Review Article

Effects of Anthropomorphic Measurements over Ocular Parameters

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1. Abstract

1.1 Purpose: To evaluate the correlation of anthropomorphic measurements (height, weight and body mass index) with ocular parameters.

1.2. Methods: The study included 155 subjects (155 eyes), age ranged from 18 to 27 years. All subjects underwent full ophthalmological examination in ophthalmology department of a tertiary care hospital including: 1. Measurement of spherical equivalent (SE) using Auto Refractometer. 2. Visual acuity using Snellen chart. 3. Anterior segment examination using slit lamp. 4. Intraocular pressure (IOP) measurement using Goldmann applanation tonometry. 5. Pentacam Scheimpflug images were used to measure Anterior Chamber Depth (ACD) and central corneal thickness. 6. IOL Master was usedto measure Axial Length (AL).

The anthropomorphic measurements body height and weight have been measuredusingawall-mountedmetricruleranddigitalfloorscale,respectively. Body Mass Index (BMI) was calculated as weight divided by square ofheight.

1.3. Results: Body height was significantly associated with higher body weight (r = 0.398, p = <0.001). Height correlated positively with axial length (r = 0.203, p = 0.011). Central corneal thickness, ACD, SE and IOP were not significantly associated with body height. Body weight was significantly associated with higher BMI (r = 0.941, p = <0.001). Body mass index and body weight were not significantly associated with all ocular parameters. Significant negative correlation was found between age and ACD (r = -0.307, p = <0.001). Also, significant positive correlation was found between AL andACD (r = 0.444, p =<0.001), as well as between CCT and IOP (r = 0.357, p = <0.001). Significant negative correlation was found between AL and SE (r = -0.608, p = <0.001), as well as between ACD and SE (r = 0.330, p = <0.001).

1.4. Conclusion: our results demonstrate a significant correlation between height and AL in this adult population. Furthermore, it affirms a negative correlation between AL and SE, and positive correlation between AL and ACD, as well as between CCT and IOP.

2. Keywords: Axial length; Anterior chamber depth; Body height; Body mass index; Central corneal thickness; Intraocular pressure; Spherical equivalent

3. Introduction

Anthropomorphism cover a variety of human body measurements, such as height, weight, and Body Mass Index (BMI), circumferences, skin fold thicknesses, lengths and breadths. Adult body measurements data are utilized toassess health status, disease hazards and body constitution changes that happen over the adult lifetime[1].Mean height is regularly peculiar within the group when populations share genetic and environmental factors. There are atypical height variation within populations such as dwarfism or gigantism, which are medical disorders caused by characteristic genes or endocrine problems[2]. BMI is a measure of weight adjusted for height, simple to calculate as weight in kilogram divided by the square of height in meters (kg/m2). Body mass index levels coordinate with body fat and with future health problems[3]. Study carried out in Central India revealed that body height and size of thee yes were associated with each other, where taller subjects had larger eyes with flatter corneas. An increase in body height per 10 cm was associated with an increase in anterior chamber depth by 1% and an increase in vitreous cavity length by1%. Subjects with a higher BMI had shorter eyes, flatter and thicker corneas. Taller subjects and subjects with a higher BMI were more hyperopic[4].The anterior chamber angle is opened and the ACD is normal as assessed by slit-lamp biomecroscopy and gonioscopy in open-angle glaucoma. The chamber angle is either occluded by≥15 degrees or the peripheral ACD is≤25% of corneal thickness in angle-closure glaucoma. The Beijing Eye Study that aimed to assess differences in anthropomorphic measures between POAG and PACG, they found that PACG was significantly associated with shorter body height, age, hyperopic refractive error, female gender and a shallower anterior chamber. But, it did not vary significantly in terms of body weight, BMI and optic discarea. The only parameter to retaina significant difference between the two glaucoma groups was ACD. Age, gender, body height, refractive error and level of education were no longer significantly associated with either of the two glaucoma groups[5].In our study, we were evaluating the relationship of anthropomorphic parameters including the height, weight and BMI with ocular parameters. The results may be helpful in inclusion of body parameters in the list of diagnostic variables and risk factors of some ocular diseases such as angle- closure glaucoma.

4. Subjects and Methods

The study included 155 subjects (155 eyes), age ranged from 18 to 27 years. All subjects underwent full ophthalmological examination in ophthalmology department of a tertiary care hospital including: 1. Measurement of spherical equivalent (SE) and Intraocular pressure (IOP) using Auto Refractometer (TRK-1P from Topcon) 2. Visual acuity using Snellen chart. 3. Anterior segment examination using slit lamp. 4. Pentacam Scheimp flug images were used to measure Anterior Chamber Depth (ACD) and central corneal thickness. 6. IOL Master was usedto measure Axial Length (AL).The anthropomorphic measurements body height (in meter) and weight (in kilogram) have beenmeasuredusingawall-mountedmetricruleranddigitalfloorscale,respectively. Body Mass Index (BMI) was calculated as weight divided by square of height (kilograms per square meter).The mean age was 20.63±1.529 yearsoldandtherangewasbetween18to27yearsold. Patients with cataract, glaucoma, anterior segment inflammation or any systemic diseases with ocular complications were excluded. The protocol of the study was explained to each participant at the time of recruitment and informedcon sent was obtained according to the Declaration of Helsinki.

5. Statistical Analysis

Statistical analysis was performed by using a commercially available statistical software package (SPSS for windows, version 22.0). Measurable data of the study was presented as mean ± standard deviation (SD). The association between clinical measurements was analyzed by Pearson’s sample correlation coefficient (r) test. All *p*-values were two-sided and were considered statistically significant when the values were less than 0.05.The mean age of subjects was 20.63±1.529 years. The mean body height was 1.59 ± 0.057 m (range, 1.45 to 1.76 m), and the mean body weight was 59.83±13.307 kg (range, 40 to 111.9 kg), resulting in a mean BMI of 23.97±4.859 kg/m^2(range, 16.023 to 42.638 kg/m^2). The mean spherical equivalent (SE) of refractive error was-1.076±1.862 diopters (range,-7.50 to+7.75 diopters) (**Table 1**).

A moderate but significant negative correlation was found between age and ACD (r = -0.307, *p*= <0.001) (**Figure 3-1**). Axial length, SE, CCT and IOP were not significantly associated with age (**Table 2**). Moderate significant positive correlation was found between body height and body weight (r = 0.398, *p*= <0.001). There was a positive weak correlation between body height and AL (r = 0.203, *p*= 0.011) (**Figure 3-2**). Central corneal thickness, IOP, ACD and SE were not significantly associated with body height (**Table 3**). Strong significant positive correlation was found between body weight and BMI (r = 0.941, *p*= <0.001). Body mass index and body weight were not significantly associated with all ocular parameters (**Table 4 & 5**).

A moderate but significant positive correlation was found between AL and ACD (r = 0.444, *p*= <0.001) (**Figure 3**), as well as between CCT and IOP (r = 0.357, *p*= <0.001) (**Figure 3-4**). A moderate but significant negative correlation was found between AL and SE (r = -0.608, *p*= <0.001) (**Figure 3-5**), as well as between ACD and SE (r = -0.330, *p* = <0.001) (**Figure 3-6**) (**Table 6**).

Table 1: Data of subjects

Parameters	Mean ± SD	Range
Age (years)	20.63 ± 1.529	18 - 27
Anthropomorphic measurements		
Height (m)	1.59 ± 0.057	1.45 – 1.76
Weight (kg)	59.83 ± 13.307	40 – 111.9
BMI (kg/m^2)	23.97 ± 4.859	16.023 – 42.638
Ocular measurements		
SE (D)	-1.076 ± 1.862	-7.50 – 7.75
IOP (mmHg)	18.87 ± 2.763	13 – 24
AL (mm)	23.75 ± 1.014	21.42 – 26.31
ACD (mm)	3.51 ± 0.325	2.46 – 4.35
CCT (μm)	555.54 ± 31.714	471 – 637

Table 2: Association (bivariate analysis) between age and ocular parameters

Parameters	SE	AL	ACD	CCT	IOP
Age correlation coefficient	0.004	0.014	-0.307	0.107	-0.148
p-value	0.959	0.863	<0.001*	0.187	0.066

*p-value statistically significant

Table 3: Association (bivariate analysis) between body height (measured in m) and clinical parameters
*p-value statistically significant

Parameters	Correlation coefficient	p-value
Body weight	0.398	<0.001*
Body mass index	0.07	0.387
Spherical equivalent	0.024	0.685
Intraocular pressure	-0.009	0.911
Axial length	0.203	0.011*
Anterior chamber depth	-0.02	0.806
Central corneal thickness	0.068	0.398

Table 4. Association (bivariate analysis) between body weight (measured in kg) and clinical parameters
*p-value statistically significant

Parameters	Correlation coefficient	p-value
Body height	0.398	<0.001*
Body mass index	0.941	<0.001*
Spherical equivalent	0.07	0.387
Intraocular pressure	0.109	0.177
Axial length	0.076	0.347
Anterior chamber depth	-0.037	0.649
Central corneal thickness	0.077	0.339

Table 5. Association (bivariate analysis) between BMI (measured in kg/m2) and clinical parameters * p-value statistically significant

Parameters	Correlation coefficient	p-value
Body height	0.07	0.387
Body weight	0.941	<0.001*
Spherical equivalent	0.074	0.357
Intraocular pressure	0.121	0.133
Axial length	0.006	0.938
Anterior chamber depth	-0.033	0.684
Central corneal thickness	0.062	0.44

Table 6. Association (bivariate analysis) between ocular parameters

Parameters	SE	AL	ACD	CCT	IOP
AL correlation coefficient	-0.608	1	0.444	0.150	-0.026
p-value	<0.001*		<0.001*	0.062	0.748
ACD correlation coefficient	-0.330	0.444	1	0.074	0.075
p-value	<0.001*	<0.001*		0.363	0.355
CCT correlation coefficient	-0.004	0.150	0.074	1	0.375
p-value	0.964	0.062	0.363		<0.001*
IOP correlation coefficient	0.026	-0.026	0.075	0.375	1
p-value	0.752	0.748	0.355	<0.001*	

Table 7: Different sample sizes, different ethnicity, age range and refractive error measurement techniques

Author	Population	N	Age	Method	Ocular parameters
Wong et al. (2001)	Singapore (Adults)	**951**	**40 – 81**	A-scan Ultrasound	AL* ACD* SE* CR*
Saw et al. (2002)	Singapore (Children)	**1449**	**7 – 9**	A-scan Ultrasound	AL* ACD* SE** CR*
Eysteinsson et al. (2005)	Iceland (Adults)	**832**	**55 – 100**	A-scan Ultrasound	AL* ACD SE CR*
Ojaimi et al. (2005)	Australia (Children)	**1765**	**6 – 13**	IOL Master	AL* ACD SE CR*
Xu et al. (2009)	China (Adults)	**3191**	**≥ 40**	Van Herick	ACD*
Nangia et al. (2010)	Central India (Adults)	**4711**	**30 – 74**	A-scan Ultrasound	AL* ACD* SE CR* CCT IOP
Xu et al. (2011)	China (Adults)	**3251**	**45 – 89**	-	ACD* CCT* SE IOP
Gunes et al. (2015)	Turkey (Adults)	**68**	**27 – 69**	LenStar	AL ACD* CCT IOP*
Current study	Saudi Arabia (Adults)	**155**	**18 – 27**	IOL Master	AL* ACD CCT SE IOP

*Significant correlation between ocular parameter and height
*Significant correlation between ocular parameter and BMI

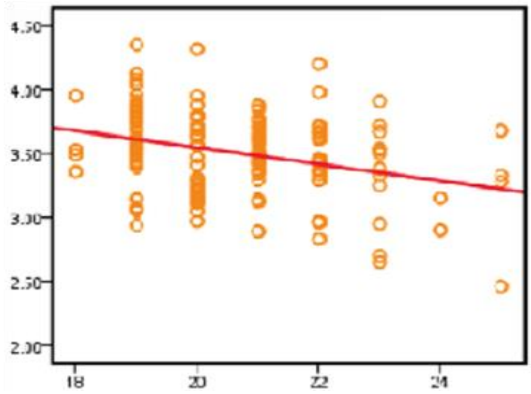

Figure 1: Scatter plot between ACD and Age.

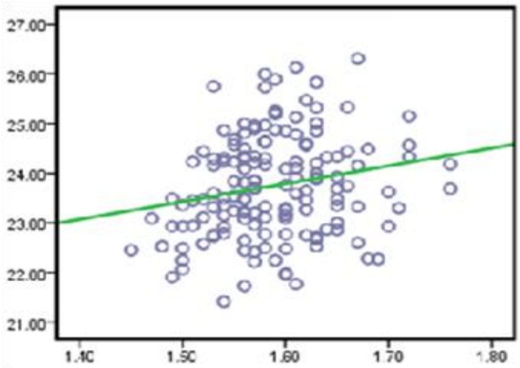

Figure 2: Scatter plot between AL and height measurements

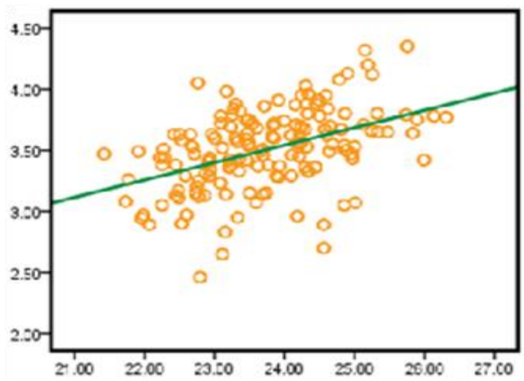

Figure 3: Scatter plot between ACD and AL measurements.

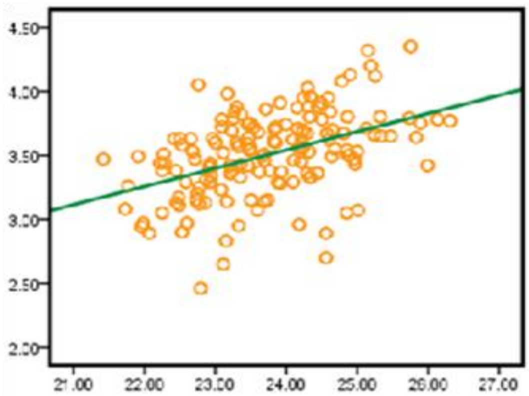

Figure 4: Scatter plot between IOP and CCT measurements.

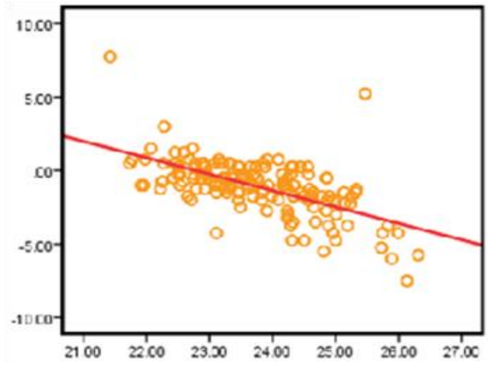

Figure 5: Scatter plot between SE and AL measurements.

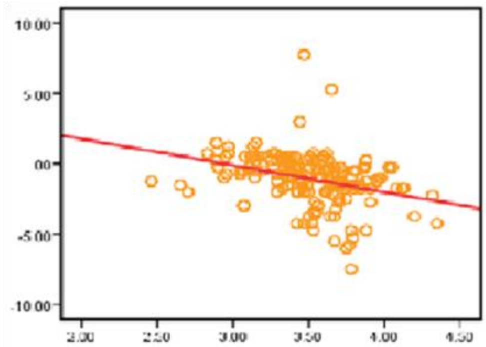

Figure 6: Scatter plot between SE and ACD measurements

6. Discussion

In this study, there was a positive correlation between body height and body weight (r = 0.398, *p*= <0.001). Also, there was a positive correlation between body height and AL (r = 0.203, *p*= 0.011). Central corneal thickness, IOP, ACD and SE were not significantly associated with body height. Body weight was significantly associated with higher BMI (r = 0.941, *p* = <0.001). Body mass index and body weight were not significantly associated with all ocular parameters. Age correlated negatively with ACD (r = -0.307, *p*= <0.001). Positive correlation was found between AL and ACD (r = 0.444, *p*= <0.001), as well as between CCT and IOP (r = 0.357, *p*= <0.001). A significant negative correlation was found between AL and SE (r = -0.608, *p*= <0.001), as well as between ACD and SE (r = 0.330, *p*= <0.001). **I**n Singapore Chinese adults aged 40 to 81 years, [3]found that adult height was related to ocular dimensions, but does not appear to influence refraction. Taller persons are more likely to has longer AL (r = 0.333, *p* = <0.001), deeper ACDs (r = 0.311, *p* = <0.001), thinner lenses (r = -0.242, *p* = <0.001) and flatter corneas (r = 0.301, *p* = <0.001). This study is consistent with the current study except for the correlation between height and ACD. On the other hand, they found that obese adults were mildly more hyperopic (r = 0.100, *p*<0.01), and this does not correspond to the current study. Similarly, taller Singapore Chinese children aged 7 to 9 years had longer ALs, thinner lenses, deeper ACDs, flatter corneas and more myopic refraction. However, obese children had refractions tend toward hyperopia [6]. The discrepancies between the results of the two studies could be due to different sample sizes, different ethnicity, age range and refractive error measurement techniques

(**Table 7**).

[7]Found that height was strongly related to AL (r = 0.252, *p*= <0.001) and corneal radius (CR) (r = 0.205, *p*= <0.001). However, there was no significant association between refraction and any of the measured anthropomorphic parameters in Australian children. Moreover, [8] found that height correlated positively with AL (*p*<0.01) and CR (*p*= <0.001). They found a significant negative correlation between AL and SE (r = -0.595, *p*<0.001), and between age and ACD (*p*= <0.001). Also, weight was unrelated to all ocular parameters. These findings are, to a great extent, consistent with the results of the current study.In the rural population of Central India aged 30 to 74, body height correlated positively with AL (*p*= 0.03) and ACD (*p*= 0.006), and negatively with CR (*p* = <0.001). Central corneal thickness (*p*= 0.44), IOP (*p*= 0.87) and SE (*p*= 0.28) were not significantly associated with body height. The BMI, when compared with body height, had a markedly lower influence on all ocular parameters [4]. This study is also consistent with the current study except for the correlation between height and ACD[5]. Suggested that taller Chinese adults had deeper peripheral ACD (*p* = <0.001) using van Herick's method.Weight and BMI were not significantly associated with peripheral ACD (*p*= 0.97) (*p* = 0.82), respectively. It confirms a recent report from the Beijing Eye Study, in which body height was significantly associated with ACD (*p* = <0.001) and CCT (*p*= <0.001). However, it was not associated with IOP (*p* = 0.99) and SE (*p* = 0.40) [5]. These studies are consistent with the current study except for the correlation between height and ACD. There was a positive correlation between BMI and IOP (r = 0.404, p < 0.001). ACD was negatively correlated with BMI. However, BMI was not associated with AL and CCT [11]. This study is inconsistent with the current study due to difference in mean BMI (30.60 kg/m^{2}vs. 23.97 kg/m^2).The limitation of the current study is that the studied subjects were females only, so it cannot provide information about the effect of anthropomorphic measurements on ocular parameters of males. In contrast to some previous population based studies, the strength of the current study is the inclusion of relatively young subjects with an average age of 20.63 ± 1.5 years modifying the ACD.

7. Conclusion and Recommendations

In conclusion, AL was significantly longer in taller subjects. Central corneal thickness, IOP, ACD and SE were not significantly associated with body height. Weight and BMI were not associated with all ocular parameters. All previous studies found a significant correlation between anthropomorphic measurements and ocular parameters due to their large sample size. These previous results help the optometrists in screening purpose. On the other hand, current study was evaluating small sample size helping in the assessment of risk factors, diagnosis and treatment of some ocular diseases. A further longitudinal study over large sample Saudi population is recommended to be performed.

8. Author Disclosure Statement

The authors declare no potential conflicts of interest with respect to the authorship, and/or publication of this article.

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