



ISSN Print: 2394-7500  
ISSN Online: 2394-5869  
Impact Factor: 8.4  
IJAR 2022; 8(3): 334-338  
[www.allresearchjournal.com](http://www.allresearchjournal.com)  
Received: 04-01-2022  
Accepted: 07-02-2022

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## The effect of coffee consumption in intraocular pressure (IOP) and blood pressure (BP)

Aparajita Kar, Neha Chaurasiya and Hari R

### Abstract

**Aim:** To observe the short term effects of coffee consumption on IOP and BP.

**Methodology:** In total 44 healthy subjects were included in the study that are based on inclusion and exclusion criteria. Baseline measurements of parameters like Intraocular pressure, Blood pressure, Central corneal thickness, Anterior chamber depth, Axial Length, Lens Thickness, Pupil Diameter were recorded in morning, after which subjects received one cup of coffee (200ml) which contain 2.29 gm of coffee powder (72.5 mg of caffeine). Post coffee consumption, the following parameters were measured after a same definite interval in all subjects and recorded.

**Results:** Mean Intraocular pressure and Blood pressure values were increased after coffee consumption, however not statistically significant when compared to before coffee consumption (p value>0.05). Anterior chamber depth was significantly increased at 1<sup>st</sup> hour and 2<sup>nd</sup> hour from the baseline (p value< 0.05) however, Lens Thickness was reduced significantly when compared from the baseline, at 1<sup>st</sup> hour and 2<sup>nd</sup> hour (p value< 0.05). Pupil Diameter, Central corneal thickness and Axial Length were not significant pre and post coffee consumption and there was no significant changes in Ocular pulse Amplitude and Ocular perfusion pressure values, pre and post coffee consumption (p value>0.05).

**Conclusion:** From above data, we can conclude that there was a significant increase in Anterior chamber depth and a significant decrease in Lens thickness after 1-2 hours of one cup of coffee consumption although Intraocular pressure and BP was not significantly affected by ingestion of a single cup of coffee in normal individual.

Intraocular pressure and BP was not significantly effected by ingestion of a single cup of coffee in normal individual although, we found a significant increase in ACD and significant decrease in LT after 1-2 hours of coffee consumption.

**Keywords:** Central corneal thickness, anterior chamber depth, lens thickness, axial length, pupil diameter, ocular perfusion pressure, ocular pulse amplitude

### Introduction

Coffee is one of the most widely consumed beverages worldwide [9]. The relationship between blood pressure and coffee is of major interest given its widespread consumption and the public health burden of high BP [2]. Caffeine has been shown to alter heart rate and BP by influencing cardiac activity [5]. Reduced systemic blood pressure is associated with reduced intraocular pressure [10]. The intraocular pressure (IOP) refers to the pressure exerted by intraocular fluid on the coats of eyeball. The normal IOP varies between 10 to 21 mm of Hg. The normal level of IOP is essentially maintained by a dynamic equilibrium between the formation and outflow of the aqueous humour.

Blood pressure refers to the lateral pressure exerted by flowing blood on the walls of the arteries. Normal blood pressure is around 120/80 mm Hg. Systolic pressure is 120 mm Hg and diastolic pressure is 80mm Hg.

The main ingredient of coffee i.e., caffeine has hydrophobic properties due to which caffeine passes to all biological membranes and after oral intake, widely distributes to all organs including the nervous system and eyes. Caffeine is attributed to decreased ocular blood flow and have an effect on sympathetic and parasympathetic nerve activity which accordingly might be expected to alter some ocular parameters like CCT, ACD, LT, AL, PD. It can also effect OPP and OPA. OPP is expressed as the difference between the arterial BP and IOP, which is considered a substitute for the venous pressure. The OPP is calculated as  $2/3 * [DBP + 1/3(SBP - DBP)] - IOP$ .

OPA is defined as the difference between the diastolic and systolic IOP. The ocular pulse is generated by the pulsatile ocular blood flow in the choroid.

Caffeine is widely consumed, and its effect on IOP and BP has been reported in a conflicted data [8].

The evaluation of AL and anterior segment parameters including anterior chamber depth (ACD), Lens thickness (LT), and Central corneal thickness (CCT), provides valuable information in understanding the mechanism of ocular pathologies, risk assessment, and monitoring of several diseases and preoperative calculations for cataract and refractive surgeries.

### Review of literature

Uzun *et al.* [8] studied the acute effects of single cup of coffee on ocular biometric parameters in healthy subjects in 2019 where Caffeine caused a significant increase in AD and ACD and a significant decrease in LT following oral intake, for at least 4 h.

In 2016, Teng *et al.* [7] found the mean differences in SBP and DBP of the two groups (caffeine intake group and control group) were +2.77 mmHg and +2.11 mmHg respectively. Therefore, the rise in both SBP and DBP after caffeine consumption was not statistically significant.

Jiwani *et al.* [3], in 2012 carried out a study on effects of caffeinated coffee consumption on intraocular pressure, ocular perfusion pressure and ocular pulse amplitude. In this study there were no significant difference in baseline in IOP, OPP and OPA between the caffeinated and decaffeinated visits. After caffeinated coffee as compared with decaffeinated coffee ingestion, mean mm Hg changes in IOP is 0.99, OPP is 1.57 and OPA was 0.23 at 60 min and 1.06, 1.26 and 0.18 at 90 min respectively.

In 2011, Mao *et al.* [4] conducted study on the effect of caffeine on intraocular pressure in normal individuals, the IOPs measured at 0.5h, 1h and 1.5h post intervention were not affected by ingestion of caffeine.

Caffeine levels peak 30-120 minutes after oral intake and caffeine's half-life is 3-6 hours. Typically, blood pressure changes occur within 30 minutes, peak in 1-2 hours, and may persist for more than 4 hours [11].

Research was aimed to examine the effect of a single cup of coffee on the blood pressure of young adults [7].

### Need / emergence of the study

To observe the short term effects of coffee consumption on IOP and BP, observing the changes in IOP and BP values with time and its clinical impact on ocular parameters.

### Aims and Objectives

#### Aim

To observe the effect of coffee consumption in healthy subjects on IOP and BP after caffeine consumption from a cup of coffee.

#### Objectives

To compare IOP and BP values before and after coffee consumption.

To observe the time duration after coffee consumption which causes changes in values of IOP and BP.

To notice the changes in ocular parameters like CCT, AL, PD, ACD, LT after coffee consumption.

To observe the changes in OPA and OPP after coffee consumption.

### Methodology

- **Source of data:** The study was conducted on staff and student of Vittala International Institute of ophthalmology, Bangalore. Each subject was given an ophthalmologic examination before the study to exclude those with undiagnosed ocular disease as mentioned in Dervişoğulları *et al.* study [1].
- **Study design:** Prospective observational study.
- **Study period:** 2-3 months
- **Sample size:** 44 healthy subjects.
- **Study area:** The study is undertaken at Vittala eye hospital, Bangalore.
- **Data collection technique:** Based on inclusion and exclusion criteria.

### Inclusion criteria

- 44 healthy subjects with age between 18 to 25 years are included in this study.
- IOP ranging between 10 to 21 mm of Hg are included.
- BP ranging around 120/80 mm of Hg are included.
- Participants willing to take part in this study after informing procedure and consent signed.

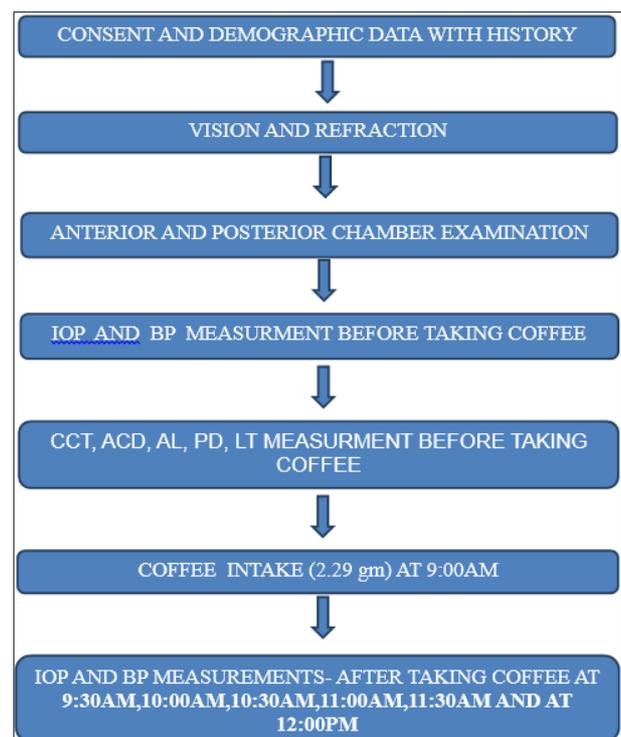
### Exclusion criteria

- No coffee (caffeine) consumption till one week.
- Any ocular or systemic abnormalities and surgeries.
- Any current medication

### Materials required

- Distance and Near vision chart (LogMAR)
- Slit lamp (Haag streit Biomicroscope)
- Direct Ophthalmoscope
- Micro weighing machine
- 2.29 gm of coffee powder (72.5mg of caffeine)
- Heart Mate Digital BP monitor
- Non contact Tonometer(NCT)
- IOL MASTER-700

### Flow chart



**Procedure**

- The study was conducted in premises of Vittala International Institute of Ophthalmology, Bangalore.
- After explaining about the procedure clearly, consent was taken from subjects.
- After which Demographic data was collected.
- Each subject underwent eye examination for any pathology using slit lamp and direct ophthalmoscope.
- Subjects were selected based on inclusion and exclusion criteria.
- Intraocular pressure (IOP by NCT) and Blood pressure (BP by HEART MATE DIGITAL BP MONITOR) was measured before 9:00AM
- Central corneal thickness (CCT), Anterior chamber depth (ACD), Axial length (AL), Lens thickness (LT), Pupil Diameter (PD) was measured before coffee intake for baseline value (By IOL MASTER-700).
- To avoid diurnal variations, all basal measurements were performed at 9:00AM in the morning by experienced technician, thereafter subject received one cup of coffee 200ml which contain 2.29 gm of coffee powder (72.5 mg of caffeine).
- After coffee intake, IOP and BP was measured at 9:30AM, 10:00AM, 10:30AM, 11:00 AM, 11:30 AM and 12:00 PM respectively and data was collected.
- In the same way, CCT, ACD, AL, LT, PD were measured every hourly upto 3 hours.

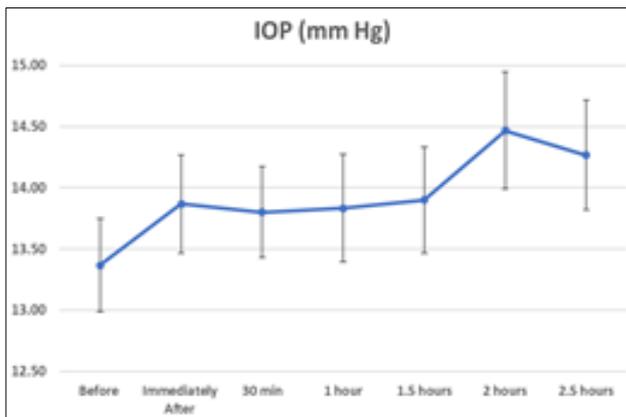
- Values were recorded at the abovementioned times and data was compared.

**Statistical analysis**

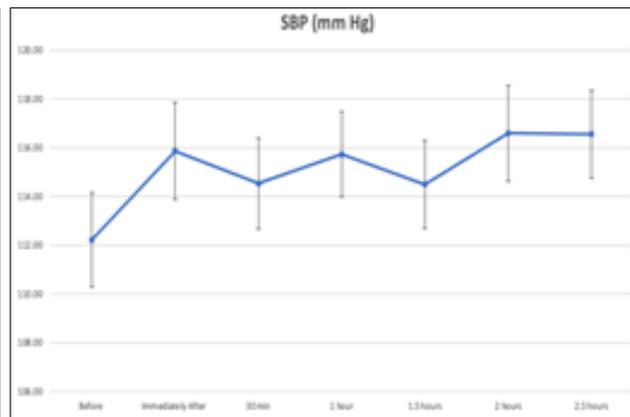
Data analysis was performed using SPSS (Statistical Package for social Sciences) version 20.0. Sample size was calculated using G\* power app assuming an alpha error of 5% and 90% of statistical power.

**Results**

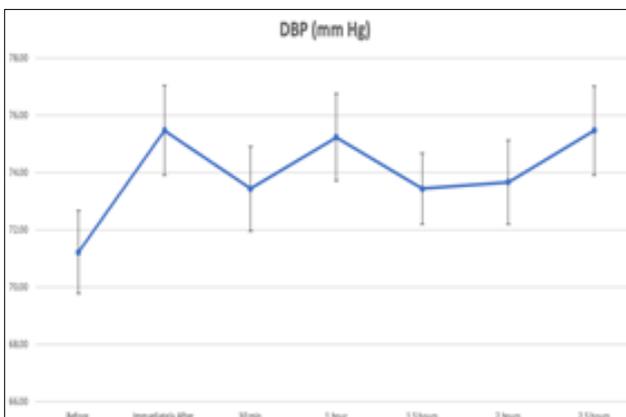
- Mean age of the subjects was 20.9+/-1.4 years (32 females, 12 males).
- Mean IOP and BP values increased after coffee consumption, however not statistically significant when compared to before coffee consumption (p value>0.05).
- Post coffee consumption peak effect is seen between 1 to 2 hours after coffee intake.
- ACD was significantly increased at 1<sup>st</sup> hour and 2<sup>nd</sup> hour from the baseline (p value< 0.05).
- LT was reduced significantly when compared from the baseline, at 1<sup>st</sup> hour and 2<sup>nd</sup> hour (p value< 0.05).
- PD, CCT and AL differences were not significant between pre and post coffee consumption.
- There was no significant changes in OPA and OPP values, pre and post coffee consumption with P-values of 0.067 and 0.091 respectively.



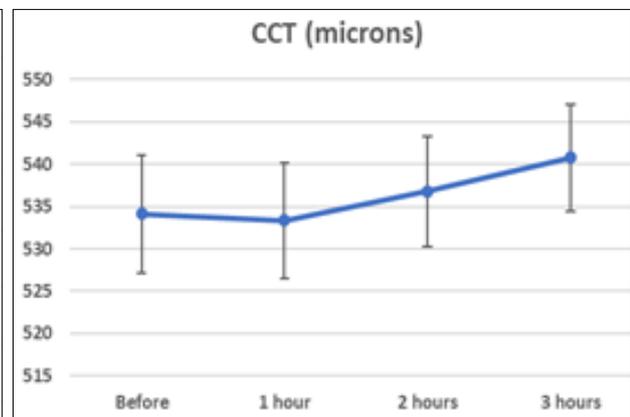
Graph 1



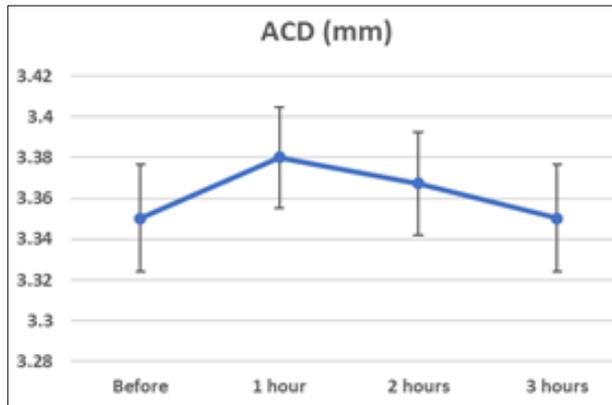
Graph 2



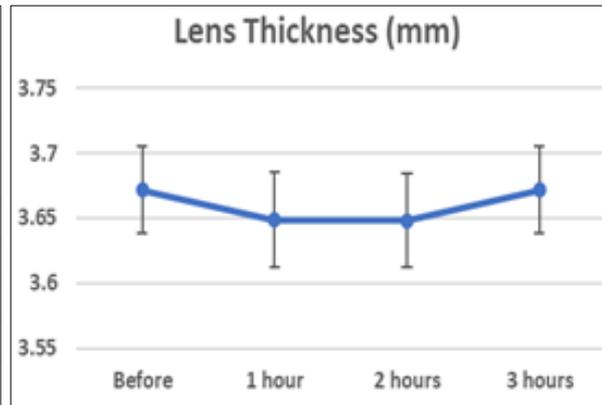
Graph 3



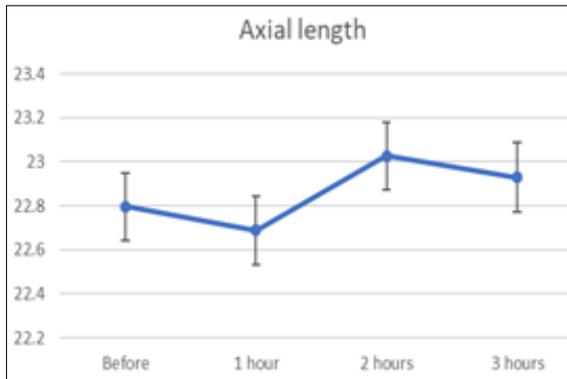
Graph 4



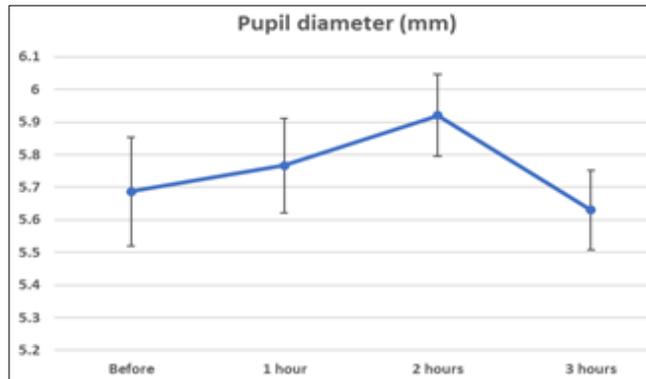
Graph 5



Graph 6



Graph 7



Graph 8

Fig 1: Graph 1 to 8 shows the changes in the values of parameters assessed post caffeine consumption from baseline

Table 1: The changes in the values of parameters assessed post caffeine consumption from baseline

	IOP (mm Hg)		SBP (mm Hg)		DBP (mm Hg)	
	Mean	SD	Mean	SD	Mean	SD
Before	13.37	2.08	112.23	10.61	71.22	7.89
Immediately After	13.87	2.21	115.87	10.87	75.47	8.58
30 min	13.8	2.04	114.53	10.21	73.43	8.14
30 min-1hour	13.83	2.39	115.73	9.62	75.23	8.3
1.5 - 2 hours	13.9	2.38	114.5	9.87	73.43	6.74
2 - 2.5 hours	14.47	2.62	116.6	10.77	73.67	8.04
2.5 - 3hours	14.27	2.45	116.57	9.86	75.47	8.47

Table 2: The changes in the values of parameters assessed post caffeine consumption from baseline

	CCT		ACD		Axial Length		Lens Thickness		Pupil Diameter	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Before	534.1	38.12	3.35	0.14	22.8	0.84	3.67	0.18	5.69	0.91
1 hour	533.33	37.16	3.38	0.14	22.69	0.86	3.65	0.2	5.77	0.79
2 hours	536.77	35.81	3.37	0.14	23.03	0.83	3.65	0.2	5.92	0.69
3 hours	540.77	34.41	3.35	0.14	22.93	0.86	3.67	0.18	5.63	0.67

Table 3: The changes in the values of parameters assessed post caffeine consumption from baseline

	Significance value for comparison every 30 minutes (p-value)					
	Before 30 min	30 min – 1 hour	1 hour –1.5 hours	1.5 hours –2 hours	2 hours -2.5 hours	2.5 -3 hours
IOP	0.173	0.722	0.905	0.839	0.121	0.623
SBP	0.059	0.327	0.367	0.323	0.218	0.983
DBP	0.803	0.076	0.183	0.234	0.824	0.148

Table 4: The changes in the values of parameters assessed post caffeine consumption from baseline

	Significance value for comparison every hour (P value)		
	Before - 1 hour	1 hour - 2hours	2 hour - 3 hours
CCT	0.213	0.201	0.549
ACD	<0.001	<0.001	0.011
Axial length	0.065	0.06	0.612
LT	<0.001	<0.001	0.912
PD	0.413	0.34	0.047

## Discussion

To rule out the effect of diurnal variations, tests were performed at the same time of the day in accordance with the study of Dervişoğulları *et al.* [11].

The main aim of this analysis was to quantitatively summarize the effect of caffeine in normal individuals. In our studies we found no significant correlation in IOP and BP between before and after single cup of coffee consumption. The mean IOP changed from 13.37 to 14.37 after coffee consumption which increased from baseline ( $p > 0.05$ ). Whereas, the mean BP (SYSTOLIC) changed from 112.23 to 116.57 and the mean BP (DIASTOLIC) changed from 71.22 to 75.47 after coffee consumption which increased from baseline ( $p > 0.05$ ). Similarly In the previous study, conducted by Mao *et al.* [4], in normal individuals, the IOPs measured at 0.5h, 1h and 1.5h post intervention were not affected by ingestion of caffeine.

We found no significant changes between OPA and OPP before and after coffee consumption ( $p > 0.05$ ) and when we compared the ocular parameters, we found significant changes in ACD from baseline (3.35 mm) to (3.38mm) at 1<sup>st</sup> hour and (3.35mm) to (3.37) at 2<sup>nd</sup> hour, and in LT from baseline (3.67mm) to (3.65 mm) at 1<sup>st</sup> hour and 2<sup>nd</sup> hour ( $p < 0.05$ ), all other parameters like AL, CCT, PD were not statistically significant ( $p > 0.05$ ). These changes due to coffee intake supports the previous study of Uzun *et al.* [8] who found in healthy subjects, ACD values was significantly greater than baseline at 1<sup>st</sup> hour and 4<sup>th</sup> hour and LT values was significantly reduced compared to baseline at 1<sup>st</sup> and upto in their subjects after coffee consumption. It was interesting to note that these authors [8] found significant effects of caffeine at comparatively higher dose of Caffeine concentration, however the significant changes in ACD and LT values in our case were found with relatively lower dose of caffeine also.

Jiwani *et al.* [3] in 2012, conducted a study on effects of caffeinated coffee consumption on intraocular pressure, ocular perfusion pressure and ocular pulse amplitude, in that study there were no significant difference in baseline in IOP, OPP and OPA between the caffeinated and decaffeinated visits. After caffeinated as compared with decaffeinated coffee ingestion, mean mm Hg changes in IOP is 0.99, OPP is 1.57 and OPA is 0.23 at 60 min and 1.06, 1.26 and 0.18 at 90min. In our study also, we found insignificant changes in the above ocular parameters after coffee consumption in our subjects. Teng *et al.* [7] in 2016, conducted a study on young adults and observed that the mean differences in SBP and DBP of the two groups were +2.77 mm Hg and +2.11 mm Hg respectively. Therefore, the rise in both SBP and DBP after caffeine consumption was not statistically significant. Similarly, we also found insignificant rise in SBP and DBP after one cup coffee consumption in the subjects involved here.

## Conclusion

From this study we can conclude that IOP and BP was not significantly effected by ingestion of a single cup of coffee in normal individual although, we found a significant increase in ACD and a significant decrease in LT after 1-2 hours of coffee consumption.

## Acknowledgement

I, Neha Chaurasiya am very thankful to my Principal Guide - Aparajita Kar, Asstt. Professor, for guiding me throughout

this research work. I am grateful for her patience, time and mentorship throughout this project. I would also like Co-Guide Hari R, Asstt. Professor throughout this study. Also, my sincere gratitude to all the enthusiastic people who helped me to complete this project through their support and cooperation.

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