Original article

Ophthalmic Anthropometry among Rural Dwellers in Mashonaland Central Province, Zimbabwe

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Abstract

Introduction

The measures of ophthalmic anthropometric parameters may vary among races and ethnic groups but are of immense importance in clinical diagnosis and management of oculo-visual defects. There is paucity of data on these measures among the Zimbabwean population.

Purpose

The aim was to determine ophthalmic anthropometric parameters among rural dwellers in Zimbabwe.

Methods

Six ophthalmic anthropometric parameters including interpupillary distance (IPD), head width (HW), temple width (TW), length to bend (LTB), and apical radius were measured using a pupillometer, PD rule, Head width calipers, Fairbank facial gauge, and ABDO frame rule.

Results

A total of 471 participants aged 18 to 100 years (mean age = 55.13; SD± 17.33 years). Of the 471 participants, 206 (43.7%) were males and 265 (56.3%) were females. A mean interpupillary distance at far was 65.57 ± 4.80 mm, mean temple width of 12.49 ± 1.53 cm, mean head width of 13.61 ± 1.39 cm and a side length to bend of 10.24 ± 1.20 cm and the apical radius was 9.94 ± 1.37.

There was a significant (P < 0.05) difference between the ophthalmic anthropometric parameters of males and females except for temple width and apical radius.

Conclusion

A narrower interpupillary distance but a wider temple width was observed among adult Zimbabweans. A significant difference in ophthalmic anthropometric parameters between males and females were observed except for temple width and apical radius. This should inform eyewear manufacturers and importers of frames on the facial and ocular parameters of Zimbabweans to improve the aesthetics and ensure a comfortable vision for wearers of already-made near vision spectacles for presbyopes.

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Keywords: temple width, head width, interpupillary distance, ophthalmic anthropometry, Zimbabwe

Introduction

Anthropometry refers to the science of measurement of living subjects.[1] Anthropometric measurements are useful in major disciplines such as optometry and ophthalmology, psychology, public health, computer vision, and forensics sciences.[2–5] The measures of ophthalmic anthropometric parameters involve ocular and facial variables which may vary among races and ethnic groups but are of immense importance in clinical diagnosis and management of oculo-visual defects.[6] Anthropometry in the ophthalmic practice provides the necessary points of reference for surgical interventions, the construction of optical frames and other devices.[7] In the manufacturing of optical frames, measurements such as interpupillary distance, head width, temple width, length to bend, and apical radius are paramount.[8] Knowledge of these measures are essential for the appropriate order of already made spectacles and frames designs.[8] A normative data serves as a useful guide to inform practitioners and industrialists about the variations within the population and how they compare with other populations.

Researchers have reported of variations in ophthalmic anthropometry among various races and populations such as Africans,[7]

Caucasians,[9] Indians,[10] Brazilian,[11] Iranian,[12] and Chinese.[13] The measures of ophthalmic anthropometric parameters are of immense importance in clinical diagnosis and management of oculo-visual defects.[7,8] There is paucity of data on these measures among a Zimbabwean population. In a study to determine the ophthalmic anthropometric data among an urban Malawian population, there was reported variations among Malawians and other West African countries.[7] Hence, it has been recommended that considerations for the design of eyewear, as well as reconstructive surgeries, should be grounded on evidence-based empiricism.[7]

It is against this backdrop that this study sought to assess the normative ophthalmic anthropometric data for adult Zimbabweans to inform evidence-based practice. The high prevalence (54.2%) of visual impairment due to uncorrected refractive error has necessitated the urgent need for evidence-based anthropometric data for the adult population in Zimbabwe to inform holistic optical intervention.[14] This has the tendency to improve compliance to spectacle wear and its acceptability as it serves as the mainstay intervention for vision correction.

Materials and Methods

Study setting

The Republic of Zimbabwe is broken down into 10 administrative provinces, which are divided into 59 districts. The study was conducted in four communities within three Districts namely, Mushumbi-Mbire, Kamutsenzere, Mukumbura and Muzarabani of Mashonaland Central province in Zimbabwe. These districts are among the 8 designated rural districts of Mashonaland Central province (total of 10 of which 2 are urban) and are predominantly inhabited by the Shona ethnic group. A previous study which randomly selected these districts for a refractive error and visual impairment studies, involved the distribution of already-made spectacles for free to the inhabitants who were diagnosed of refractive errors. [14] This study setting was therefore chosen to determine the ophthalmic anthropometric features relevant for optimal visual performance.

Study design

This was a population-based cross-sectional study. The study involved measurement and collation of ophthalmic anthropometric data of participants. This study was among natives of Mushumbi-Mbire, Kamutsenzere, Mukumbura and Muzarabani of Mashonaland Central province, Zimbabwe. The

interpupillary distance (IPD), head width (HW), temple width (TW), length to bend (LTB), and apical radius. The study was undertaken between September and December, 2019.

Sampling techniques and size calculation

A random sampling method was used to select 3 districts (Mt. Darwin district, Muzarabani district and Mbire district) from the 10 districts in the Mashonaland Central province using the lottery method. Within these 3 districts, 4 communities i.e. Kamustenzere, Mukumbura, Mushumbi, and Muzarabani were randomly selected. This technique resulted in the selection of 2 communities in the Mt. Darwin district and one each from Mbire and Muzarabani districts. The sample frame (total population size for the 4 communities i.e. 53,344) was obtained from the 2012 national census figures.[15] The minimum sample size was determined from the sample frame and proportionately assigned to each community per population size. Using Slovin's formula (n = N/(1 + N(e)^2), [16] we got a sample of 399.

Where: n = number of samples; N = total population; e = error margin / margin of error

The required samples were selected from each of the 4 communities by first spinning a bottle at a central location or center of the community and the direction the bottle faced was followed. Every other household along this direction in the community is selected and all household members 18 years and older were invited to the community health center, after giving their consent to participate in the study, for a comprehensive eye examination and measurement of ocular anthropometric variables. Households were examined until the required number of participants in a given community was exhausted. The team then moves to the next selected community to repeat the same procedure.

Data collection procedure

Data collection involved the use of a data extraction sheet to collect data on demographics, and facial measures. The measurements were taken by a single ophthalmic technician with over ten years of practice experience. The others were optometrists who were involved in the comprehensive eye examinations of the participants.

The data extracted included

1. A digital pupillometer (Sussex Vision International, West Sussex, UK) was used to measure interpupillary distance at distance (DIPD).

2. The Temple width calipers (Sussex Vision International, West Sussex, UK) were used to measure the Temple width and Head width.
3. The Rees-Fairbank facial gauge (Sussex Vision International, West Sussex, UK) was used to take measures of apical radius, and side length to bend. Each parameter was taken in triplicate and a mean computed.

Inclusion and exclusion criteria

The study included all natives who had no ocular history of strabismus, and craniofacial anomalies during the study period and were 18 years and older. This is because participants with strabismus and craniofacial anomalies present with an artificially high or low measurements.(8]

Data analysis

Data were analyzed using the IBM SPSS version 21 (SPSS Inc, Chicago, USA). Descriptive statistics were computed for all variables after the data have been screened and normality tests carried out. Independent sample t-test was used to determine whether the mean differences observed between variables were statistically significant at an alpha level (p) of 0.05. Levene's test for equality was used to determine any difference in gender and anthropometric variables.

Ethical consideration

The study adhered to the tenets of the Declaration of Helsinki and approval was sought from the Research Ethics Committee of the Bindura University of Science Education (BUSE) Research and Postgraduate Center with reference number RBGA/01/19. Both written and oral informed consent of the participants was obtained. There were no risks and/or discomfort associated with participating in the study, and no financial remunerations were offered to the participants. To participate in this study was voluntary and participants were informed that they could withdraw their participation at any point and that in the event of refusal/withdrawal of participation, they would not incur penalty or loss of treatment or other benefits to which they would normally be entitled.

Results

Demographics of participants

A total of 471 participants within four communities were involved in this study. Their ages ranged from 18 to 100 years (mean age = 55.13; SD± 17.33 years). Of the 471 participants, 206 (43.7%) were males and 265 (56.3%) were females Table1.

Table 1. Distribution of age and gender

Demographics		Frequency	Percentage (%)
Age group (in years)	Young adults (18 to 35)	63	13.4
	Middle age (36 to 59)	213	45.2
	Elderly (> 60)	195	41.4
Sex	Male	206	43.7
	Female	265	56.3
Total		471	100

Means of ophthalmic anthropometric parameters

The mean distance interpupillary distance was 65.57 ± 4.80 mm, the apical radius was 9.94 ± 1.37 mm, mean of temple width was 12.49 ± 1.53 cm, head width had a mean value of 13.61 ± 1.39 cm, bridge projection was 0.64 ± 0.48 cm, and length of side was 10.24 ± 1.20 cm as shown in Table 2.

Table 2. Distribution of ophthalmic anthropometric parameters

	Variables		PDOU	APICAL RADIUS	TEMPLE WIDTH	HEAD WIDTH	BRIDGE	LENGTH OF SIDE
Age	**Young adults (18 - 35)**	Mean	66.62	9.95	13.05	13.98	0.44	10.14
		N	63	63	63	63	63	63
		Std. D	3.90	1.16	0.92	0.92	0.50	1.06
	Middle age (36 – 59)	Mean	65.91	9.87	12.71	13.81	0.60	10.23
		N	213	213	213	213	213	213
		Std. D	5.25	1.34	1.30	0.91	0.49	1.07
	Elderly (> 60)	Mean	64.82	10.02	12.07	13.26	0.77	10.28
		N	195	195	195	195	195	195
		Std. D	4.40	1.47	1.79	1.82	0.42	1.37
Sex	**Females**	Mean	64.98	9.98	12.37	13.47	0.61	9.97
		N	265	265	265	265	265	265
		Std. D	4.27	1.41	1.47	1.47	0.49	1.18
	Males	Mean	66.36	9.89	12.63	13.79	0.70	10.59
		N	206	206	206	206	206	206
		Std. D	5.32	1.32	1.59	1.24	0.46	1.13

PDOU-distance interpupillary distance in both eyes; Bridge =-Bridge projection -

Comparison of anthropometric measures between males and females

A Levene's Test for equality of variances and independent T-test to determine ophthalmic anthropometric parameters among male and female participants were employed in this study. There was a significant difference between the mean ophthalmic anthropometric parameters among males and females except for temple width and apical radius with *P*-value < 0.05 as shown in Table 3.

Table 3. Comparison of mean anthropometric measures between males and females

Variables	Means		F	Sig.	T	Sig. (2-tailed)
PDOU	Males = 66.36	Equal variances assumed	6.39	0.01	-3.09	0.00
	Females = 64.98	Equal variances not assumed			-3.00	0.00
Apical radius	Males = 9.89	Equal variances assumed	2.29	0.13	0.69	0.49
	Females = 9.98	Equal variances not assumed			0.70	0.48
Temple width	Males = 12.63	Equal variances assumed	0.05	0.83	-1.86	0.06
	Females = 12.37	Equal variances not assumed			-1.84	0.07
Head width	Males = 13.79	Equal variances assumed	0.03	0.87	-2.44	0.02
	Females = 13.47	Equal variances not assumed			-2.49	0.01
Bridge projection	Males = 0.70	Equal variances assumed	19.20	0.00	-2.17	0.03
	Females = 0.61	Equal variances not assumed			-2.19	0.03
Length of side	Males = 10.59	Equal variances assumed	0.13	0.72	-5.73	0.00
	Females = 9.97	Equal variances not assumed			-5.76	0.00

Discussion

Of great importance to prevent antipathy to the spectacle wear both in adults and children is the need to measure accurately facial parameters which are relevant for spectacle fit among these age groups.[9] The number of participants in this study was consistent with other studies in Africa which reported 304 in Malawi and 500 in Nigeria.[7,17] This

current study involved adults with an age range different from the study in Malawi,[7] which reported an age range of 6-25, and Mozambique [18] with a range of 17-26. This study involved only adults since children tend to have smaller ophthalmic anthropometry parameters compared to adults and including them in this study might have resulted in smaller average measures. However, a similar research in children is imperative to fully appreciate the trend. To the best of our knowledge, this is the first data on ophthalmic anthropometry among Zimbabweans and data can be compared only to that of other African countries and the rest of the world.

The mean interpupillary distance (IPD) was almost the same as reported in Malawi (65.5 ± 4.5 mm),[7] but slightly less than the reported 68 mm among Mozambicans.[18] However, studies in other parts of Africa have reported wider IPD in countries such as Nigeria and Ghana than reported in this study.[17,19] This might have resulted from the type of measuring instrument used such as pupillometer or millimeter rule, racial variations as well as ethnicity.[17,19] The mean interpupillary distance for distance was wider in males than females as there was a statistically significant difference between the mean value for males and females. Similar studies have reported a wider IPD among males than females which is consistent with this study.[7,20–24] This can be attributed to larger craniofacial skeletons among males of African descent.[25–27]

The temple width recorded in this study is consistent with a similar study in Malawi (12.1 cm).[7] In contrast, a narrower temple width has been reported in Ghana while a wider temple width of 1cm has been reported among Hong Kong Chinese adults.[19,23] The mean temple width was wider among males than females but there was no statistically significant difference between the means for both sexes. This was not consistent with similar studies on ophthalmic anthropometry [7,19,23] which reported that males had a wider temple width than females. The reason for the difference from this current study could not be determined.

A difference of more than approximately 10 mm (1cm) was observed between head width and temple width which is consistent with a similar study in Malawi.[7] However, a study in Hong Kong reported of over 30 mm difference in the two parameters.[23] This can be attributed to racial variations. Also, persons of Asian descent have wider angles and curved temples than Africans which may account for the

variation.[7] It is important to measure the head width in ophthalmic dispensing since a tight head width will result in pressure to the sides of the head resulting in a gradual movement of the frame forwards. Knowledge of these parameters are useful in aiding manufacturers in the design of spectacles for specific populations.

The side length to bend distance was consistent with the studies in Malawi [7] and Hong Kong.[23] There is no significant difference in ear dimensions of Caucasians,[25] compared to other ethnic groups and this parameter plays an integral role in the design of side length to bend distance of an optical frame. It can be concluded that there is no geographical and racial variation in the distribution of side length to bend distance among the general population. The side length to bend plays an integral part in frame selection for adults and children but this parameter can be adjusted through heating and re-bending method by an optician if the temple of the frame is made of plastic material other than a metal temple.

Conclusion

The ophthalmic anthropometric measures of adult Zimbabweans vary significantly from that of Asian, Caucasians and West African populations but comparable to fellow Southern African countries such as Malawi and Mozambique. This should inform eyewear manufacturers and importers of frames on the facial and ocular parameters of Zimbabweans to improve the aesthetics and ensure a comfortable vision for wearers of already-made near vision spectacles for presbyopes. Non-governmental organizations (NGOs) and other philanthropic groups in eye care are to be guided by this data in the selection and sorting of already made eyewear for eye care missions across Africa.

Conflict of interest

All authors declare that they do not have any conflicts of interest.

Authors' contribution

Author SK conceived the idea and designed the study, and SK, ST, and MAK wrote the protocol, managed the literature searches, collected data and wrote the first draft of the manuscript. Authors MAK, and EA managed the analysis of the study and interpretation of data and critically revised the content. All authors read and approved the final manuscript.

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