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Central Corneal Thickness Measurement in Sub-Saharan Africa: Review

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Abstract: *The aim of this study is to evaluate the central corneal thickness (CCT) for non-glaucomatous and glaucomatous subjects in Sub-Saharan Africans (SSA).*

This is a review of literature for corneal thickness measurement in Sub-Saharan Africa. We conducted an electronic search from the following databases: Pubmed, Google, Embase websites for the articles of original studies on central corneal thickness conducted in Africa.

1637 non-glaucomatous patients had drawn from 5 SSA countries (South Africa, Nigeria, Ghana, Cameroon, Ethiopia) and 705 glaucomatous patients from 5 SSA countries (Ghana, Uganda, Nigeria, Ethiopia, Ivory Coast). The patient's ages were range of 5 to 90 years for non-glaucomatous and 7 to 90 years for glaucomatous patients. The outcome of the central corneal thickness (CCT) was ranged of 440µm - 670µm and its mean value varied from 512 µm to 550 µm for non glaucomatous subjects. The thicker and thinner mean values were found in Nigeria and South Africa respectively. The type of glaucoma founded was primary open-angle glaucoma (POAG), pseudoexfoliation glaucoma (PEX), and the mean IOP was range of 11.55mmHg to 32.72mmHg. The mean value of CCT for glaucomatous subjects varied from 508.07µm - 538µm. The thicker and thinner mean values were found in Nigeria and Ethiopia respectively.

The CCT is naturally thin for the SSA, it is for non-glaucomatous such as glaucomatous subjects, but it is thicker for younger than older age. This finding is comparable to the North African people, African Americans and Afro-Caribbeans but for African Americans and Afro-Caribbeans is always included in the normal value.

Key words: *central corneal thickness – glaucoma - Sub-Saharan Africa*

I. Introduction

Although the measurement of intraocular pressure (IOP) with Goldmann applanation tonometer GAT may be less prone to biomechanical influences than Schiotz tonometry, it is known to be affected by corneal biomechanical factors such as corneal curvature, central corneal thickness (CCT)[1], hydration, elasticity, hysteresis, and rigidity[2,3].

The CCT is supposed to influence the IOP measured through the cornea [4] with an overestimation of IOP in thicker corneas and an underestimation in thinner corneas. Correction of the IOP based on the CCT what were corrected by using the linear correction formula [1,5,6,7]:

$$\text{Corrected IOP} = \frac{\text{Measured IOP - (CCT – Reference CCT)*2.5}}{50}$$

And thus the CCT is taken into consideration in decision-making for glaucoma patients [8].

For every 30 mm difference in CCT from the mean in either way, there was an approximately 1.1mm Hg difference in the estimated IOP from the mean IOP (13.40mm Hg) [9].

A rise in CCT by 100 µm was followed by an increase in IOP of about 2.8 mmHg for both eyes taken together[10].

A variety of instruments are available for measuring the corneal thickness, and although ultrasound pachymeters are considered the gold standard [11,12], some others, such as Orbscan (Technolas Perfect Vision GmbH), Pentacam (Oculus Inc.), PARK (Oculus Inc.), Visante (Carl Zeiss Meditec), have the advantage of performing noncontact measurements, and they are more convenient to use in most situations [13], beside all that, Specular microscopy, confocal microscopy, ultrasound biomicroscopy (UBM), slit-scanning corneal

topography, the Scheimpflug system, optical biometry, and spectral optical coherence tomography (SOCT) [14], Visante™ anterior segment optical coherence tomography (Visante OCT) [15], CS4 [16], ultrasound biomicroscopy (UBM) [17], and SP-2000P are also available [18].

However, the rotating Scheimpflug camera (Pentacam, Oculus, Inc., Wetzlar, Germany) is considered to be one of the most reliable devices that measures CCT values comparable to ultrasound corneal pachymetry instruments [19,20,21].

The results of the study conducted by Aghaian E et al indicate that CCT vary among Asian subpopulations; Japanese have thinner corneas than Chinese and Filipinos. Caucasians, Chinese, Hispanics, and Filipinos have comparable CCT measurements, whereas the corneas of African Americans are significantly thinner than that of all races. Additionally, older individuals; glaucoma suspects; and participants with normal tension glaucoma (NTG), primary open-angle glaucoma (POAG), pseudoexfoliation glaucoma (PEX), and chronic angle-closure glaucoma (CACG) have thinner corneas. Ocular hypertensives, however, have thicker corneas.[22]

View result CCT is different along ethnic and thinner of CCT among African-American, we have an objective to evaluate the CCT for non-glaucomatous and glaucomatous subjects in Sub-Saharan Africans (SSA).

II. CCT for non glaucomatous subjects

1637 non-glaucomatous patients drawn from 5 sub-Saharan countries (South Africa, Nigeria, Ghana, Cameroon, Ethiopia) were assessed after collection of the articles from Pubmed database, Google, Embase [9,10,23,24,25,26,27,28,29,30]

The largest cluster of average CCT for non-glaucomatous African subjects was between 512.4 and 550 µm.

There was only one study lead in Cameroon showed the thinnest and the thickest average of CCT for non glaucomatous subjects, ranged of 440µm - 670µm respectively.

Study characteristics are summarized in **Table 1**.

Detry-Morel M considered IOP values < 21 mmHg and CCT values ranging from 527 to 560 µm as normal. Corneas with a central thickness value below 527 µm were considered as thin and those with a central thickness value above 560 µm were considered as thick corneas [31].

According to this finding, the CCT for non-glaucomatous in SSA people is widely thin for the minimum average such as the maximum average, except for the value found in black Cameroonian children showed that the maximum value of CCT was 670µm [23]. Perhaps this maximum value for children (maximum value) is just confirmation of some constatation, showed the CCT was thinner for older than for younger age. It was found of many studies led in SSA [9,10,24,25,26,27] such as elsewhere[6,32,33]. And that study showed no statistically significant difference in CCT between the age groups [23].

This finding is comparable to the North African people. Study conducted in Egypt for non-glaucomatous subjects showed the average CCT was 530.06 ± 38.03 µm. It was found to be lower in Egyptians than in Caucasian, Hispanic, and Japanese populations but comparable to African and African American populations [34]. Among Sudanese non-glaucomatous population, mean CCT was 530.15 ± 58.10 µm [35].

Compare to the African American, their mean CCT is almost the same value as those in SSA for the minimum average such as the maximum average, as of the conclusion of the some of the writing, showed the African American people has thin corneal thickness compare to another people. For example, Rodrigo J. Torres et al founded average American Indians/Alaskan Natives (AI/AN) CCT was found to be thicker than that of African Americans (528.5 ± 33.2 µm) but similar to that of White persons (551.9 ±28.3 µm) [36]. African Americans were found to have thinner central cornea thickness measurements (right eye, 531.0 ± 36.3 µm; left eye, 530.0 ± 34.6µm) than Caucasians (557.6 ± 34.5 µm). This finding in African Americans may lead to lower applanation intraocular pressure readings compared with those of Caucasians, potentially resulting in an underestimation of the actual level of intraocular pressure [37]. And for the Barbados Eye Study Group shows, black participants tended to have thinner corneas (mean thickness, 529.8 µm) than mixed (black and white) (537.8 µm) and white participants (545.2 µm), respectively[33]. But for them, the average CCT is always included between normal values (527 to 560 µm).

The most of the studies led elsewhere showed the average CCT within this normal value, except the thin CCT founded for normal Japanese population led by Suzuki S et al, the average CCT was 517.5±29.8µm [38] and in New York, the mean CCT measurement for healthy corneas was 506±29.5µm (range, 454 to 574 µm) [39].

The thick CCT for examined eyes in Poland. The mean CCT was 563.0 ± 38.1µm [6]. A study conducted for Malay ethnicity living in Singapore showed CCT was normally distributed with a mean of 541.2 µm in the right eye[40]. In Latinos, the mean CCT was 546.9 ± 33.5 µm [32].

CCT of Chinese (555.6 µm), Caucasian (550.4 µm), Filipino (550.6 µm), and Hispanic (548.1 µm) participants did not significantly differ. The CCT of Japanese participants (531.7 µm) was significantly less than

that of Caucasians, Chinese, Filipinos, and Hispanics (all, $P \leq 0.001$) and greater than that of African Americans ($P = 0.03$). African Americans had a CCT (521.0 µm) less than that of all races ($P \leq 0.05$) [41].

There is a diversification of the results found for the CCT for among non-glaucoma participants.

For the age and gender of the participant, a study conducted for Malay ethnicity living in Singapore showed CCT was while controlling for age and gender [40]. It was greater in AI/AN females than in AI/AN males (557.6 ±33.3 µm vs 550.1 ± 34.5 µm; *P*=.03) [36].

The CCT in normal Japanese persons has found that men had greater CCT measurements than women [38]. But, there was no statistically significant difference in CCT between men and women for the subjects in Poland and in Sudan [6,35]. Saw all of these results, the same finding was also found in SSA that is in South Africa [28], Nigeria [24,25] respectively.

A positive, but inconsistent association between CCT and IOP was found in South Africa[28], IOP is significantly affected by CCT in Ethiopia and Nigeria[9,29], CCT was negatively correlated with age in Cameroon [10], and there was no significant association between CCT and IOP in Nigeria [26]. Elsewhere, there was a strong correlation between CCT and IOP among the non-glaucomatous population. There is an increase in CCT with increased IOP [32,34,35,38,40].

Table 1. Summary of studies of central corneal thickness for non-glaucomatous subjects

First author, area, year	Study population	Study design and methodology	Interventions	Outcomes
Z Sardiwalla, South Africa, 2012 [28]	100 patients, 18-25 years Non glaucomatous		CCT was measured with the non-contact Nidek NT530P Tonopachy™ IOP readings were taken with the GAT	CCT(µm) = 442-642 (mean=512.4) IOP (mmHg)= 9-21 (mean=13.8) Males=CCT= 442-642 (mean=513.2); IOP= 10-21 (mean=14.0) Female= CCT= 443-583 (mean=511.6) IOP= 9-21 (mean13.6)
O. E. Babalola, Nigeria, 2009 [29]	88 patients (174 eyes) Non glaucomatous		CCT was measured using the PacScan 300AP (Sonomed, Lake Success, NY, USA) ultrasonic pachymeter. IOP was measured, first by GAT and then by NCT	average CCT was 537.9 µm GAT IOP = 8 - 44 (mean=17.42)
Christine T. Ntim-Amponsah, Ghana, 2012 [30]	253 patients 112 men and 141 women Age: 21-90 years, mean age of 58 years Non glaucomatous	A case–control study	CCT was measured by a research assistant with ultrasonic pachymetry (model DGH 55 pachmate).	The CCT= 530.00 µm. Mean CCT= 531.06 µm.
André Omgbwa Eballe, Cameroon, 2010 [23]	102 children (204 eyes) Age= 5–16 years Normal IOP patients	A prospective, observational, consecutive case series	CCT measured by a hand-held ultrasonic pachymeter (Quantel Medical Inc, Clermont-Ferrand France, Model Pocket, Class II) Three measurements of intraocular pressure were also taken using a NCT.	The average CCT for both eyes was 538.06 ± 38.03 µm. Average CCT was 541.41 ± 36.45 µm in boys and 536.15 ± 38.91 µm in girls, with no statistically significant difference between the two groups. There was also no statistically significant difference in CCT between the age groups, comprising Group 1 (5–7 years), Group 2 (8–10 years), Group 3 (11–13 years), and Group 4 (14–16 years). CCT was lower in black children than in

				Caucasian, Hispanic, and Japanese children. Nevertheless, our average CCT values were within the standard range, varying between 527 and 560 μm.
Eghosasere Iyamu, Nigeria, 2013 [24]	95 subjects Age: 20-69 years, with mean age 44.9±15.2 years Non glaucomatous	observational, prospective, cross-sectional study	IOP assessed by Easy-Eye NCT [Keeler Instruments Inc., USA]). The central corneal thickness was measured by ultrasound pachymetry using SW-1000P ultrasound Pachymeter	The mean CCT= 547.0±29.5μm The differences in mean CCT of 19.6 μm (between age groups 20-39 and 50-59 years), 20.9 μm (between age groups 20-39 and 60-69 years) were statistically significant ($p < 0.05$). However, the mean differences of 11.6 μm (between 40-49 and 50-59 years) and 12.9μm (between 40-49 and 60-69 years) were not statistically significant ($p > 0.05$). The least difference in mean CCT of 1.2 μm was seen between age groups 50-59 and 60-69 years. Shows the descriptive statistics of CCT according to age groups. CCT and age shows a statistically significant inverse correlation ($r = -0.32$, $r2 = 10.2\%$, $p = 0.002$).
André Omgbwa Eballe, Cameroon, 2010 [10]	485 patients (970 eyes) Age: 5 to 75 years with an average of 31.4 ± 15.5 years; mean age= 32.8 ± 16.1 in men and 30.6 ± 15.1 years in women. Non glaucomatous	prospective, analytical study	CCT was measured using a hand-held ultrasonic pachymeter (Quantel Medical). IOP were measured using a NCT (TOPCON)	The average IOP was 13.01 ± 2.97 mmHg in both eyes. The average CCT was 529.29 ± 35.9 μm in the right eye, 528.19 ± 35.9 μm in the left eye and 528.74 ± 35.89 μm in both eyes, range 440–670 μm.
Karl Mercieca, Nigeria, 2007 [25]	34 patients Age: 17-68 years, mean age 63.1 ± 11.2 years 12 men		CCT was measured by means of ultrasound pachymetry (pachymeter used was Micropach 200 P+	Mean CCT= 535±38μm. Men had higher mean CCT than women (541±47 vs. 522±22μm, respectively; P = 0.035) Decreasing values of CCT were

	12 women Non glaucomatous		Pachymeter; Sonomed)	significantly related to older age (P = 0.002)
Yeshigeta Gelaw, Ethiopia, 2010 [9]	300 patients Age: 18 and above mean age= 42.57 years 184 (61.3%)=m males Non glaucomatous	cross-sectional study	The CCT was measured using OcuScan RxP Ophthalmic Ultrasound System. IOP was measured by GAT	Mean IOP= 13.39mm Hg, Mean= CCT 518.68 µm. There was statistically significant relationship between CCT and IOP (r=0.199, P<0.001) and a borderline statistically significant detectable change of CCT with age (r=0.012, P=0.057) with a downward trend of at least 0.001mm decrease in CCT/decade starting from age 30 years but with pronounced change from 50 years onward. For every 30 mm difference in CCT from the mean in either way. The CCT of Ethiopians is thin and hence can result in underestimation of IOP measured by GAT.
E Iyamu, Nigeria, 2010 [26]	85 patients mean age 44.7 ± 15.1 years 49 males and 36 females. Non glaucomatous		The CCT was measured by ultrasound pachymetry (SW-1000P pachymeter, Tianjin Suowei Electronic Technology, China) and IOP with Keeler Pulsair EasyEye NCT (Keeler Instruments, USA).	The mean CCT= 550.0 ± 36.3µm The mean IOP= 15.0 ± 2.6mmHg. There was a downward trend in the CCT towards the older age, significant association between CCT and age (r=-0.25, p=0.021). No significant association between CCT and IOP (r=0.052, p=0.64).
E Iyamu, Nigeria, 2011 [27]	95 patients 56 males 39 females aged 20-69 years with mean age of 47.1 ± 14.1 years Non glaucomatous	observational, prospective, cross-sectional study	CCT was measured by ultrasound pachymetry (SW-1000P ultrasound pachymeter, Tianjin Suowei Electronic Technology, China) The IOP was assessed by NCT (Keeler Pulsair EasyEye tonometer).	Mean CCT= 550.1 ± 33.1µm CCT significantly correlated with age (p=0.01), and the regression model predicts a decrease of 6.0 µm in CCT per decade. IOP had to be between 10-21mmHg.

CCT=central corneal thickness; IOP= intraocular pressure; GAT= Goldmann aplanation tonometer; NCT= non-contact tonometer

CCT for glaucomatous subjects

705 glaucomatous patients drawn from 5 sub-Saharan countries (Ghana, Uganda, Nigeria, Ethiopia, Ivory Coast) were assessed after collection of the articles from Pubmed database, Google, Embase [25,30,42,43,44]. Study characteristics are summarized in Table 2.

The patient's ages assessed were range of 12.15 to 90 years. Some study did not bring out the relationship between age and CCT value[42]; some of them showed no significant difference between the mean age [30,44] and some of them have the same result as other studies, showed the CCT is thicker in younger age and thinner in older age [25,43]. According to the sex of the patients, one study did not bring out the relationship between gender of the patient and the CCT value [42]; no significant difference between the gender distribution founded for 2 studies [30,44] the CCT was thicker for male patient founded in 1 study [25] and it was slightly higher in female than in male for 1 study [43].

According to the Korean glaucoma society, a higher CCT was associated younger age (P = 0.001), male sex (P = 0.005), and the absence of hypertension (P = 0.018) [45]. The result founded in Lithuania, showed, the patients have thicker corneas. In the elderly group CCT were 545 ± 39µm; and in young healthy subjects the values CCT were 555 ±43µm. No difference in CCT was observed between sexes. CCT do not differ between cataract surgery, chronic primary open-angle glaucoma patients, patients with extraocular pathology and healthy medical students [46].

The Ocular Hypertension Treatment Study (OHTS) identified decreased CCT as a powerful predictor of glaucoma risk among patients with ocular hypertension [47], glaucomatous optic neuropathy, greater severity of visual field damage [48] and more rapid progression of established visual field loss [49]. Somewhere else, the studies led by Brian A. Francis et al has found that persons with thin CCT had a significantly higher prevalence of OAG than did those with normal or thick CCTs at all levels of IOP [50]. Whereas in other studies, the patients has the in the NTG have the thinnest CCT (490 ± 56.6 µm and 495 ± 35.4 µm) [51].

The type of glaucoma founded in this study was POAG and NTG and the mean IOP was range of 11.55mmHg to 32.72mmHg.

The mean value of CCT varied from 508.07µm - 538µm. The thicker and thinner mean values were found in Nigeria and Ethiopia respectively.

The most of the studies conclude that the African people has thin CCT [25,42,43,45], and it is thinner compared to another ethics such as the white people, Caucasians, Latinos, and Asians[25,42]. This thinner average of CCT was similar between populations living in SSA and African Americans and Afro-Caribbeans[43]. But despite of the most of these finding, there was one study led in the West African population, concluded that CCT may predict the development of glaucoma; however, it may not be a powerful predictor at the ranges of CCT [30].

View this matches the value of CCT in SSA, if we take into account the consideration of Detry-Morel M [31] for the normal value of CCT, the minimum mean CCT was widely thin for the glaucomatous patients, and it was found for all the studies. And if we observed the maximum mean CCT, it remains in the normal fork but it has about the same minimum value of CCT found in other ethnicities such as in France, Azar G et al showed that according to the various types of glaucoma, mean CCT was 542.7 ± 37.6 µm, respectively in the POAG group, 530.4 ± 45.2 µm and 535 ± 43.6 µm in the CACG group, 549.3 ± 24.8 µm and 558 ± 37.3 µm in the PXG group, and 490 ± 56.6 µm and 495 ± 35.4 µm in the NTG group. The NTG group seems to have the thinnest CCT [51].

According to the Korean glaucoma society, the mean CCT was 530.9 ± 31.5µm [45]. In Spain, it was 537.76 ± 32.24 µm [52]. In Karachi, 537.44µm with Orbscan II scanning slit topographer and mean CCT 542.04 µm with ultrasonic pachymeter (P = 0.007) [53]. In Taiwan, the CCT measurement of eyes with glaucoma suspect, primary angle-closure glaucoma, and primary open-angle glaucoma measured by Orbscan II was 563.63 ± 35.867µm [54]. In Brazil, the mean CCT for PCG patients was 534 ± 72.3 µm [55]. According to Italian Glaucoma Register, the CCT between the two eyes (Right 545.68 ± 35.82 µm, Left 546.89 ± 36.09 µm) could be associated to a worse glaucoma in the thinner cornea eye [56]. In Lithuania, CCT were 540 ±64µm, this value in the glaucoma group were statistically significant [46]. For Canadian patient who had open-angle-glaucoma had CCT 544 ± 40 µm OD and 541 ± 40 µm OS [57]. In India, the mean CCT was 531±32.9 µm (range, 448 to 626 µm) [58]. In UK, the mean CCT was 561.5 ± 35.7 µm, 538.9 ± 41.4 µm, 538.3 ± 40.3 µm for ocular hypertension (OHT), primary open angle glaucoma (POAG) and normal pressure glaucoma (NPG) subjects respectively [59].

View all result, none of the CCT values found elsewhere had thin CCT comparable to the minimum mean CCT found in SSA for the glaucoma patient. Although some values of CCT for glaucoma patient are included in the normal fork, the thinnest mean value of CCT was found in SSA.

Taking into account of those results, it could be applied in the case of SSA the quote that said that decreased CCT as a powerful predictor of glaucoma risk among patients with ocular hypertension[47], and the conclusion of Barbados Eye Study Group shows a marginally significant relationship (with thinner corneas) was found with a clinical diagnosis of glaucoma (P =.07) [33], because it is known that the CCT is thin in the SSA for non-glaucomatous or glaucomatous subjects compared to other ethnicities and Fatima Kyari and colleagues founded that glaucoma in SSA is a public health problem and predominantly open-angle glaucoma. It has a high prevalence, an early onset and progresses more rapidly than in Caucasians [60]. And another finding showed, globally, an estimated 8.4 million people who are blind as the result of glaucoma [61], the highest prevalence of open-angle glaucoma occurs in Africans [61,62] or African origin populations at all ages [62].

As the thin CCT was shown for non-glaucomatous and glaucomatous SSA people, this above citation could be contradicted even if the finding found by Fatima Kyari and colleagues seems logical way compare to the CCT because despite all this, some study proves otherwise, and said although glaucoma is common in AI/ANs, we did not find an association with thin CCT [36].

Table 1. Summary of studies of central corneal thickness for glaucomatous subjects

First author, area, year	Study population	Study design and methodology	Interventions	Outcomes
Christine T. Ntim-Amponsah, Ghana, 2012 [30]	253 glaucoma Cases (primary open-angle glaucoma) 108 men 145 women age 21 - 90 years, mean age=58 years	A case–control study	CCT was measured by a research assistant with ultrasonic pachymetry (model DGH 55 pachmate).	The mean CCT of the right eye for the glaucoma cases was 524.28 µm and for the left eye for the glaucoma cases was 524.70 µm
Mbumba BF, Uganda, 2012 [42]	109 patients Age: 60-79 years, mean age=63.67 ± 12.97 years. 67.9% males 32.1% females Glaucoma patients	cross sectional study	IOP was measured Using GAT central corneal thickness according to the correction table provided with Pachmate™ hand held pachymeter.	Mean IOP= 32.72 ± 11.55 mm Hg. Mean CCT= 516.19 ± 39.95µm. IOP was higher and CCT was much thinner compared to Caucasians, Latinos, and Asians. Increased IOP influences significantly visual acuity deterioration and optic disc cupping.
Karl Mercieca, Nigeria, 2007 [25]	36 patients 19 men 17 women Age: 17 - 68 years, mean		CCT was measured by means of ultrasound pachymetry (pachymeter used was	Glaucomatous patients had a average CCT 526±38µm Men had higher mean CCT than women (541±47 vs. 522±22µm, respectively; P =

	age= 61.5 ±9.1 years. Glaucomatous patients		Micropach 200 P+ Pachymeter; Sonomed)	0.035) Decreasing values of CCT were significantly related to older age (P = 0.002)
Yeshigeta Gelaw, Ethiopia, 2012 [43]	199 patients Age:18 years and above, mean age= 59.38 years 61.8%= males 38.2%= females 74.4% POAG 15.6% ocular hypertension (OHT) 16% normal tension glaucoma (NTG)	cross-sectional study	The CCT was measured by OcuScanW RxP Ophthalmic Ultrasound and IOP was measured with GAT	mean IOP=19.46 mmHg, mean CCT= 508.07µm, The mean CCT in females was 512.25 µm, which was slightly higher than the mean CCT in males 505.48 µm but this difference in mean CCTs was not statistically significant. A positive relationship was found between CCT and IOP (p < 0.001). The mean CCT of Ethiopian glaucoma patients is thin in comparison to other ethnic groups and patients with OHT have thicker corneas than POAG patients.
P. Folquet, Ivory Coast, 2007 [44]	188 patients 64 men, 124 women Mean age= 44,70 ± 12,18 years (men), 42,63 ± 12,15 years (women) POAG	Retrospective study	CCT was measured by means of ultrasound pachymetry IOP was measured with GAT.	The difference of age was not statistically significant (p = 0,269). Mean CCT was 523.09 ± 32.49 µm for men and 519.89 ± 31.95 µm for women. The different of CCT was not statistically significant between men and women (p = 0.518).

CCT=central corneal thickness; IOP= intraocular pressure; GAT= Goldmann aplanation tonometer; NCT= non-contact tonometer

In addition, consideration must be given to certain risk factors that could affect the CCT, which is not yet done in SSA, such as a study conducted for Malay ethnicity living in Singapore showed CCT was greater in individuals with higher body mass index (BMI) (*P* = .038), greater axial length (*P* =.005), and greater radius of corneal curvature (*P* < .001). Individuals with chronic kidney disease (CKD) (*P* = 0.012) and metabolic syndrome (*P* < .001) also had greater CCT [40]. The Beijing Eye Study demonstrated that men and individuals who lived in urban areas had thicker corneas than women and those who lived in rural areas [63]. Among Japanese persons, the Tajimi Study reported that CCT was related to a range of ocular (eg, refractive error and corneal curvature) and systemic (eg, height, weight, and blood pressure [BP]) factors [64].

Study conducted in China found smoking was found to be correlated with decreased CCT in AOAG and combined POAG (JOAG + AOAG) [65].

In Italia, no significant difference in CCT was found between patients treated with prostaglandin analogs (PGA) and for the topical carbonic anhydrase inhibitors (TCAI), suggesting that these topical medications did not statistically and clinically change the CCT.

[66]. But elsewhere has found different result, concluded, Prostaglandins appear to be associated with a small but significant central corneal thickness reduction over time. Serial central corneal thickness measurements might be helpful in glaucoma patients, particularly those on prostaglandins [67].

For pregnant women, the mean CCT in the second and third trimester of pregnancy was measured to be higher than in the first trimester and at 3 months postpartum (p < 0.001). In the third trimester, a 3.1% increase in CCT was associated with a 9.5 % decrease in IOP.

An increase in CCT was accompanied by a decrease in IOP in the second and third trimesters. Physiologic changes occurring in CCT and IOP should be considered in the management of glaucoma during pregnancy [68].

Because some factors increasing or decreasing the CCT could be predisposing in SSA and this should be identified, such the study led in Nigeria has found BMI <18.5 (Under weight) 3.5%, 18.5-24.9 (Normal) 50.1%, 25-29.0 (Over weight) 28.7% and ≤30.0 (Obesity) 17.7%. And they concluded that Obesity was not associated with a larger VCDR [69].

Somewhere else, Gao X et al discovered novel SNPs for CCT in Latinos and provided the first reported evidence of the corneal expression of LOC100506532. These results help to further increase understanding of the genetic architecture of CCT [70]. The results suggest previously reported CCT loci are not significantly associated with POAG susceptibility. By performing a quantitative analysis of CCT and a subsequent analysis of POAG, SNPs in two cell adhesion molecules, NTM and CNTNAP4, were identified and may increase POAG susceptibility in a subset of cases [71]. In a combined analysis, Hoehn R and collaborators confirmed quantitative trait loci on chromosomes 9q34 and 16q24 for association with CCT. ZNF469 missense mutation is involved in a syndrome with very thin cornea (brittle cornea syndrome). Collagen type 5 determines the diameter of the corneal collagen fibrils. In Caucasian population-based GWA study, they reinforce the involvement of collagen-related genes influencing CCT in Caucasians.

[72] And the previous experiment on the large-scale genome-wide for an African Americans about POAG had identified an association of rs10120688 in the CDNK2B-AS1 region with POAG (P = 0.0020). In the subgroup analyses, significant associations were identified for rs10965245 (P = 0.0005) in the CDKN2B-AS1 region with HPG and rs11849906 in the SIX1/SIX6 region with NPG (P = 0.006). No significant association was identified with any loci in the Ghanaian

samples. And they concluded that POAG genetic susceptibility alleles associated in Caucasians appear to play a greatly reduced role in populations of African ancestry. Thus, the major genetic components of POAG of African origin remain to be identified [73].

The pursuit of such a study could be very interesting to clear up well this problem of glaucoma in Africa.

III. Conclusion

The CCT is naturally thin for the SSA, it is for non-glaucomatous such as glaucomatous subjects, but it is thicker for younger than older age. This finding is comparable to the North African people, African Americans and Afro-Caribbeans but for African Americans and Afro-Caribbeans is always included in the normal value.

It needs to pursue large-scale genome-wide association studies to know the major genetic components of POAG of African origin, wich remain to be identified.

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