



# The Relationship between Body Mass Index and Intra-ocular Pressure in Port Harcourt Nigeria

C. N. Pedro-Egbe<sup>1\*</sup>, E. A. Awoyesuku<sup>1</sup>, G. I. Nathaniel<sup>2</sup>  
and R. O. Komolafe<sup>2</sup>

<sup>1</sup>Department of Surgery, Ophthalmology Unit, University of Port Harcourt, Nigeria.

<sup>2</sup>Department of Ophthalmology, University of Port Harcourt Teaching Hospital, Port Harcourt, Nigeria.

## Authors' contributions

*This work was carried out in collaboration with other authors. Authors CNP and EAA designed the study and wrote the protocol. Authors GIN and ROK performed the literature search and all authors took part in the study. Author CNP performed the statistical analysis and wrote the first draft of the manuscript. All authors read and approved the final manuscript.*

Research Article

Received 4<sup>th</sup> December 2012  
Accepted 30<sup>th</sup> January 2013  
Published 27<sup>th</sup> February 2013

## ABSTRACT

**Background:** There are conflicting reports regarding the relationship between body mass index (BMI) and intraocular pressure (IOP). There is a need to evaluate these contradicting findings in our environment.

**Aim:** To examine the relationship between intraocular pressure and body mass index (BMI) in a population screened for glaucoma at the University of Port Harcourt, Nigeria

**Materials and Method:** This study was part of a one-day screening exercise for glaucoma at the University of Port Harcourt. All subjects participated with willful consent. Demographic data included age, sex, race and occupation. Height was measured with a wall-mounted tape and weight with a bathroom scale. Intraocular pressure was measured with Perkins hand-held applanation tonometer and funduscopy was carried out with a direct ophthalmoscope. BMI was calculated as weight in kilograms divided by the square of height in meters (Weight/Height<sup>2</sup>).

**Results:** A total of 491 subjects were screened. There were 230 males (46.8%) and 261 females (53.2%). About 50% (n=246/491) of the participants had normal BMI,

\*Corresponding author: Email: [cpegbe@weltekng.com](mailto:cpegbe@weltekng.com);

28.7%(n=141) were overweight while 17.7%(n=87) were obese. The mean BMI was  $25.39 \pm 4.82$ . Most obese participants were females (n= 63/87; 72.4%) while most males had normal body weight (n=131; 53.2%). The relationship between BMI and gender was statistically significant ( $P=0.00$ ). The mean intraocular pressure of all participants was  $16.21 \pm 5.01$ mmHg. Most overweight (88.6%; n=241/272) and obese persons (n=149; 87.6%) had normal IOP. There was however no statistically significant relationship between BMI and IOP ( $P=0.473$ ;  $r^2=0.02$ ).

**Conclusion:** In a population screened for glaucoma at the University of Port Harcourt, Nigeria, we found no statistically significant relationship between BMI and intraocular pressure but there was a statistically significant relationship between BMI and age.

*Keywords: BMI; intraocular pressure; relationship.*

## 1. INTRODUCTION

Glaucoma is an optic neuropathy characterized by progressive degeneration of retinal ganglion cells and their axons, manifested by increasing optic disc cupping and deterioration of visual function [1]. Though, the second commonest cause of blindness in the world, [2] its etiology is not fully understood. The relationships between body mass index (BMI) and primary open angle glaucoma (POAG) are controversial. Although intraocular pressure (IOP) is no longer included in the definition of open-angle glaucoma (OAG), it remains the only modifiable and a major risk factor for the development and progression of the disease [3-4]. Some studies have reported factors such as race (African ancestry), [5,6] and BMI [7-11] as associations of elevated intra-ocular pressure. Other studies which have also reported this positive association between BMI and elevated IOP include those of Lees et al., [12] Memarzadeh et al in The Los Angeles Latino Eye Study, [13] and Klein and Wu et al. respectively [14-15] It has been suggested that increased orbital pressure due to excess orbital fat may increase episcleral venous pressure and result in a decrease in outflow facility [16]. Alternatively, that the deposition of lipids has been suggested to reduce outflow facility for aqueous thereby resulting in higher IOP in obese subjects [17]. Some studies however report a tendency for glaucoma patients to have a lower BMI than control subjects [18] and in some of these studies, increased BMI appears to be a protective factor for open angle glaucoma [19,20].

Although most of these listed studies on the relationship between BMI and IOP have been done in Caucasians and Asians, a community-based study on the relationship between IOP, systemic blood pressure and obesity in Port Harcourt, Nigeria, also reported no association between elevated intra-ocular pressure and obesity (Okorie UN; Part II Dissertation 2010, National Postgraduate Medical College of Nigeria, unpublished).

This study aims to examine the relationship between intra-ocular pressure and body mass index (BMI) in a population screened for glaucoma at the University of Port Harcourt, Port Harcourt, Nigeria.

## 2. MATERIALS AND METHODS

This study was part of a one-day screening exercise for glaucoma at the University of Port Harcourt, Rivers State, Nigeria. The University is located at Choba, a suburb of Port Harcourt, which is the center of the oil industry in Nigeria. The University of Port Harcourt

Teaching Hospital Ethics Committee gave ethical approval, and all subjects participated with willful verbal consent. Demographic data included age, sex, race and occupation. Height was measured with a wall-mounted tape and weight with a bathroom scale (I.I Hanson, Ireland) with minimal clothing (no jackets on) and no shoes on. Intraocular pressure was measured with Perkins hand-held applanation tonometer (Perkins MK 2; HS Clemens Clarke International, Essex, UK) and the average of 3 readings recorded. Funduscopy was carried out with a direct ophthalmoscope (Welch Allyn Ref 11720 NY USA). BMI was calculated as weight in kilograms divided by the square of height in meters (Weight/Height<sup>2</sup>). Exclusion criteria included subjects who were known diabetics and hypertensives (as admitted on questioning), or those who have had some form of ocular surgeries such as cataract extraction. Data was analyzed using Epi-Info Version 6.04D and statistical significance taken as  $P < 0.05$ .

### 3. RESULTS

A total of 491 subjects were screened. There 230 males (46.8%), and 261 females (53.2%) giving a male to female ratio of about 1:1.2. The mean age of the subjects was  $35 \pm 13.29$  years and over 85% (n=431) of the study population was aged between 20-59 years old (Table 1).

**Table 1. Age and sex distribution of the study population**

Age groups (Years)	Male	Female	Total
<10	2 (0.4)	3(0.6)	5(1.0)
10-19	20 (4.1)	23(4.7)	43(8.8)
20-29	70 (14.3)	80(16.3)	150(30.5)
30-39	36 (7.3)	47(9.6)	83(16.9)
40-49	47 (9.6)	78(15.9)	125(25.5)
50-59	48 (9.8)	25(5.1)	73(14.9)
60-69	6 (1.2)	4(1.0)	10(2.0)
70-79	1 (0.2)	1(0.2)	2(0.4)
<b>TOTAL</b>	<b>230(46.8)</b>	<b>261(53.2)</b>	<b>491(100.0)</b>

\*Significant; Chi square = 15.97; P = 0.02\*

Table 2 shows that most participants had normal VCDR (89.4%). Only 102 (10.6%) eyes had cupped discs. The mean VCDR was  $0.378 \pm 0.126$ . Funduscopy was not done in 16 eyes because of lens opacity. The relationship between age and VCDR is statistically significant ( $P=0.03$ ).

**Table 2. Age groups and Cupping of the optic disc**

VCDR	Age groups							Total%
	<10-19	20-29	30-39	40-49	50-59	60-69	70-79	
Normal ( $\leq 0.5$ )	88 (9.1)	262 (27.12)	155 (16.04)	214 (22.15)	122 (12.62)	20 (2.07)	3 (0.31)	<b>864 (89.4)</b>
Abnormal ( $> 0.5$ )	8 (0.8)	33 (3.41)	7 (0.72)	33 (3.41)	21 (2.17)	0 (0.00)	0 (0.0)	<b>102 (10.6)</b>
<b>Total</b>	<b>96 (9.9)</b>	<b>295 (30.5)</b>	<b>162 (16.8)</b>	<b>247 (25.6)</b>	<b>143 (14.8)</b>	<b>20 (2.1)</b>	<b>3 (0.3)</b>	<b>966 (100.0)</b>

Chi square = 15.47; P = 0.03\*

Table 3 shows the BMI groupings. About 28%(n=141) of the participants were overweight while 17.7%(n=87) were obese but about half of the participants however had normal body weight (53.6%). The mean weight of the 491 participants was 69.13 ± 14.18 kg and the mean height was 1.65 ± 0.11 meters. The mean BMI was 25.39 ± 4.82 kg/m<sup>2</sup>

**Table 3. BMI Categories**

BMI (kg/m <sup>2</sup> ) categories	Frequency (%)
<18.5 (Under Weight)	17(3.5)
18.5-24.9 (Normal)	246(50.1)
25-29.0 (Over Weight)	141(28.7)
≥30.0 (Obesity)	87(17.7)
TOTAL	491(100.0)

Table 4 shows BMI according to age groupings. Most of the obese persons (n=76; 87.4%) were aged between 30-59 years old while most participants with normal weight (n=148/246) were in the 10-29 year group. No participant in the 50-79 year age group was underweight and none was overweight in the 10-19 year age group. The relationship between BMI and age was statistically significant (*P* = 0.00)

**Table 4. BMI Categories by Age Groups**

BMI total	Age groups (Years)							
	<10-19	20-29	30-39	40-49	50-59	60-69	70-79	
<18.5 (Underweight)	9 (1.8)	5 (1.0)	1(0.2)	2(0.4)	0(0.0)	0(0.0)	0(0.0)	17(3.5)
18.5-24.9 (Normal)	35(7.1)	114(23.2)	34(6.9)	34(6.9)	25(5.1)	3(0.6)	1(0.2)	246(50.1)
25-29.0 (Overweight)	4(0.8)	24(4.9)	31(6.3)	49(10.0)	29(5.9)	3(0.6)	1(0.2)	141(28.7)
≥30.0 (Obesity)	0(0.0)	7(1.4)	17(3.5)	40(8.1)	19(3.9)	4(0.8)	0(0.0)	87(17.7)
Total	48(9.8)	150(30.5)	83(16.9)	125(25.5)	73(14.4)	10(2.0)	2(0.4)	491(100)

\*Significant; Chi square = 214.97; P = 0.00\*

Table 5 shows the relationship between BMI and gender. Most obese participants were females (n= 63/87; 72.4%). Over 28% of the participants were overweight and there was not much difference between the males and females (n=69:72). Most males however had normal body weight (n=131; 53.2%). The relationship between BMI and gender was statistically significant (*P* =0.00)

**Table 5. BMI according to Gender**

BMI category	Gender		Total (%)
	Male (%)	Female (%)	
<18.5 (Underweight)	6 (1.2)	11(2.3)	17(3.5)
18.5-24.9 (Normal)	131(26.7)	115(23.4)	246(50.1)
25-29.0 (Overweight)	69 (14.0)	72(14.7)	141(28.7)
≥ 30.0 (Obesity)	24 (4.9)	63(12.8)	87(17.7)

TOTAL	230 (46.8)	261 (53.2)	491 (100)
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Chi square = 18.17; P = 0.00\*

Table 6 and 7 show BMI in relation to intraocular pressure. The mean intraocular pressure of all participants was 16.21±5.01mmHg. Most obese persons (n=149; 87.6%) had normal IOP. The same goes for overweight participants, where 88.6% (n=241/272) had normal intraocular pressures. There was no statistically significant relationship between BMI and IOP (P=0.47; R<sup>2</sup>=0.02).

**Table 6. BMI in relation to IOP**

BMI Category	IOP No (%)		Total (%)
	Normal (≤21mmHg)	Abnormal (>21mmHg)	
<18.5 (Underweight)	25 (2.7)	1 (0.1)	26 (2.8)
18.5-24.9 (Normal)	416(44.8)	44(4.7)	460(49.6)
25-29.0(Overweight)	241(26.0)	31(3.3)	272(29.3)
≥30.0 (Obesity)	149(16.0)	21(2.3)	170(18.3)
TOTAL	831(89.5)	97(10.5)	928(100.0)

\*Not Significant; Chi square = 2.51; P= 0.47\*

**Table 7. Correlation of BMI and IOP**

BMI	IOP
The Pearson correlation coefficient, r	0.12
R <sup>2</sup>	0.02

R<sup>2</sup> = 0.02 (showing that only 2% of the BMI values are related to IOP)

#### 4. DISCUSSION

In this population-based study of participants at a glaucoma screening exercise in Port Harcourt, Nigeria, we found no association between body mass index and elevated intraocular pressure as there was no statistically significant relationship between the two (P=0.47). Those aged between 30-59 years old had the highest intraocular pressure values compared to those aged 60 years and above whose IOPs were normal. This was however not statistically significant. Most of the participants had normal BMI. Of the participants that were obese, over 72% were females. Most participants who were either overweight (86.6%) or obese (87.6%) had normal intraocular pressures. Our finding tends to agree with most other studies that have reported no such association including the one by Okorie UN in Port Harcourt, Nigeria. Our result is surprisingly similar to hers even though the population studied is different. Her population was those aged 40-90 years while ours was a cross-sectional study. Incidentally, the study by Mori et al was cross-sectional and they reported a significant association between IOP and obesity in both cross-sectional and longitudinal analysis. Their findings also suggested that obesity was an independent risk factor for increase in IOP. Our results may have differed from that of Mori et al because of their larger sample size (n=70,139) compared to ours. A larger sample size is more likely to detect statistical significance than a smaller one.

The Rotterdam Eye Study reported a 7% reduction in the risk of developing OAG for each unit increase in BMI in women, but no significant effect in men. This association between BMI and primary OAG in women is attributed to declining estrogen levels with age [21]. Declining estrogen levels is important in the pathogenesis of POAG in women. Heavier

women have higher estrogen levels, and this may be protective as has been demonstrated in animal models of glaucoma where estrogen is found to have neuro-protective effects [21].

The pathogenesis for this positive relationship has been suggested to be due to excess orbital fat, which may increase episcleral venous pressure, reduce outflow facility and cause a rise in IOP [16]. Alternatively, the deposition of lipids in obesity has been suggested to reduce outflow facility [17]. Our result however, differs from most other reported studies where there is a positive relationship between obesity and elevated IOP [7-17]. Most of these studies were done in Asians, Caucasians and Latinos [7-17], while ours is an all black population and this may have accounted for the difference in results. No reason is immediately apparent for this inverse relationship between BMI and IOP noted in our study. There is therefore the need for further studies involving a larger sample size before reasonable conclusions can be drawn from this study.

## **5. CONCLUSION**

In a population screened for glaucoma at the University of Port Harcourt, the authors found a statistically significant relationship between BMI and age but no statistically significant relationship between BMI and Intra-ocular pressure. This may be because of the small sample size. We therefore need further studies involving a larger sample size before reasonable conclusions are drawn.

## **CONSENT FORM**

Since this was a glaucoma screening exercise, individuals walked in freely to be screened. Therefore, willful verbal consent was obtained from all participants. This was stated in the section on materials and methods.

## **ETHICAL CLEARANCE**

The University of Port Harcourt Teaching Hospital was informed of the glaucoma screening exercise in the neighboring university community and approval was given for the exercise to go on. Ethical clearance does not therefore apply here.

## **COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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