

Original Research Article

ASSOCIATION OF BODY MASS INDEX WITH INTRAOCULAR PRESSURE IN PREMENOPAUSAL AND POSTMENOPAUSAL WOMEN

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ABSTRACT

Background: Intraocular pressure (IOP) is a key determinant in glaucoma pathogenesis and may be influenced by systemic factors such as body mass index (BMI) and hormonal status. Menopause-related hormonal changes, particularly reduced estrogen levels, are known to affect ocular physiology, necessitating evaluation of their combined impact on IOP. **Objectives:** To determine the influence of BMI on IOP in premenopausal and postmenopausal women, compare mean IOP between groups, and assess the correlation between BMI categories and IOP.

Materials and Methods: A hospital-based prospective observational study was conducted on 140 women aged 45–55 years, divided into premenopausal (n=35) and postmenopausal (n=105) groups. BMI was categorized, and IOP was measured and analyzed using SYSTAT, with $p < 0.05$ considered significant.

Results: Mean IOP was significantly higher in postmenopausal women (16.92 ± 0.83 mmHg) than premenopausal women (14.84 ± 0.81 mmHg; $p < 0.001$). IOP increased progressively with BMI in both groups ($p < 0.001$). Two-way ANOVA showed significant independent effects of BMI and menopausal status on IOP without interaction.

Conclusion: Both BMI and menopausal status independently influence IOP, with higher values observed in obese and postmenopausal women, indicating increased risk for ocular hypertension.

Keywords: Body Mass Index, Intraocular Pressure, Menopause, Premenopausal, Postmenopausal, Glaucoma Risk.

INTRODUCTION

Intraocular pressure (IOP) is the pressure inside the eye that helps maintain its normal structure and proper visual function. It is mainly controlled by the production and drainage of aqueous humor through specific outflow pathways in the eye.^[1,2] Any imbalance between production and drainage can lead to increased IOP. Elevated IOP is a major risk factor for glaucoma, a progressive optic nerve disease that can result in irreversible vision loss if not detected early.^[3] Body mass index (BMI) is a commonly used measure to assess body weight based on height. It is an important indicator of general health. Several studies have shown that higher BMI is associated with higher intraocular pressure. This may be due to

increased blood volume, higher episcleral venous pressure, and metabolic changes that affect fluid balance in the eye.^[4,5] These findings suggest that individuals with higher BMI may have a greater risk of elevated IOP.

Hormonal factors also play an important role in regulating intraocular pressure. In women, menopause causes a significant decrease in estrogen levels, which can affect ocular tissues, blood flow, and aqueous humor dynamics.^[6] Research has shown that postmenopausal women tend to have slightly higher IOP and changes in corneal thickness compared to premenopausal women, indicating that hormonal changes influence eye pressure.^[7] In addition, intraocular pressure may change gradually with age due to structural and physiological changes

in the eye.^[8] While BMI has been studied in relation to various health conditions in women, including bone and metabolic health,^[9] its combined effect with menopausal status on intraocular pressure is still not fully understood.

MATERIALS AND METHODS

Study Design: A hospital-based prospective observational study.

Study Site: The research was carried out at the Department of Ophthalmology, Chhatrapati Shivaji Subharti Hospital based on the Subharti Medical College, Subharti University, Meerut, Uttar Pradesh.

Sample Size: 140

Study Population: The study population consisted of female patients aged between 45 and 55 years attending the Eye OPD of Chhatrapati Shivaji Subharti Hospital, Meerut.

Based on menopausal status, the participants were divided into two groups:

- **Group A:** Premenopausal females
- **Group B:** Postmenopausal females

Inclusion Criteria

- Female patients aged 45-55 years
- Premenopausal and postmenopausal women
- Patients willing to participate and providing written informed consent

Exclusion Criteria

- Females outside the age group of 45-55 years
- History of premature menopause or surgical menopause
- Patients with diabetes mellitus or hypertension
- Patients on hormone replacement therapy
- History of glaucoma or ocular hypertension
- Pre-existing primary or secondary glaucoma

Statistical Analysis: Data were analyzed using Microsoft Excel and SYSTAT. Qualitative data were expressed as frequencies and percentages, quantitative as mean $\pm$ SD; $p < 0.05$ was considered statistically significant, with results shown in tables and graphs.

RESULTS

The study included 140 female participants aged 45–55 years, divided into premenopausal ($n=35$) and postmenopausal ($n=105$) groups with no missing data. The mean age was lower in premenopausal women (45.81 ± 0.71 years) compared to postmenopausal women (51.84 ± 2.31 years).

However, mean BMI was similar in both groups (26.84 ± 5.43 vs 26.49 ± 5.08 kg/m²), indicating comparable baseline characteristics for analyzing the relationship between BMI and intraocular pressure.

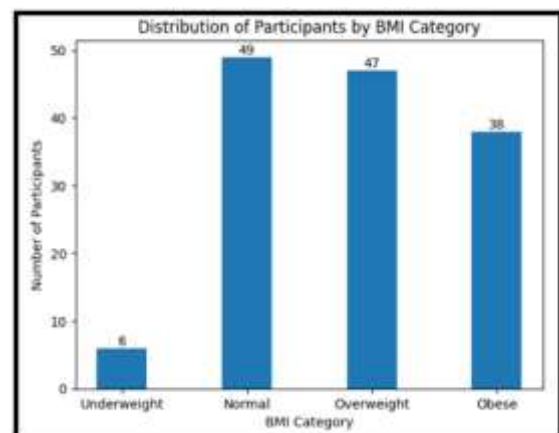


Figure 1: Distribution of Participants by BMI Category

In Figure 1, The distribution shows that 49 participants had normal BMI (35%), followed by overweight (47, 33.5%) and obese (38, 27.1%), while only a small proportion were underweight (6, 4.2%), indicating a predominance of higher BMI categories in the study population.

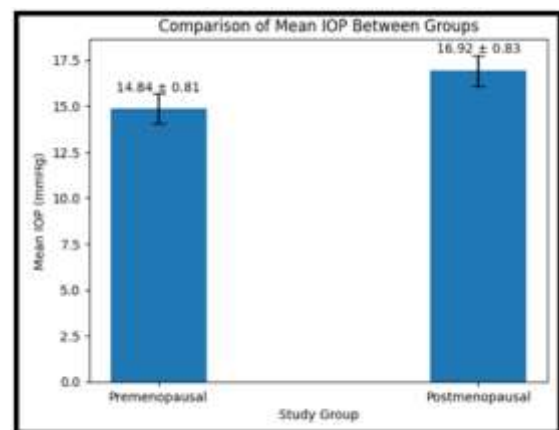


Figure 2: Comparison of Mean IOP Between Premenopausal and Postmenopausal Women

In Figure 2, The mean intraocular pressure was lower in premenopausal women (14.84 ± 0.81 mmHg, $n=35$) compared to postmenopausal women (16.92 ± 0.83 mmHg, $n=105$), showing a statistically significant increase in IOP after menopause ($p < 0.001$).

Table 1: Association between BMI Categories and Mean IOP in Both Groups

BMI Category	Group A (Premenopausal) Mean IOP $\pm$ SD	n	Group B (Postmenopausal) Mean IOP $\pm$ SD	n	p-value
Underweight	13.98 $\pm$ 0.04	2	16.03 $\pm$ 0.13	4	<0.001
Normal	14.03 $\pm$ 0.18	12	16.02 $\pm$ 0.22	37	<0.001
Overweight	14.98 $\pm$ 0.20	11	17.09 $\pm$ 0.17	36	<0.001
Obese	15.92 $\pm$ 0.16	10	18.01 $\pm$ 0.21	28	<0.001

Table 1 shows progressive increase in mean intraocular pressure (IOP) with rising BMI in both premenopausal and postmenopausal women, with consistently higher values in the postmenopausal group. In underweight individuals, IOP was 13.98 ± 0.04 mmHg (n=2) in premenopausal and 16.03 ± 0.13 mmHg (n=4) in postmenopausal women. In the normal BMI category, it was 14.03 ± 0.18 mmHg

(n=12) and 16.02 ± 0.22 mmHg (n=37), respectively. Among overweight participants, IOP increased to 14.98 ± 0.20 mmHg (n=11) and 17.09 ± 0.17 mmHg (n=36). The highest values were observed in obese individuals, with 15.92 ± 0.16 mmHg (n=10) and 18.01 ± 0.21 mmHg (n=28). This trend was statistically significant across all categories ($p < 0.001$).

Table 2: Two-Way ANOVA Showing Effect of BMI and Menopausal Status on IOP

Source of Variation	df	F value	p-value
Menopausal Status	1	3075.44	<0.001
BMI Category	3	799.54	<0.001
Interaction (Menopause × BMI)	3	0.74	0.53

Table 2 Shows two-way ANOVA showed that both menopausal status ($F = 3075.44$, $p < 0.001$) and BMI category ($F = 799.54$, $p < 0.001$) had a significant independent effect on intraocular pressure, while their interaction was not significant ($F = 0.74$, $p = 0.53$), indicating that BMI and menopause influence IOP separately.

DISCUSSION

The present study demonstrated that although mean BMI was comparable between premenopausal (26.84 ± 5.43 kg/m²) and postmenopausal women (26.49 ± 5.08 kg/m²), intraocular pressure (IOP) was significantly higher in postmenopausal women (16.92 ± 0.83 mmHg) compared to premenopausal women (14.84 ± 0.81 mmHg; $p < 0.001$), suggesting a strong hormonal influence on IOP which is independent of BMI. Similar findings were observed in Pourbagherkhah et al. (2026),^[7] where postmenopausal women exhibited significantly higher IOP along with reduced central corneal thickness, emphasizing the role of estrogen deficiency in altering aqueous humor dynamics. Estrogen is known to enhance trabecular meshwork outflow and regulate nitric oxide-mediated vasodilation; thus, its decline after menopause leads to increased outflow resistance and elevated IOP. Additionally, the predominance of higher BMI categories in the study, with 33.5% overweight and 27.1% obese individuals, aligns with Khan et al. (2021),^[4] who reported that each unit increase in BMI raises the risk of elevated IOP by 6%. Even in underweight individuals IOP was 13.98 ± 0.04 mmHg in premenopausal group which substantially increases to 16.03 ± 0.13 mmHg in postmenopausal women.

Mechanically, increased BMI contributes to elevated episcleral venous pressure, oxidative stress, and altered lipid metabolism, all of which impair aqueous humor drainage. Furthermore, adipose tissue-related inflammation and increased orbital fat may mechanically elevate IOP. While Kumar et al. (2016),^[9] highlighted that the influence of BMI may diminish after menopause. The current findings further emphasised that hormonal changes play a dominant role, with BMI acting as an additive risk

factor in modulating intraocular pressure. A consistent rise in intraocular pressure (IOP) with increasing BMI in both premenopausal (13.98 ± 0.04 to 15.92 ± 0.16 mmHg) and postmenopausal women (16.03 ± 0.13 to 18.01 ± 0.21 mmHg), with significantly higher values in postmenopausal women ($p < 0.001$), aligning with findings by Khan S (2021).^[4] Similarly, Pourbagherkhah P (2026),^[7] observed higher IOP in postmenopausal women, supporting hormonal influence. Two-way ANOVA confirmed independent effects of menopause ($F = 3075.44$) and BMI ($F = 799.54$) with Intraocular Pressure.

CONCLUSION

The present study conclusively demonstrates that both body mass index (BMI) and menopausal status independently and significantly influence intraocular pressure (IOP) among women aged 45–55 years. Despite comparable mean BMI between premenopausal (26.84 ± 5.43 kg/m²) and postmenopausal women (26.49 ± 5.08 kg/m²), postmenopausal women exhibited significantly higher mean IOP (16.92 ± 0.83 mmHg) compared to premenopausal women (14.84 ± 0.81 mmHg; $p < 0.001$), highlighting the critical role of hormonal changes, particularly estrogen deficiency, in ocular physiology. A progressive rise in IOP with increasing BMI across both groups further establishes BMI as a modifiable risk factor, with values increasing from 13.98 ± 0.04 to 15.92 ± 0.16 mmHg in premenopausal and 16.03 ± 0.13 to 18.01 ± 0.21 mmHg in postmenopausal women. The two-way ANOVA confirms that BMI and menopausal status act as independent determinants without significant interaction ($p = 0.53$).

These findings emphasize the need for targeted screening and early ophthalmic evaluation in overweight and postmenopausal women for early detection of raised intraocular pressure and prevention of ocular hypertension related complications.

Conflict of Interest: None.

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Ethical Approval: Obtained.

Consent: Written consent secured.

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