National Journal of Physiology, Pharmacy and Pharmacology

RESEARCH ARTICLE

Effects of body mass index on intraocular pressure and ocular perfusion pressure in individuals with prehypertension

Sudha B Sreenivas, Vinitha K R

Department of Physiology, JSS Medical College, Affiliated to JSS Academy of Higher Education and Research, Mysuru, Karnataka, India

Correspondence to: Vinitha K R, E-mail: vinithakr@gmail.com

Received: May 07, 2020; **Accepted:** May 29, 2020

ABSTRACT

Background: Elevated intraocular pressure (IOP) and reduced ocular perfusion pressure (OPP) are major risk factors in the development and progression of glaucoma. Although both obesity and prehypertension are risk factors in elevating IOP, very few studies have analyzed the effects of obesity on IOP and OPP in pre-hypertensive individuals. **Aim and Objective:** This study aims to assess the effects of body mass index (BMI) on IOP and OPP in pre-hypertensive individuals. **Materials and Methods:** A total of 100 voluntary participants with prehypertension (systolic blood pressure of 120–139 mmHg or diastolic blood pressure of 80–89 mmHg) in the age group of 20–50 years were selected from an ophthalmology clinic in Mysuru. They were categorized into two groups based on their BMI into obese and non-obese pre-hypertensive groups. IOP was recorded using rebound tonometer and OPP was calculated. **Results:** Statistically significant elevation in IOP and reduction in OPP values of both the eyes were observed in obese pre-hypertensive group. **Conclusion:** Obesity compounds the effect of prehypertension on IOP and OPP probably by early disruption of the autoregulatory mechanisms that maintain constant ocular blood flow. Understanding of the complex relationship between IOP and OPP in obese, pre-hypertensive population might help in preventing the risk of developing glaucoma.

KEY WORDS: Body Mass Index; Intraocular Pressure; Ocular Perfusion Pressure; Prehypertension

INTRODUCTION

Obesity is a rapidly emerging global epidemic with profound public health consequences. It is an excessive accumulation of fat in the body resulting in increase in weight beyond that considered desirable with regard to age, height, and bone structure.[1] Obesity is a complex condition resulting from the interplay among genetics, environment, and lifestyle.[2] It is an established fact that increase in body mass index (BMI), which is one of the specific indicators of obesity, is a significant risk factor for hypertension.[3]

Access this article online	
Website: www.njppp.com	Quick Response code
DOI: 10.5455/njppp.2020.10.05137202029052020	

Prehypertension, a precursor of clinical hypertension, is an asymptomatic silent killer that can cause subclinical atherosclerosis. It is associated with an increased risk of major cardiovascular events, thus pointing to the need for its early identification and management.[4] According to JNC 7, the WHO classification, prehypertension is defined as above-optimal systolic and diastolic blood pressure of 120–139 or 80–89 mmHg, respectively.[5] This is further classified as elevated hypertension and Stage I hypertension by American College of Cardiology and American Heart Association (ACC/AHA).[6]

Intraocular pressure (IOP) is the pressure exerted by aqueous humor on the intraocular tissues. Elevated IOP can cause glaucomatous optic nerve damage due to their mechanical effects on the optic nerve head.[7] Ocular perfusion pressure (OPP) is an important determinant of ocular blood flow and it reflects the vascular status of the optic disc. It is expressed

as the difference between the arterial BP and IOP. Reduced OPP could diminish ocular blood flow, leading to ischemia and poor irrigation of ocular nervous tissues, thus having deleterious effects on the optic disc. Hence, variations in IOP and OPP could be probable risk factors for ocular vascular deregulation, thus increasing the incidence and progression of glaucoma. According to the WHO, glaucoma is the second leading cause of blindness in the world, which can affect the quality of life of these patients.[8]

An association between increased BMI and elevated IOP in adults and children has been observed in recent reviews.[9] A potential relationship between obesity and eye diseases such as cataract, diabetic retinopathy, and age-related macular degeneration has been reported.[10] Although both obesity and prehypertension are independent risk factors in elevating IOP, very few studies have analyzed the composite effects of obesity and prehypertension on IOP and OPP. The purpose of this study was to evaluate the relationship between IOP, OPP, and BMI in pre-hypertensive individuals as they are modifiable risk factors for glaucoma.

Objective

The objective of the study was to assess the effects of BMI on IOP and OPP in pre-hypertensive individuals.

MATERIALS AND METHODS

This comparative cross-sectional study comprised 100 voluntary participants with prehypertension (systolic blood pressure (SBP) of 120–139 mmHg or diastolic blood pressure (DBP) of 80–89 mmHg) in the age group of 20–50 years, from an ophthalmology clinic in Mysuru. Subjects with conjunctivitis, glaucoma, contact lens users, smokers, alcoholics, hypertensives, and individuals with a history of diabetes mellitus or chronic kidney diseases were excluded from the study. The Institutional Ethical Clearance was obtained.

Details of the procedure were explained to the participants and informed consent was taken. Anthropometric measurements were made and their BP was recorded after a rest period of 5 minutes using sphygmomanometer. They were categorized into Group 1 and Group 2 based on their BMI. Group 1 included non-obese pre-hypertensive subjects with normal BMI between 18.5 and 22.9 kg/m^2 and Group 2 comprised overweight and obese pre-hypertensive subjects with BMI greater than 22.9 kg/m^2. IOP was recorded in sitting position using SW-500 rebound tonometer (Tianjin Suowei Electronic Technology Co., Ltd., Tianjin, China). All the recordings were done between 11 am and 1 pm by the same person to minimize the bias of examiners and diurnal variations of IOP.[11]

Mean arterial pressure (MAP) and mean OPP (MOPP) were calculated[11] using the following formulas: MAP = DBP+1/3 (SBP-DBP); MOPP = (2/3) MAP–IOP

Statistical Analysis

Data collected were entered into MS Excel 2010 and analyzed using SPSS version 23. Descriptive statistical measures such as arithmetic mean and standard deviation were applied. Inferential statistical tests like unpaired *t*-test for comparison between groups were used. Pearson's correlation was used to find out the relationship between BMI, IOP, and OPP. Differences were interpreted as statistically significant at $P<0.05$.

RESULTS

The mean age of the subjects in Group 1 was 36.6 ± 10.65 years and in Group 2 was 37.6 ± 8.19 years. The gender-wise distribution of subjects was 60 females and 40 males. The mean BMI was 20.74 kg/m^2 in Group 1 and 26.37 kg/m^2 in Group 2. Statistically significant elevations in IOP of both the eyes were observed in Group 2 with high BMI. Reduction in OPP was also observed in the same group though it was not statistically significant [Table 1]. The IOP values of both the eyes showed a significant positive correlation with BMI. Although a negative correlation was observed between OPP values of both the eyes and BMI, it was not statistically significant [Table 2].

DISCUSSION

Our study aimed to analyze the effects of BMI on IOP and OPP in overweight and obese pre-hypertensive individuals.

Table 1: Mean and SD values of BP, IOP, and OPP parameters between the two groups

Parameters in (mmHg)	Group 1 (Mean±SD)	Group 2 (Mean±SD)	*P*-value
SBP	124.29±5.27	126.38±5.86	0.08
DBP	81.08±2.11	80.92±2.81	0.81
MAP	95.47±2.81	96.07±2.77	0.30
Right IOP	16.27±1.18	16.72±0.76	0.04*
Left IOP	16.18±1.25	16.7±0.79	0.02*
Right OPP	47.38±2.17	47.33±1.78	0.93
Left OPP	47.46±1.91	47.35±1.89	0.81

*$P<0.05$. IOP: Intraocular pressure, OPP: Ocular perfusion pressure, SBP: Systolic blood pressure, DBP: Diastolic blood pressure and MAP: Mean arterial pressure

Table 2: Correlation between BMI and ocular pressures

Ocular pressures	BMI	
	r-value	*P*-value
Right IOP	0.228	0.02*
Right OPP	−0.017	0.87
Left IOP	0.239	0.02*
Left OPP	−0.031	0.76

*$P<0.05$, IOP: Intraocular pressure, OPP: Ocular perfusion pressure, BMI: Body mass index

There was a statistically significant elevation in IOP and mild reduction in OPP values of both the eyes in the group with high BMI when compared with the non-obese pre-hypertensive group. A significant positive correlation between IOP and BMI was observed, whereas OPP was negatively correlated with BMI.

Sandra Ngo *et al.* observed a negative correlation between OPP and IOP in the overweight and obese population.[12] Increased mean BP levels with increasing BMI were observed in African and Asian population[13] and a strong association was found between obesity and prehypertension as well.[14] Obese individuals may have a greater tendency toward elevated BP and their eyes are more sensitive to OPP changes. This could be related to pathological changes in intraocular blood vessels of obese pre-hypertensives by damaging the small vessels of the optic disc, thus increasing the risk of glaucoma.[9] Moreover, adaptation to changes in OPP might be better in normal BMI group due to healthier and more resilient blood vessels.[12] However, higher BMI was associated with a lower risk of primary open angle glaucoma in a prospective cohort study on Caucasian population[15] which is contrary to our findings. Another study conducted on Nigerian population, also states that obesity is an independent risk factor for increase in BP and IOP which may result in systemic hypertension and glaucoma.[16] However, it was observed that IOP levels were higher in pre-hypertensive individuals as well.[17] The cause for association of obesity with IOP is unclear. It could be due to mechanical effects such as excessive intraorbital adipose tissue, increased blood viscosity, and increased episcleral venous pressure causing impairment of aqueous outflow.[18] The pathophysiologic basis for the relationship between BP and IOP is complex and not well understood. Increased BP probably leads to increased aqueous humor ultrafiltration by means of increased ciliary arterial pressure thus increasing IOP.[19]

OPP is a derivative of BP and IOP. Reduction in OPP observed in overweight and obese pre-hypertensive group of our study could increase the probability of the development of glaucoma. High BMI leads to autonomic and endothelial dysfunction that can decrease choroidal perfusion and ocular blood flow.[10] Although obesity and prehypertension are considered as independent risk factors for increased IOP and a fall in OPP, they intensify the deleterious effects on ocular blood flow as observed in our study. Further studies with Doppler optical coherence tomography can be done to study the exact ocular blood flow.[20] A clear picture of the interplay between BMI, BP, and IOP could be obtained if this study is done on a larger population and in glaucomatous patients.

CONCLUSION

Obesity compounds the effect of prehypertension on IOP and OPP probably by early disruption of the autoregulatory mechanisms that maintain constant ocular blood flow. Understanding of the complex relationship between IOP and OPP in obese pre-hypertensive population might help in early detection and preventing the risk of glaucoma development by reducing their BMI with weight loss remedies and sedentary lifestyle modifications.

REFERENCES

1. Vinaykumar S, Sharanabasappa SD, Prameela J. Association between body mass index and blood pressure among children age group 5 to 15 years in a tertiary care centre: A descriptive study. Int J Contemp Pediatr 2016;3:1055.
2. Jana V, Snieder H, Lagou V. Gene-lifestyle interactions in obesity. Curr Nutr Rep 2012;1:184-96.
3. Droyvold WB, Midthjell K, Nilsen TI, Holmen J. Change in body mass index and its impact on blood pressure: A prospective population study. Int J Obes (Lond) 2005;29:650-5.
4. Israeli E, Schochat T, Korzets Z, Tekes-Manova D, Bernheim J, Golan E. Prehypertension and obesity in adolescents: A population study. Am J Hypertens 2006;19:708-12.
5. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, *et al*. Seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure. Hypertension 2003;42:1206-52.
6. Whelton PK, Carey RM, Aronow WS, Casey DE Jr., Collins KJ, Himmelfarb CD, *et al*. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: Executive summary: A report of the American college of cardiology/American heart association task force on clinical practice guidelines. Hypertension 2018;71:1135.
7. Harris A, Rechtman E, Siesky B, Jonescu-Cuypers C, McCranor L, Garzozi HJ. The role of optic nerve blood flow in the pathogenesis of glaucoma. Ophthalmol Clin North Am 2005;18:345-53.
8. Kingman S. Glaucoma is second leading cause of blindness globally. Bull World Health Organ 2004;82:887-8.
9. Deb AK, Kaliaperumal SR, Sengupta S. Relationship between systemic hypertension, perfusion pressure and glaucoma: A comparative study in adult Indian population. Indian J Ophthalmol 2014;62:917-22.
10. Karadag R, Arslanyilmaz Z, Aydin B, Ibrahim FH. Effects of body mass index on intraocular pressure and ocular pulse amplitude. Int J Ophthalmol 2012;5:605-8.
11. Robert NW, James DB, David GH, Felipe M. Intraocular Pressure Consensus, Series 4. Netherlands: Kugler

Publications; 2007.
12. Ngo S, Harris A, Siesky BA, Schroeder A, Eckert G, Holland S. Blood pressure, ocular perfusion pressure, and body mass index in glaucoma patients. Eur J Ophthalmol 2013;23:664-9.
13. Tesfaye F, Nawi NG, Van Minh H, Byass P, Berhane Y, Bonita R, *et al*. Association between body mass index and blood pressure across three populations in Africa and Asia. J Hum Hypertens 2007;21:28-37.
14. Wakabayashi I. Stronger associations of obesity with prehypertension and hypertension in young women than in young men. J Hypertens 2012;30:1423-9.
15. Pasquale LR, Willett WC, Rosner BA, Kang JH. Anthropometric measures and their relation to incident primary open-angle glaucoma. Ophthalmology 2010;117:1521-9.
16. Gladys OG, George OB. Relationship between body mass index, intraocular pressure, blood pressure and age in Nigerian population. J Clin Exp Ophthalmol 2015;6:4.
17. Sreenivas SB, Vinitha KR, Kulkarni P. A comparative study of intraocular pressure and ocular perfusion pressure changes in prehypertensive individuals. Natl J Physiol Pharm Pharmacol 2018;8:1396-9.
18. Cheung N, Wong TY. Obesity and eye diseases. Surv Ophthalmol 2007;52:180-95.
19. Deokule S. How is systemic blood pressure and intraocular pressure related? J Curr Glaucoma Pract 2009;3:1-4.
20. Cherecheanu AP, Garhofer G, Schmidl D, Werkmeister R, Schmetterer L. Ocular perfusion pressure and ocular blood flow in glaucoma. Curr Opin Pharmacol 2013;13:36-42.

How to cite this article: Sreenivas SB, Vinitha KR. Effects of body mass index on intraocular pressure and ocular perfusion pressure in individuals with prehypertension. Natl J Physiol Pharm Pharmacol 2020;10(09):740-743.

Source of Support: Nil, **Conflicts of Interest:** None declared.