EVALUATION OF OCULAR ANTERIOR CHAMBER DEPTH AND BODY MASS INDEX IN NORMAL BLACKS IN A NIGERIAN CITY

Abstract

AIM: To evaluate ocular anterior chamber depth (ACD) and body mass index (BMI) in a normal population in Port Harcourt City Local Government Area (LGA), with a view to determine formulae in estimating intraocular lens power for cataract surgeries and possible association with angle closure glaucoma and other ocular pathological conditions.

METHOD: This is a multi-stage study with inclusion criteria of Visual Acuity > 6/18, age greater than 18 years with no history of past ocular surgeries or trauma. Data obtained through a structured proforma included age, sex, tribe, occupation and level of education. Body Mass Index (BMI) was measured using a standard height and weight automated scale (SECA 769,220). Comprehensive ocular examination done and Anterior Chamber Depth (ACD) measured using Amplitude (A) scan ultrasonography (SONOMED PACSCAN 300AP). Data was analyzed using SPSS (Version 17), and p value was set at ≤ 0.05.

RESULTS: Four hundred and sixty six (466) subjects participated in the study made up of two hundred and twelve (212) males (45.5%) and two hundred and fifty four (254) females (54.5%) with M: F ratio of 1:1.2. The age range was 18-92 years and mean age of the subjects studied 43.0±14.2 years. Findings revealed mean ACD and Body Mass Index to be 3.1±0.5mm and 26.9±6.2kg/m^2 respectively. The mean ACD was greater in males than females. There was a statistically significant relationship between age and ACD. Obesity was found to be higher in females (n=97; 78.2%) compared to the males among those with BMI >30Kg/m2 and this was found to be statistically significant (p=0.0001). A larger proportion of subjects with normal BMI and overweight BMI 25-29.5 Kg/m2 were males**.** There was a statistically significant difference in the ACD values between genders among those overweight (BMI 25- 29.5Kg/m^2) and the obese (BMI >30 Kg/m^2)

CONCLUSION: There was a statistically significant difference in the ACD values between genders among those overweight.

Keywords: Evaluation Ocular Anterior Chamber Depth Mass Index Black.

Introduction

Anterior Chamber Depth (ACD) is an important biometric parameter in the eye, and the measurement is important in several conditions including the determination of the refractive status of the eye as well as determination of intraocular lens power for patients prior to cataract surgery. Several studies have also related it to anthropometric measurements including Body Mass Index (BMI).[1].

The anterior chamber depth (ACD), defined as the distance measured along the eye's optical axis from the posterior surface of the cornea to the anterior surface of the crystalline lens, [2], is an important biometric measurement. It is approximately 3.5mm (1.99-4.75mm). In a study carried out in Central India by Jonas et al,[3], mean anterior chamber depth was noted to be 3.2mm. Anterior chamber depth varies with refractive error, age, sex, ethnicity, genetics and amplitude of accommodation.[4]. ACD measurement and dimensions are said to be very important in the diagnosis of angle closure glaucoma, as shallow anterior chamber depth is noted to be one of the most consistent and important ocular risk factors for angle closure glaucoma. [5,6].

Body Mass Index (BMI) is an anthropometric measurement used in determining the state of well-being of the body and it is also used as a measure of body size as it provides a crude index of the body's fat content.

The parameters used in its determination are weight in kilograms, and height in meters.[7,8]It is defined as the individuals body weight divided by the square of their height.[9] Increased BMI has been known to be associated with several ocular pathological conditions,[10] such as cataract,[8] retinal vein occlusion,[11] age related macular degeneration,[10] reduction in retinal vascular caliber,[11] as well as raised intraocular pressure (IOP).[12]

There is a paucity or dearth of studies in our environment and Africa reporting the relationship of BMI and anterior chamber depth although there are varying reports on the relationship between ACD and BMI by several authors outside this continent.

The ACD is measured using either contact methods like the A scan biometer, non-contact methods like the IOL master,[13]or clinically by the Van Herrick's and Redman Smith's methods respectively.[14] Its depth increases from birth until it stabilizes at about 15 years. Minimal change occurs from adolescence to 30 years usually as a result of deposition of lens fibers anteriorly.[4]

In the EPIC-Norfolk Eye study, [5] with 2519 adults, ACD varied with age and sex. There was a significant inverse association between ACD and refraction in women, but not in men (p-value<0.0001).

Wong et al,[15] in a population based descriptive cross sectional study of adult Chinese aged between 40 to 81 years in Singapore, noted that people aged between 40-49 when compared with those between 70-81 years had deeper ACD (+0.52mm) . Women had shallower ACDs than men after controlling for age. Similarly, Shufelt et al,[16] in a population based study, reported that Latino women had significantly shallower ACD than men and that older individuals had shallower ACD as compared with younger individuals. In the Central India Eye and Medical study,[3] a population based study carried out on 4711 Indian subjects, it was noted also that shallower anterior chamber depth was significantly associated with older age and the female gender.

Similarly Olurin, [17] in a study on 1646 eyes of 823 Nigerians, surmised that anterior chambers were deeper in males than females and that significant shallowing occurred with age. This was in keeping with a case control study carried out on 240 newly diagnosed glaucoma subjects compared to 250 subjects without glaucoma, by Ashaye, [18] in Nigeria. The study stated that although mean central ACD was shallower in cases than control, the mean ACD was shallower in females than males and also decreased with age in both cases and controls. The findings on ACD in Nigerians were in agreement with those in the other races previously mentioned, thus it can be surmised that age is an important consideration in the assessment of the anterior chamber depth.

In a cross sectional clinic based study by Wang et al,[19] using 466 subjects and 4 gender and age matched cohorts of Caucasians, American Chinese and Southern and Northern mainland Chinese, anterior ocular segment biometry features and related factors using anterior segment Optical Coherence Tomography (OCT) were studied, and it showed that Chinese female and older subjects tended to have smaller anterior chamber depth as well as width than Caucasians. This was thought to be attributable to shorter corneal arc depth in the Chinese.

A study carried out by Olurin,[17] to measure the anterior chamber depth in Nigerians and compare findings with previous observations in Caucasians, observed that the mean ACD was 3.22mm and that the ACD was significantly deeper in males than females and that significant shallowing occurred with age. The author concluded that no significant differences could be found between the 2 racial groups.

This dimension of ACD noted in Nigerians is in keeping with findings in other racial groups around the world.[3,5,20,21]

Body Mass Index is an anthropometric parameter measured by dividing the weight of an Individual in kg by the height in m^2. It is said to be an indicator of body size although independent of size and stature[3]. It is also used to assess the degree of obesity as a BMI of less than 18 kg/m^2 is termed underweight,18.5-24.99 kg/m^2 termed normal weight, 25- 29.9 kg/m^2 termed pre obesity or overweight and over 30kg/m^2 is described as obesity.[22] Lower BMIs are said to be associated with smoking, alcohol consumption and low socio economic status whereas higher BMIs are associated with diabetes mellitus and hypertension.[8] Meta analytical studies by Stevens et al,[23] show the highest prevalence of obesity in Caucasians, Mediterraneans and some parts of Africa (North and central America, Latin America, the middle East and Southern sub Saharan Africa), with the lowest values in Asia and other parts of Africa (Southern and South East Asia, Eastern Sub Saharan Africa) and mid values in Western Sub Saharan Africa.

In a study by Chiu et al, [24] in Taiwan, elderly men were found to be taller and heavier than elderly women, but women were seen to have a higher mean value of BMI (Kg/m2). The prevalence of overweight was 27.3% in men and 34.9% in women, while the prevalence for obesity was 3.2% in men and 6.4% in females. Overall the Taiwanese were said to have lower BMI levels than those in Kuwait, Sweden United states and native America. This was said to have been due to nutritional differences between races. This was similar to results gotten by Desalu et al,[25] on 810 subjects in Ilorin where the prevalence of obesity was 9.8% and that for overweight was 35.1%. Of those found to be obese, 24% were male and 75.9% were female. Obesity was seen to be strongly associated with Female gender, age ≥ 40 years and socioeconomic status.

A review of literature carried out by John et al,[26]on Nigerians in different states of the country, noted that the prevalence of obesity was between 8.1%-22.2% and that for overweight between 20.3% and 35.1%. The prevalence of overweight and obesity were said to be higher in females and the also in the age ranges of above 60 years and 70 years for men and women respectively with the lowest prevalence in the age range of between 20-29 years. This is in agreement with outcomes of studies in other parts of the world the world.

Some studies have shown that the BMI of an individual might be related to the size of the ocular components and thus affect the refractive status of the individual; [5] some other studies have shown relationships between BMI, height and weight and the sizes of ocular components.[1,5]

Method

This is a multi-stage study with inclusion criteria of Visual Acuity > 6/18, age greater than 18 years with no history of past ocular surgeries or trauma. Data obtained through a structured interviewer based proforma included age, sex, tribe, occupation and level of education. Body Mass Index (BMI) was measured using a standard height and weight automated scale (SECA 769,220). Comprehensive ocular examinations done included visual acuity with Snellen's chart, intra ocular pressure with Perkin's applanation tonometer, and funduscopy with Welch Allen's ophthalmoscope and Anterior Chamber Depth (ACD) measured using Amplitude (A) scan ultrasonography (SONOMED PACSCAN 300AP). Data was analyzed using SPSS (Version 17), and p value was set at ≤ 0.05.

Results

Four hundred and sixty six (466) subjects from the general adult population were studied.

The Anterior Chamber Depth (ACD) and Body Mass Index (BMI) values in one randomly selected eye of the population studied were analysed.

The mean age of the subjects studied was 43.0±14.2 years with the age distribution between 18 and 91 years, and a peak age group of between 31 and 40 years as shown in Figure 1.

The mean age for males was 41.6 ±12.7 years and that for females 44.8+15.8 years.

There were two hundred and twelve (212) males (45.5%) two hundred and fifty four (254) females (54.5%) with male to female ratio of 1: 1.2.

The gender distribution for different ages is shown in Table 1. About one quarter of the males in the population studied, (n=54; 25.5% of total male population) were within 41 and 50 years and majority of the female population (n=83; 32.6% of female population) were within 31 and 40 years. There was a significant difference between both genders at different age groups (p= 0.01).

The mean ACD of the general adult population studied was 3.1 ±0.5mm (range 2.5 to 6.5mm). The mean ACD distribution in males was 3.2 ±0.3mm (2.5 to 4.0 mm) and in females 3.1 ±0.6 mm (2.5 to 6.5 mm). The mean difference between genders was 0.1±0.1 (95% C.I -0.02 to 0.1, t-value 1.4 and p= 0.172).

The mean distribution of ACD in different age groups between genders is shown in Figure 2.

The peak mean ACD in males was found among those within 61 and 70 years while in females was within 18 and 40 years.

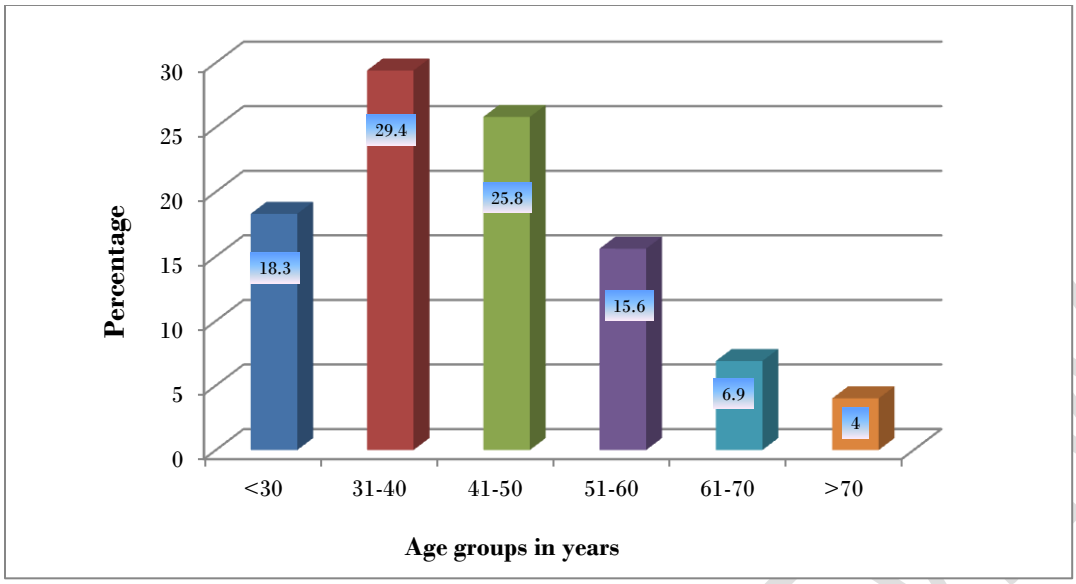
Figures 3 shows that a statistically significant negative relationship was found between age and ACD in the general population studied (r= -0.262, p= 0.0001) that for every increase in age by 1 year, ACD narrows by -0.005mm (C.I -0.007 to -0.003mm at a constant value of 3.339). This generates the hypothetical equation for ACD estimation from age as

ACD = 3.339 – 0.005 (age in years).

The relationship between age and ACD between gender was analysed and it showed that a strong negative relationship existed between age and ACD in both gender respectively ($p<0.05$). Among the male population a unit rise in age caused a decrease in ACD by -0.004mm (CI -0.007 to -0.002) while in the females a decrease in ACD value by -0.007mm (CI -0.01 to -0.005) was found.

Obesity was found to be higher in females (n=97; 78.2%) compared to the males among those with BMI >30Kg/m^2 and this was found to be statistically significant (p=0.0001). A larger proportion of subjects with normal BMI and overweight BMI 25-29.5 Kg/m^2 were males as shown in Table 2.

The distribution of ACD with BMI groups among different genders is shown in Table 3. There was a statistically significant difference in the ACD values between genders among those overweight (BMI 25- 29.5Kg/m^2) and the obese (BMI >30 Kg/m^2) as shown in Table 2. Although more females were noted to be obese, their mean ACD was found to be lower compared to the males.



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190 **Figure 1: Age distribution of study population**

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192 **Table 1: Gender distribution of different age groups**

Age groups / Gender	Male	Female	Total
	N (%)	N (%)	N (%)
<30 years	43(51.2)	41(48.8)	**84 (18.0)**
31 – 40 years	48 (36.6)	83 (63.4)	**131 (28.1)**
41 – 50years	54 (43.5)	70 (56.5)	**124 (26.6)**
51 – 60 years	38 (50.7)	37 (49.3)	**75 (16.1)**

61 – 70 years	14 (42.4)	19 (57.6)	**33 (7.1)**
>70 years	15 (78.9)	4(21.1)	**19 (4.1)**
Total	**212 (45.5)**	**254 (54.5)**	**466 (100.0)**

X^2 = 6.52, df=1, p-value 0.01

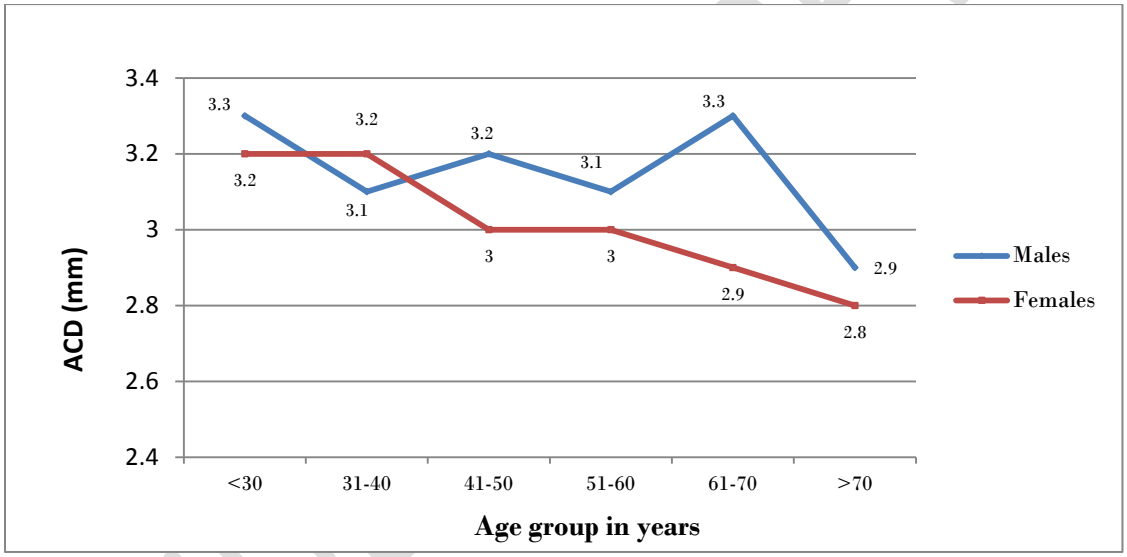
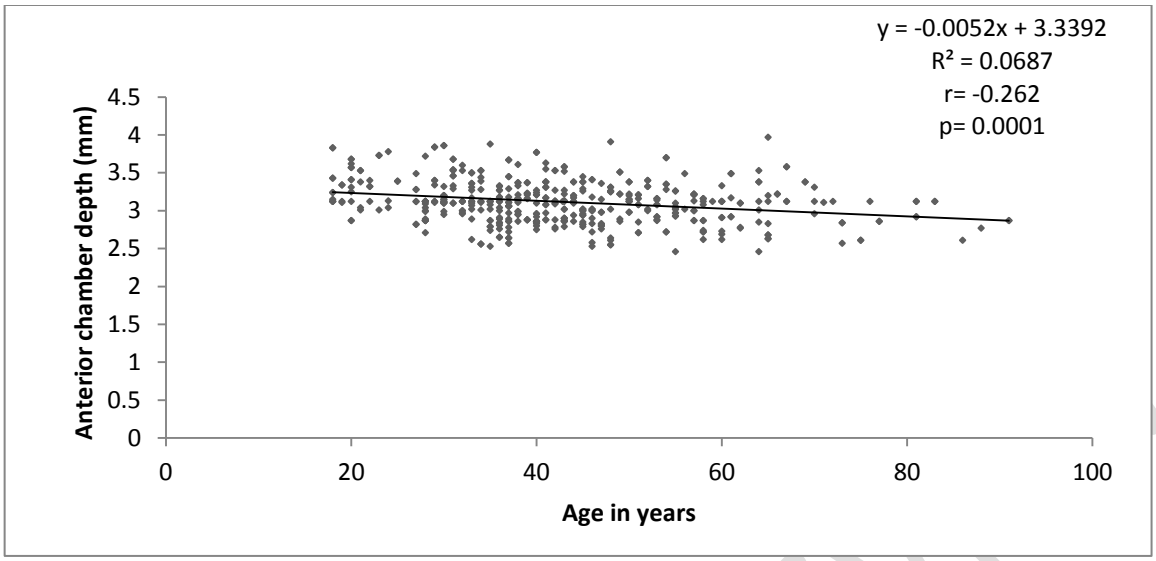


Figure 2: Mean ACD distribution between genders at different age groups



Bivariate linear regression

Figure 3: Relationship between Age and ACD in general population

Table 2: BMI distribution in different genders

BMI group	Male	Female	Total	X^2	p-value
	n (%)	n (%)	n (%)		
<18.5	12 (52.2)	11 (47.8)	23(4.9)	0.043	0.924
18.5 – 24.5	81 (54.7)	67(45.3)	148 (31.8)	1.321	0.249
25 – 29.5	92 (53.8)	79 (46.2)	171 (36.7)	0.99	0.320

≥30	27 (21.8)	97 (78.2)	124 (26.6)	39.52	0.0001
Total	**212 (45.5)**	**254 (54.4)**	**466 (100.0)**		

Chi-square test. df= 1

Table 3: Mean distribution of ACD with BMI group in different genders

		ACD			
BMI group		**Mean ±S.D**	**t- value**	**p-value**	
	N	Male	Female		
<18.5	23	3.4±0.3	3.2±0.3	**1.64**	0.116
18.5 – 24.5	148	3.1±0.3	3.1 ±0.3	0.150	0.881
25 – 29.5	171	3.1±0.2	3.0± 0.3	2.68	0.008

≥30	124	3.3 ±0.3	3.0 ±0.2	4.52	0.000
Total	**466**	**3.2 ±0.3**	**3.1 ±0.3**		

Independent t-test

Discussion

This study evaluates ocular anterior chamber depth (ACD) and body mass index (BMI) in a normal population in Port Harcourt City Local Government Area (LGA), with a view to determine formulae in estimating intraocular lens power for cataract surgeries and possible association with angle closure glaucoma and other ocular pathological conditions.

Most of the subjects studied were of Rivers ethnicity (n=184; 39.5%) which could be explained by the fact that the study was carried out in the communities that make up Port Harcourt city LGA. This was similar to the study carried out by Adio,[6] on 400 subjects in UPTH eye clinic where 56% of the subjects were from Rivers state. Most of the subjects were businessmen and women which may probably be due to the fact that Port Harcourt is largely a commercial city.

The mean anterior chamber depth in this study was 3.1±0.5mm (Fig 2) which was similar to that noted by Olurin et al,[51] (3.23mm) in Nigerians , the Blue mountain eye study (3.10mm) and the Central India Eye study,[18] (3.2mm) whilst being higher than the values noted by Fanny et al,[34]in Cameroonians (2.65mm). and that in the study on Iranians by Hashemi et al,[7](2.62mm). The difference in the mean anterior chamber depths in these populations may not have been unrelated to the smaller sample size in the Cameroonian study (n=325 eyes) and the fact that Iranians have been postulated to have a low ACD.[7] The lower mean ACD values amongst the Iranians may also be related to the fact that the Iranian study was carried out amongst those aged 40 to 70 years, this is in agreement with several studies,[20,27,74] and the index study that notes that ACD reduces with age.

The mean distribution of ACD in males (3.2mm) in this study was shown to be higher than that in females (3.1mm), although this difference was not statistically significant similar to the study by Elabjer et al,[32] where it was noted that there was no statistically significant difference of right eye ACD between both gender. This result differed from that noted by the EPIC-Norfolk study,[9] and the Los Angeles-Latino eye study,[50]and Reykjavik eye study where there was a statistically significant higher value of ACD for males as compared to females ($p<0.001$).

There was noted to be a strong negative relationship between ACD and age in this study in both gender ($p<0.05$), as an increase in age by one year caused a 0.004mm and 0.007mm decrease in ACD in females and males respectively. This was similar to results got by Hashemi et al,[7] where ACD was noted to decrease by 0.013mm per year of aging. This is also in agreement with the EPIC-Norfolk study,[9] the Reykjavik study,[33] and the study by Hosny et al,[27] where there was found to be statistically significant inverse relationships between ACD and age.

Obesity was found to be higher in females (n=97; 78.2%) compared to the males among those with BMI >30Kg/m^2 and this was found to be statistically significant ($p=0.0001$). A larger proportion of subjects with normal BMI and overweight BMI 25-29.5 Kg/m^2 were males as shown in Table 2.

The distribution of ACD with BMI groups among different genders is shown in Table 3. There was a statistically significant difference in the ACD values between genders among those overweight (BMI 25- 29.5Kg/m^2) and the obese (BMI >30 Kg/m^2) as shown in Table 2. Although more females were noted to be obese, their mean ACD was found to be lower compared to the males.

Conclusion

There was noted to be a strong negative relationship between ACD and age in this study in both gender. There was a statistically significant difference in the ACD values between genders among those overweight as shown by the BMI values.

References

1. Nangia V, Jonas JB, Matin A, Kulkarni M, Sinha A, Gupta R. Body height and ocular dimensions in the adult population in rural Central India. The Central India Eye and Medical Study. Graefes Arch Clin Exp Ophthalmol 2010;248:1657–1666.

2. Patel RP, Pandit RT. Comparison of Anterior Chamber Depth Measurements from the Galilei Dual Scheimpflug Analyzer with IOLMaster. J Ophthalmol 2012;2012:430249.

3. Jonas JB, Nangia V, Gupta R, Khare A, Sinha A, Agarwal S, et al. Anterior chamber depth and its associations with ocular and general parameters in adults. Clin Exp Ophthalmol 2012;40:550–556.

4. Duane P, Fellman R L SL. Gonioscopy. In: Duane's Ophthalmology on CD-ROM. Lipincotts Williams and Wilkins; 2006. page volume 3: chapter 44.

5. Foster PJ, Broadway DC, Hayat S, Luben R, Dalzell N, Bingham S, et al. Refractive error, axial length and anterior chamber depth of the eye in British adults: the EPIC-Norfolk Eye Study. Br J Ophthalmol 2010;94:827–830.

6. Hoffer KJ. Axial dimension of the human cataractous lens. Arch Ophthalmol 1993;111:914–918.

7. Axial length. Encycl. Ophthalmol.2013;Available from: http://www.springerreference.com/docs/html/chapterdbid/335541.html [assessed 22 Jul 2014]

8. Caulfield LE, West SK, Barrón Y, Cid-Ruzafa J. Anthropometric status and cataract: the Salisbury Eye Evaluation project. Am J Clin Nutr 1999;69:237–242.

9. Wong TY, Foster PJ, Johnson GJ, Klein BE, Seah SK. The relationship between ocular dimensions and refraction with adult stature: The Tanjong Pagar survey. Invest Ophthalmol Vis Sci 2001;42:1237–1242.

10. Momeni-Moghaddam H, Kundart J, Ehsani M, Abdeh-Kykha A. Body mass index and binocular vision skills. Saudi J Ophthalmol 2012;26:331–334.

11. Cheung N, Saw SM, Islam FMA, Rogers SL, Shankar A, de Haseth K, et al. BMI and retinal vascular caliber in children. Obes (Silver Spring) 2007;15:209–215.

12. Lin CP, Lin YS, Wu SC, Ko YS. Age- and gender-specific association between intraocular pressure and metabolic variables in a Taiwanese population. Eur J Intern Med 2012;23:76–82.

13. Comparison of IOL master and ultrasound biomicroscopy in anterior chamber depth measurement. Int J Ophthalmol 2009;2:352–354.

14. Wong T-Y, Liew G, Cheung N. Gonioscopy. In: Ophthalmology Examinations Review. Singapore: World Scientific Publishing Co. Pte.Ltd.; 2011. page 61–63.

15. Wong TY, Foster PJ, Ng TP, Tielsch JM, Johnson GJ, Seah SK. Variations in ocular biometry in an adult Chinese population in Singapore: The Tanjong Pagar survey. Invest Ophthalmol Vis Sci 2001;42:73–80.

16. Shufelt C, Fraser-Bell S, Ying-Lai M, Torres M, Varma R. Refractive error, ocular biometry, and lens opalescence in an adult population: the Los Angeles Latino Eye Study. Invest Ophthalmol Vis Sci 2005;46:4450–4460.

17. Olurin O. Anterior chamber depths of Nigerians. Ann Ophthalmol 1977;9:315–326.

18. Ashaye AO. The anterior chamber angles in Nigerians. Afr J Med Med Sci 2003;32:315–320.

19. Wang D, Huang G, He M, Wu L, Lin S. Comparison of anterior ocular segment biometry features and related factors among American Caucasians, American Chinese and mainland Chinese. Clin Exp Ophthalmol 2012;40:542–549.

20. Fotedar R, Wang JJ, Burlutsky G, Morgan IG, Rose K, Wong TY, et al. Distribution of axial length and ocular biometry measured using partial coherence laser interferometry (IOL Master) in an older white population. Ophthalmology 2010;117:417–423.

21. Elabjer BK, Petrinović-Doresić J, Durić M, Busić M, Elabjer E. Cross-sectional study of ocular optical components interactions in emmetropes. Coll Antropol 2007;31:743–749.

22. WHO. The International Classification of adult underweight, overweight and obesity according to BMI. 2011;Available from: http://pgblazer.com/2011/08/new-updated-who-classification-of-bmi.html[assessed Jun 23 2014]

23. Stevens GA, Singh GM, Lu Y, Danaei G, Lin JK, Finucane MM, et al. National, regional, and global trends in adult overweight and obesity prevalences. Popul Heal metr 2012;10:22.

24. Chiu HC, Chang HY, Mau LW, Lee TK, Liu HW. Height, weight, and body mass index of elderly persons in Taiwan. J Gerontol A Biol Sci Med Sci 2000;55:M684–690.

25. Desalu OO, Salami AK, Oluboyo PO OJ. Prevalence and Sociodemographic Determinants of Obesity Among Adults in an Urban Nigerian Population. Sahel Med J 2008;11:61–64.

26. John C, Ohagwu KA, Isa SE, Ogah OS. Prevalence of overweight and obesity in adult Nigerians – a systematic review. Diabetes, Metabollic Syndr Obes Targets Ther 2013;6:43–47.