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**Research Article**

# Effect of Aerobic Exercise on Intraocular Pressure in Relation to Body Mass Index

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**Abstract:** Physiological and biochemical changes that normally occur during physical exercise are profound. This study was conducted with the aim of understanding the possible effect of physical exercise on intraocular pressure (IOP). As a part of this study, IOP was measured before and after exercise on 100 subjects (50M, 50F) with no ocular abnormality who are in the range of 18-21 years of age by using Schiotz Tonometer. Weight, height and body mass index (BMI) were recorded. The subjects were divided into two groups according to BMI. The first group consists of subjects with BMI >22 and the second with <22 BMI. Materials used in the study were Schiotz Tonometer, Measuring tape, Weighing Scale and Paracaine eye drops. The results obtained before and after exercise were compared. The data is presented as the mean ± SD. Student's *t*-test is used to calculate significance between means. The IOP showed a statistically significant fall following moderate exercise. Significantly higher base line IOP is observed in subjects with >22 BMI. The present study indicates the association of BMI with intraocular pressure. Gender wise comparison of intraocular pressure did not reveal much significance.
**Keywords:** Body mass index, Intraocular pressure (IOP), Physical exercise, Glaucoma, Schiotz tonometer.

## INTRODUCTION

Regular and sustained physical exercise is known to have beneficial effect on the various systems of the body—physical, metabolic and psychological. It is also known to cause changes in vascular pressure, serum osmolarity, hormone levels, decrease in blood pH, and increase in blood lactate.

Virtually all tissues and systems of human body respond to exercise programmes and the eye is no exception [1]. Many studies have shown important details concerning the Cardiovascular and Pulmonary physiological changes that are attributable to regular physical exercise regimen. But not many studies are available on the effects of exercise on the ocular physiological changes like intraocular pressure (IOP).

Physical exercise is known to have effect on IOP and systemic cardiovascular factors and therefore may affect glaucoma pathophysiology [2].

Glaucoma is defined as a disturbance of the structural or functional integrity of the optic nerve that can usually be arrested or diminished by adequate lowering of IOP [3].

It is estimated that Glaucoma accounts for 13.5% of global blindness [4]. New statistics by WHO in 2002 has shown that glaucoma as the second leading cause of blindness globally, after cataracts. However, perhaps it presents an even greater public health challenge than cataracts because the blindness it causes is irreversible [5].

It has been reported that glaucoma was prevalent in 2.6% population in South India [6]. Population-based studies have suggested that more than 90% of glaucoma cases in the country remain undiagnosed [7]. Glaucoma is a disease characterised by progressive optic neuropathy that results in retinal ganglion cell death affecting approximately 68 million people worldwide. The risk factors of glaucoma include intraocular pressure (IOP), race, genetics, age and vascular factors [8].

Generally physically fit persons are more likely to have a lower resting IOP. Physical exercise produces a transient reduction of IOP. This phenomenon is at least in part caused by acidosis and alterations in serum osmolality. IOP fluctuates over the course of the day. The most common diurnal variation has the maximum pressure in the morning hours and the minimum pressure late at night or early in the morning. Many studies have attempted to identify the risk factors associated with development of elevated IOP [9].

Several studies in Western population have reported that age is related positively with IOP. Moreover, some epidemiological studies have examined the relationship between Body Mass Index and IOP [10]. These studies have shown that high BMI is an independent risk factor for IOP when considered with age and hypertension. The combined evidence from several studies has suggested that the high level of BMI is strongly associated with risk of increased IOP [11].

This study is attempted to examine the possible correlation between BMI and IOP in adult population and to understand the ocular physiological changes with special focus on the possible changes in intraocular pressure that are attributable to regular physical exercise. The present study is aimed at observing the effect of exercise on intraocular pressure in relation to BMI.

## MATERIAL AND METHODS

One hundred healthy medical students in age group of 18-21 years volunteered to participate in the study. Clearance from the Institutional Ethical Committee was obtained before undertaking the study. This study was conducted in the Physiology Laboratory of Rangaraya Medical College, Kakinada during 2011-12. The study was conducted during morning hours after light breakfast, and commenced with the measurement and recording of the body weight, height and body mass index of the subjects. Pulse rate and blood pressure were measured before and after exercise. Height was measured in centimetres without footwear using a vertically movable scale. Weight was measured to the nearest 100 grams by using a digital scale. BMI was derived by Quetelet index (body weight/ height$^{2)}$. Resting blood pressure (systolic and diastolic) was measured using a mercury sphygmomanometer, with the subject in a supine posture and after a rest of 15 minutes in this posture. IOP was recorded by using a Schiotz tonometer and following the standard protocol, with the subject in supine position. The scale of Schiotz tonometer was calibrated in such a fashion that each scale unit represented 0.05 mm protrusion of the plunger. The recording of the IOP was always started with 5.5 gms weight. However, if the scale reading was less than one, additional weight was added to the plunger to make it 7.5 gm or 10 gm, as indicated. A conversion table or a Friedenwald nomogram was then used to derive the IOP in mmHg from the scale reading and the plunger weight. The subjects were divided into two groups; the first group having BMI >22 and the second BMI <22. Materials used in the study were Schiotz Tonometer, Measuring Tape, Weighing Scale and Paracaine eye drops. After the resting period, the subjects' height and weight were recorded. Paracaine eye drops were instilled in both the eyes and then intraocular pressure recorded using Schiotz Tonometer after 2 min allowing anaesthetic to act. To determine pre-exercise IOP, three successive RE and LE readings were taken at intervals of 1 hour each. The RE and LE pressures were kept separate and each average of three was taken as that eye's pre-exercise IOP. All measurements were made with a Schiotz tonometer. By this method the attempt was to exclude all the changes of IOP due to diurnal variation, and repeated measurements with tonometer. All measurements were performed by the same examiner, first on the right eye and then on the left eye. Then each subject exercised on a bicycle ergometer with 2Kg load, 30 pedaling and 78 revolutions per minute for total 10 min duration. Four IOP recordings were taken after completion of exercise. The first recording was done one minute after completion of exercise. The second recording after fifteen minutes, the third after 30 minutes and the fourth after 60 minutes of performance of exercise respectively. The exercise testing was performed in the normal room temperature with bright light. Intraocular Pressure was measured in both eyes. The statistical analysis was done using students unpaired t-test. Results were expressed in terms of mean and standard deviation. P value was taken significant at 5 percent confidence level ($p<0.05$).

## RESULTS

The age of the study group ranged from 18 to 21 years, with mean age at 18.74 ± 0.70. The height of study group ranged from 150 to 180 cms with a mean height at 162.17± 3.96 cms. The weight of the study group ranged from 43 to 78 kg with a mean weight at 54.91 ± 3.77 Kgs. Each subject completed 10 minutes of exercise on the bicycle Ergometer with 2 kg load, 30 pedaling and 78 revolutions per minute. The degree of exertion was moderate. Blood pressure changes before after exercise are shown in Table 1. IOP changes in both groups before and after exercise are shown in Table 2.

**Table 1: Blood pressure recording in both groups before and after exercise**

| Variable | BMI >22 Mean ± SD | BMI <22 Mean ± SD | p value |
|---|---|---|---|
| Systolic BP Basal | 120 ± 3.87 | 114 ± 5.75 | 0.0001 |
| Systolic after 1 min exercise | 150 ± 6.31 | 143 ± 7.56 | 0.0001 |
| Systolic after 15 min exercise | 125 ± 3.20 | 120 ± 4.71 | 0.0001 |
| Diastolic pressure | 72 ± 2.84 | 69 ± 4.60 | 0.0009 |
| Diastolic after 1 min exercise | 67 ± 4.49 | 70 ± 2.27 | 0.0032 |
| Diastolic after 15 min exercise | 71 ± 2.33 | 68 ± 2.33 | 0.0025 |

**Table 2: Mean difference of IOP before and after exercise**

| Variable | BMI | N | Mean ± SD | Difference | Difference % | p Value |
|---|---|---|---|---|---|---|
| IOP before exercise | >22 | 23 | 16.56±2.014 | | | |
| | <22 | 77 | 16.31±2.174 | | | |
| 1 minute after completion of exercise | >22 | 23 | 10.65±1.151 | 5.91 | 56.46 | 0.0001 |
| | <22 | 77 | 10.42±1.081 | 5.89 | 56.22 | |
| 15 minutes after completion of exercise | >22 | 23 | 11.85±1.687 | 4.8 | 41.69 | NS |
| | <22 | 77 | 11.50±1.179 | 4.71 | 40.27 | |
| 30 minutes after completion of exercise | >22 | 23 | 13.67±1.78 | 2.92 | 21.88 | NS |
| | <22 | 77 | 13.38±1.554 | 2.89 | 21.44 | |
| 60 minutes after completion of exercise | >22 | 23 | 15.87±1.758 | 1.44 | 8.99 | NS |
| | <22 | 77 | 15.86±2.101 | 1.39 | 8.98 | |

NS: Not significant (p>0.05); S: Significant * (p <0.05)

## DISCUSSION

The intraocular pressure is maintained within the normal range of 10- 20 mmHg by maintaining a balance between various mechanical parameters. Values between 21-24 mmHg are considered as suspicious, whereas the values exceeding 24 mmHg are considered as abnormal [12]. In the present study, significantly higher base line IOP was observed in subjects with >22 BMI. Intraocular Pressure decreased after exercise in both the eyes. There was no statistical difference in the IOP of right and left eyes. Hence analysis is done for the right eye only. The mean fall in intraocular pressure in subjects with BMI > 22 was 5.91 mmHg and in subjects with BMI< 22 was 5.89 mmHg in the readings taken 1 minute after completion of exercise. The maximum fall in IOP occurred 1 minute after completion of exercise. The mean IOP significantly decreased 1 minute after completion of exercise in subjects having BMI >22. The reduction was statically significant (p value 0.0001). The intraocular pressure was still below baseline at 15, 30 and 60 minutes after completion of exercise (41%, 21% and 8% fall) and statically not significant. Gender wise comparison of intraocular pressure both before and after exercise did not reveal much significance.

The present study indicates the association of BMI with intraocular pressure. The mechanism of increase of BMI on IOP may be due to excess intraorbital fat tissue, an increase in episcleral venous pressure and consequent decrease in outflow facility [10]. Obesity increases blood viscosity through increased red cell count, haemoglobin, and heamatocrit, thus increasing outflow resistance of episcleral vein [10, 13].

This study evaluated BMI as a risk factor for increased IOP. This study showed positive correlation between BMI and IOP. A study done on Korean population by Lee JS *et al*. [14] reported that the mean IOP increased proportionally with degree of obesity in both genders. Similar observations had also been reported by Barbados [15] and the Beaver Dam Eye studies [16], where a large body size, as measured by BMI had found to be associated with increased IOP. A study done in Pakistani population by Danish Zafar *et al*. [11] also reported a positive correlation between BMI and IOP in both males and females.

In summary it can be said that the present study shows that physical exercise significantly decreases the intraocular pressure and it has a correlation with body mass index in young age group.

## CONCLUSION

The increased BMI might be suggested as an independent risk factor for elevation of IOP. In this study, IOP exhibited a positive correlation with BMI, especially in the group with BMI more than 22. This outcome reaffirms the importance of weight control in preventing increased IOP. This knowledge could be extrapolated and it could be used as a tool for screening disorders which are related to IOP, such as glaucoma. Clinicians should introduce lifestyle modifications in a gradual and graded manner so as to achieve a reduction in glaucoma occurrence.

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