Statistical analysis was conducted on 388 subjects who completed the study out of which 201 of them had history of caffeine intake giving a prevalence of caffeine intake to be 51.80. Irrespective of caffeine intake, mean intra ocular pressure was higher in the right eye compared to the left eye. Mean IOP was also significantly higher in caffeine positive group (right eye = 22.05±6.61 mmHg versus 12.21±5.31 mmHg; $p<0.05$, and the left eye = 19.40±5.94 mmHg versus 11.87±5.05 mmHg; $p<0.05$) compared to caffeine negative group. Judging by the findings herein presented, caffeine intake may be a risk factor for high IOP and may predispose to glaucoma, visual impairment and blindness.

1. Introduction

In humans, caffeine acts as a central nervous system stimulant, temporarily warding off drowsiness and restoring alertness [1]. It is the world's most widely consumed psychoactive drug, but unlike many other psychoactive substances, it is legal and unregulated in nearly all parts of the world as beverages containing caffeine, such as coffee, tea, soft drinks, and energy drinks, enjoy great popularity. Although it is generally recognized as safe by the Food and Drug Administration because the toxic doses (over 10 grams) are much higher than typically used doses (less than 500 milligrams), several studies have documented both positive and negative effects on

anxiety disorder [2], disruption of sleep [3], equivocal risk to pregnancy [4].

Of interest, studies have shown that caffeine affect blood flow at various sites of the human body. For example, caffeine acts as stimulant by increasing blood pressure and decreasing heart rate [5, 6]. Mathew and Wilson [7] reported that caffeine to decreases cerebral flow by approximately 15–30%. Bottcher *et al.* [8] reported effect on coronary artery blood flow by increasing vascular resistance at rest while Lotfi and Grunwald [9] reported reduction of retinal blood flow by 13% using a blue field stimulation technique. There has been a report of 6% decrease in choroid–retina blood flow 60 minutes post oral administration of 100 mg caffeine using a laser speckle tissue analyzer in healthy subjects [10]. Another study in healthy volunteers reported post oral caffeine application to cause a significant increase in the resistive index of the ophthalmic, central and the short posterior ciliary arteries using the colour Doppler ultrasonography [11].

Although advice regarding caffeine consumption varies because of controversies regarding the degree to which acute caffeine intake influences intra ocular pressure (IOP), several studies found IOP changes to be negligible [9-12], whereas others report increases of approximately 1 to 4 mmHg [13-16]. A meta-analysis study by Li *et al.* [17] called for randomized clinical trials to better assess effect caffeine has on IOP in those with or at risk for glaucoma and in older subjects. It is therefore the aim of this study to determine the effect of caffeine (indicated in caffeinated drinks) on intraocular pressures among adults attending the Ophthalmic Clinics in a Specialist Teaching Hospital (ISTH), Irrua-Nigeria.

2. Materials and Methods

2.1. Study Design and Area

The study is a retrospective study designed among 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 and documentation of ocular pressures.

The Irrua Specialist Teaching Hospital is located in Irrua, Esan Central Local Government Area in Edo State, Nigeria. It is a Federal Government owned tertiary hospital which also serves as a teaching hospital for the College of Medicine, Ambrose Alli University, Ekpoma, Esan West Local Government Area in Edo State, Nigeria. Its administrative headquarters is in Irrua. Irrua had an area of approximately 253 km² and a population of 105,310 at 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 Exclusion Criteria

The study was targeted at all patients referred to and attending the Eye Clinics of the Department of Ophthalmology, Irrua Specialist Teaching Hospital, Irrua, Edo State -Nigeria. All patients between 20 and 70 years, both sexes, with no ocular inflammation or rubeotic glaucoma,

All patients who are ages <20 or > 70 years, have undergone any form of ocular surgery, head injuries patients and patients with existing ocular infection or inflammation were excluded. Patients who had problem recalling history of coffee intake were also excluded.

2.3. Sample Size Determination and Procedures

Sample size was determined as described by Araoye [18] using the formula below;

$$\mathrm{N} = \frac{Z^2 p(1-p)}{0.05^2}$$

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

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

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

The study employed the simple random sampling technique to sample 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.

2.4. Instrument of Data Collection

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 intraocular pressure measurement and assessments.

2.5. Validity and Reliability of Data Instrument

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.

2.6. 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 glaucoma patients. A direct face to face interview was conducted by 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 history of consumption of caffeinated drinks, tea and chocolate [19]. The questionnaire provided responses with possibilities for intake and 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. Quantification of coffee per day was not included in the questionnaire.

2.7. Ocular Pressure Measurement

Ocular examination was performed during the recruitment period, including fundus examination and intraocular pressure (IOP) measurement using standard Goldman applanation tonometer. The fundus was viewed using the indirect ophthalmoscope.

2.8. Data Analysis

Data analysis was carried out using the Statistical package for social sciences (SPSS) version 20. The data was entered into the computer and subjected to descriptive statistic (frequency, percentage and mean) 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.

2.9. 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 [20].

3. Results

Three hundred and eight-eight (388) adult subjects attending the Ophthalmic Clinic of ISTH completed the study. Table 1 shows the mean age and sex distribution of the sampled population. Participants with positive history of caffeine intake (test; 57.08±14.65 years) were older than those with negative history of caffeine intake (control; 50.41±18.68 years). However, the difference in their age was statistically not significant ($p>0.05$). There were more males than females in the test and control groups. Specifically, 106 males and 95 females make up the test group while 100 males and 87 females make up the control group.

Table 1. *Mean age and sex distribution of the sampled population.*

Variable	Number of Participants		Mean age of Participants	
	Control	Test	Control	Test
Age (years)	187	201	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

Values are mean ± standard deviation. There was no significant different in the means. Test = Positive history of caffeine intake; Control = Negative history of caffeine intake.

Analysis showed that 201 of them have history of caffeine ingestion while 187 do not. The prevalence of caffeine ingestion in the study was 51.80 and this was higher in males (27.32%) than females (24.48%) (See figure 1).

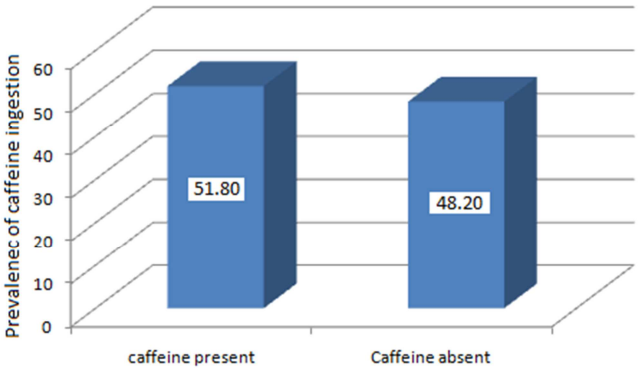

Figure 1. *Proportion of caffeine ingestion among adults attending the ophthalmic Clinics of ISTH*

Table 2 shows the mean intra ocular pressure between caffeine positive and negative groups of patients attending Ophthalmic Clinics of ISTH. Mean intra ocular pressure was higher in the right eye compared to the left eye irrespective of caffeine intake. Also, mean IOP was higher among subjects positive to caffeine intake compared to those negative to caffeine intake. Specifically, mean IOP in the right eye was significantly higher ($p<0.05$) in caffeine positive group (22.05±6.61 mmHg) compared to caffeine negative group (12.21±5.31 mmHg). Similarly, in the left eye, mean IOP was significantly higher ($p<0.05$) among caffeine intake group (19.40±5.94 mmHg) compared to caffeine negative group (11.87±5.05 mmHg).

Table 2. *Mean intra ocular pressure between caffeine positive and negative groups of patients attending Ophthalmic Clinics of ISTH.*

Variables	Left eye (mmHg)		Right eye (mmHg)	
	Control (n=187)	Test (n=201)	Control (n=187)	Test (n=201)
Mean intra ocular pressure (mmHg)	11.87±5.05	19.40±5.94*	12.21±5.31	22.05±6.61*

* indicates significant difference at p≤0.05 compared to control; Test = Positive history of caffeine ingestion; Control = Negative history of caffeine ingestion.

4. Discussion

The present study to assess the effect of caffeinated drinks on IOP in adults attending the Ophthalmic Clinics in Irrua Specialist Teaching Hospital showed that caffeine intake cause an increase in IOP. In support of the finding of the present study, Avisar *et al.* [13], Higginbotham *et al.* [16] and Leydhecker [21] reported a transient increase (1–2 mmHg) in IOP following coffee intake while Wilensky [22], Chandrasekaran *et al.* [23] and Peczon and Grant [24] documented no effect.

The mean IOP value in caffeine intake group in this study (22.05±6.61 mmHg in right eye and 19.40±5.94 mmHg in left eye) is high compared to the mean IOP of 15.3 mmHg among Indian population [25], 12.9 mmHg in a Pakistani population [26], 14.7 mmHg in American Asians [27] and 13.3 mmHg in a Nepalese population [28]. It is known that mean IOP varies between 10 and 20mm Hg [29] and 10 and 21mm Hg [30] and that values higher than the upper limit is termed ocular hypertension, which is defined as intraocular pressure higher than normal, in the absence of optic nerve damage or visual loss [31]. It therefore implicates that caffeine intake may predisposes to ocular hypertension and may be worsen in patients with glaucoma.

An elevated IOP is one of the major risk factors for developing glaucoma or glaucomatous optic neuropathy and its progression [32]. In a study by Sakata *et al.* [33], IOP values increase progressively from the hypertensive patients without retinopathy, to the hypertensive with retinopathy and diabetic hypertensive with retinopathy. Thus, the higher values observed in caffeine ingestion in this study is an issue that calls for attention and a suggestion that caffeine intake may be implicated in the increase IOP observed in different populations.

5. Conclusion

Based on the findings of this study, it can be concluded that caffeine intake might be a risk factor for high IOP and can predisposes to visual impairment, glaucoma and blindness in the population. In another words, the dietary habits, especially consumption of caffeinated drinks and beverages can cause abnormalities in the IOP and may result in the dysfunction of the eye, which in turn may affect the vision and ultimately the quantity/quality of life. Thus, while IOP is an important modifiable risk factor for glaucomatous optic neuropathy, other factors such as the dietary habit (like caffeine intake) can also be influential. It is therefore recommended that practices to reduce caffeine intake in the population be promoted and that clinicians concerned especially ophthalmologists be aware of the implication of caffeine intake on IOP.

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