Determinants of Optical Coherence Tomography Parameters in a Population-based Study

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• PURPOSE: To study the effects of age, sex, intraocular pressure (IOP), corneal thickness, axial length (AXL), disc area, and the signal strength of the scan on optical coherence tomography (OCT) parameters of normal subjects in the L V Prasad Eye Institute-Glaucoma Epidemiological and Molecular Genetic Study (LVPEI-GLEAMS), a population-based study.

• DESIGN: Cross-sectional study.

• METHODS: A total of 1,100 eyes (1,100 subjects) of normal adults aged between 40 and 80 years from LVPEI-GLEAMS underwent macular and optic nerve head imaging with spectral-domain OCT (SDOCT). Effect of age, sex, IOP, central corneal thickness (CCT) and AXL, disc area, and signal strength of the OCT scan on retinal nerve fiber layer (RNFL) thickness, rim area, and ganglion cell–inner plexiform layer (GC-IPL) thickness measurements were evaluated using univariate and multivariate regression models.

• RESULTS: Mean rim area, RNFL, and GC-IPL thickness were 1.31 mm^2 (standard deviation [SD] = 0.22), 93.7 μm (SD = 9.3) and 79.6 μm (SD = 8.7), respectively. Age had a negative association with RNFL thickness (coefficient: −0.18, $P < .001$) and GC-IPL thickness (−0.18, $P < .001$). GC-IPL thickness was significantly less in women than in men (−1.05, $P < .001$). AXL had a negative association with rim area (−0.05, $P < .001$). Disc area was positively associated with RNFL thickness (4.90, $P < .001$) and rim area (0.15, $P < .001$). Signal strength of OCT scan was positively associated with RNFL thickness (1.6, $P < .001$) and negatively associated with rim area (−0.02, $P < .001$).

• CONCLUSION: Age, sex, AXL, disc area, and signal strength of the scan were significantly associated with OCT measurements. These factors may need to be considered while interpreting the OCT parameters in pathologic conditions such as glaucoma. (Am J Ophthalmol 2021;224:163–171. © 2020 Elsevier Inc. All rights reserved.)

EVALUATION OF OPTIC NERVE HEAD (ONH) AND retinal nerve fiber layer (RNFL) is fundamental in diagnosing and managing glaucoma. Optic disc and RNFL can be examined both subjectively and objectively to detect the glaucomatous structural changes. A good-quality optic disc stereo photograph[1] aids in detecting glaucomatous changes. However, optic disc examination on stereo photographs is subjective and the agreement in differentiating early glaucomatous changes from physiological variations, even among experts, is far from excellent.[1–3] Moreover, glaucomatous changes in stereo photographs are nonquantifiable. Imaging techniques such as optical coherence tomography (OCT), confocal scanning laser ophthalmoscopy, and scanning laser polarimetry were developed to provide an objective and quantitative assessment of RNFL and optic disc.[3]

OCT is a noninvasive imaging technology that is akin to in vivo histology of tissues under study, which makes it a convenient instrument to study the layers of the retina and optic disc structure. Spectral-domain OCT (SDOCT) is the most common commercially available technology that obtains high-resolution images at a fast scanning speed. SDOCT instrument scans the ONH, macula, and peripapillary RNFL with various in-built protocols. Ganglion cell–inner plexiform layer (GC-IPL) thickness at macula determined by OCT is also shown to be significantly reduced in glaucoma.[4]

Various subject-related (age, sex, etc), eye-related (disc area [DA], refraction, axial length [AXL], etc), and technology-related (signal strength [SS] of the OCT scan) factors are known to affect the OCT measurements.[5–13] Understanding the factors that can affect the measurements of OCT is important to interpret the changes seen in the disease conditions meaningfully. The association between some of these determinants and OCT parameters has been studied previously.[5–13] However, most of these studies were hospital-based and with limited sample size.

L V Prasad Eye Institute–Glaucoma Epidemiology and Molecular Genetics Study (LVPEI-GLEAMS) is a

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population-based study conducted in a rural cohort in 16 villages of Guntur district in the state of Andhra Pradesh, India, in the year 2009.[14] All subjects in the study underwent OCT scanning as a part of their examination. The aim of the present study was to evaluate the effect of age, sex, intraocular pressure (IOP), central corneal thickness (CCT), AXL, DA, and SS of the OCT scan on the ONH, RNFL, and GC-IPL parameters in normal subjects of GLEAMS.

METHODS

DATA FOR THE ANALYSIS WERE OBTAINED FROM LVPEI-GLEAMS, a population-based, cross-sectional, observational study in Indian subjects aged between 40-80 years, residing in a rural setting of Andhra Pradesh, India. The study was approved by the institutional ethics committee and was conducted in accordance with the tenets of the Declaration of Helsinki. Written informed consent was taken from all study participants.

Various aspects and design of LVPEI-GLEAMS are published elsewhere.[14] Relevant study design for this particular study is discussed below. All examinations were carried out by experienced optometrists and vision technicians trained in relevant diagnostic procedures. All subjects underwent a comprehensive ophthalmic examination that included visual acuity and refraction, IOP, gonioscopy, CCT, dilated fundus examination, fundus photography, anterior segment optical coherence tomography (ASOCT), posterior segment OCT imaging with Cirrus high-definition OCT (model 4000, software version 6.0; Carl Zeiss Meditec Inc, Dublin, California, USA), and visual field examination with Humphrey Field Analyzer II 750i (Carl Zeiss Meditec Inc, Dublin, California, USA).

• **VISUAL FIELDS:** Standardized visual field testing was performed with the 24-2 Swedish interactive threshold algorithm before any contact procedures. Fields with fixation losses >20% or false-positive or false-negative response rates >33% were considered to be unreliable and were repeated a maximum of 3 times to get a reliable result. Fields with good reliability and not satisfying any of Anderson's criteria[15] were labeled as normal visual fields.

• **OPTIC DISC STEREO PHOTOGRAPHY:** Following pharmacologic dilation of the pupils, sequential stereoscopic optic disc photographs, full-field color, red-free, and 4-field fundus photographs were obtained for both eyes of each subject using the fundus camera (TRC-NW8; Topcon, Oakland, New Jersey, USA). All photographic evaluations were performed by 2 experienced optometrists (G.B.J. and U.A.K.) on a large screen liquid crystal display monitor with a stereoscopic viewer (Screen-Vu stereo viewer; Berezin Stereo Photography Products, Mission Viejo, California, USA). The graders were masked to patient identification, diagnosis, and visual field status. The fundus stereo photographs not satisfying criteria of structural damage defined as intereye asymmetry in cup-to-disc ratio of ≥0.2, thinning of the neuroretinal rim in either superior or inferior temporal quadrants, localized or diffuse RNFL defects, and presence of nerve fiber layer hemorrhage or total cupping of the optic disc[14] were considered as a normal optic disc. Disagreements between the observers were resolved by a glaucoma specialist (N.C.). All these eyes had to have normal and reliable visual fields to be included in the study.

• **IMAGING:** All subjects were pharmacologically dilated before the examination and all scans were acquired in the same session. All the participants of the study underwent 512 × 128 macular cube and 200 × 200 optic disc cube protocols.

• **OCT TECHNIQUE OF SCANNING:** *Optic disc cube scan.* In this protocol, laser scan captures a cube of data comprising of 200 A-scans with 200 linear B-scans (40,000 points) in a 6 mm × 6 mm optic disc cube area in 1.5 seconds (27,000 A-scans in 1 second). The software then defines the optic disc margin and cup in a 3-dimensional cube. The Bruch membrane opening is defined as the optic disc margin. Rim width around the entire circumference is then measured by the thickness of neuroretinal rim available as the nerve exits the Bruch membrane opening. ONH parameters of rim area (RA), DA, average cup-to-disc ratio, vertical cup-to-disc ratio, cup volume were calculated.

The square root of the ratio of the area of the cup to DA gives average cup-to-disc ratio. The ratio of cup diameter to disc diameter in vertical meridian through the cup center gives the vertical cup-to-disc ratio. Cup volume is the 3-dimensional measurement of volume between plane created 200 μm offset to the plane of cup outline at the vitreoretinal interface and the posterior surface of the ONH. ONH parameters are automatically generated by the manufacturer's automated analysis algorithm without user intervention.

The RNFL algorithm provides standard measurement within the same 3-dimensional disc cube. The central dark spot in the center of the retinal pigment epithelium is defined as the center of the optic disc and circle of data with radius 1.73 mm from the central dark spot is generated. This 2-dimensional data are processed via bilinear interpolation to get 512 A-scans. Average of these A-scans give RNFL thickness.

Macula scan. In this protocol, a 512 × 128 cube scan is used with a 6 mm × 6 mm grid using a series of 128 horizontal lines, each consisting of 512 A-scans/line. A ganglion cell analysis algorithm identifies the outer boundaries for macular RNFL and inner plexiform layer.

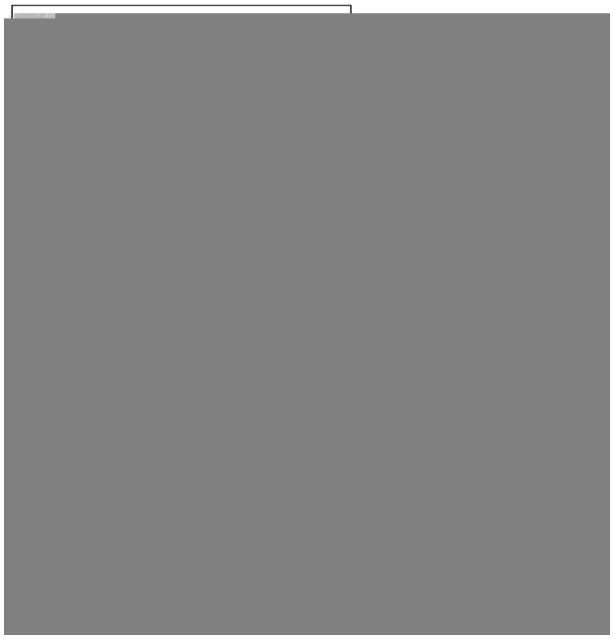

FIGURE 1. Flow chart depicting the inclusion and exclusion of study subjects.

The distance between these 2 layers is defined as macular GC-IPL thickness. Average, minimum, and sectoral (superotemporal, superior, superonasal, inferonasal, inferior, and inferotemporal) macular GC-IPL thickness measurements were calculated.

Measurement of other ocular parameters. Both unaided and aided distance and near vision measurements were performed. The IOP was measured by Goldmann applanation tonometer (Haag-Streit AT 900; Haag-Streit AG, Köniz, Switzerland) in all participants and 0.5% proparacaine eye drops (Paracain; Sunways India Pvt Ltd, Mumbai, India) was used to anesthetize the cornea and a 2% fluorescein strip to stain the tear film. CCT and AXL measurements were performed with an AL-1000 ultrasonic pachymeter (Tomey Corporation, Noritakeshinmachi, Nagoya, Japan). Both eyes were anesthetized by instilling 0.5% proparacaine eye drops into the lower fornix. One measurement was taken for each eye. If the standard deviation was more than 5 mm, the measurement was repeated. A similar procedure was followed for measuring AXL but only 5 sets of measurements were taken.

All subjects with suspicion of having glaucoma or diagnosed glaucoma (structural damage as defined above with corresponding visual field defects) and any other eye diseases that could be a confounder were excluded from the study. SDOCT scans with SS < 6 were excluded. Scanned images that did not have sharp focus and illumination, with poor centration and errors in segmentation, were also excluded from this study.

TABLE 1. Demographic and Clinical Features of the Study Subjects

Parameters	Mean	SD	Range
Age	49.5	7.6	40-85
Sex, male:female	450:651		
Right eye: left eye	761:340		
Intraocular pressure (mm Hg)	12.7	2.3	10-21
Central corneal thickness (μm)	524	32	319-630
Axial length (mm)	22.6	0.7	20-26
Signal strength of ONH scan	6.9	1.0	6-10
Signal strength of macula scan	7.8	1.2	6-10
Refractive error (diopters)	0.04	1.0	-6 to 11.5

ONH = optic nerve head; SD = standard deviation.

• **STATISTICAL ANALYSIS:** Baseline demographic details and ocular characteristics were expressed as mean ± standard deviation (SD) or median with interquartile range wherever applicable. Effect of age, sex, IOP, CCT, AXL, disc area, and SS of OCT scans on average RNFL thickness, RA, and GC-IPL thickness was evaluated using univariate and multivariate regression models. All associations significant at $P < .05$ on univariate models were evaluated in multivariate models. To account for the large sample size, $P < .01$ was considered to be statistically significant in the final multivariate models. Multicollinearity among the determinants were evaluated using correlation analysis, and determinants correlated with each other with Pearson r of >0.5 were considered to be collinear. However, none of the determinants was found to be collinear. As measurements from both eyes of the same subject are likely to be correlated, the standard statistical methods for parameter estimation lead to underestimation of standard errors. Therefore, the cluster of data for the study subject was considered as the unit of resampling when calculating standard errors.[16] Statistical analysis was performed using Stata (v14.2; Stata Corp, College Station, Texas, USA) software.

RESULTS

OF THE 7,666 EYES OF 3,833 SUBJECTS IN LVPEI-GLEAMS, 1,100 eyes of 1,100 subjects were included for the current analysis. Only 1 eye of each patient was included in the study. Figure 1 depicts the process of inclusion of subjects into this study. Table 1 shows the demographic and clinical features of this study population. Table 2 shows the RNFL, ONH, and GC-IPL parameters of study subjects. The RNFL was thickest in the inferior sector and thinnest in the temporal sector, while the GC-IPL was thickest in the superonasal sector and thinnest in the inferior sector.

TABLE 2. Retinal nerve fiber layer thickness, optic nerve head, and ganglion cell–inner plexiform layer parameters of the study subjects

Parameters	Mean	SD	Range
RNFL thickness parameters			
Average (μm)	93.7	9.3	64-120
Inferior sector (μm)	122	15.6	65-173
Superior sector (μm)	120	16.1	26-173
Nasal sector (μm)	74.6	11.3	22-115
Temporal sector (μm)	58.3	9.6	28-105
ONH parameters			
Rim area (mm^2)	1.3	0.2	0.7-2.5
Disc area (mm^2)	1.9	0.3	1.1-3.5
Average CDR	0.5	0.1	0.1-0.8
Vertical CDR	0.5	0.2	0.1-0.8
Cup volume (mm^3)	0.2	0.2	0.0-1.2
GCIPL thickness parameters			
GCIPL average (μm)	79.6	8.7	14-100
GCIPL minimum (μm)	73.76	13.0	00-96
Superotemporal quadrant (μm)	78.3	8.5	23-104
Superior quadrant (μm)	80.1	9.1	24-108
Superonasal quadrant (μm)	82.1	9.6	22-116
Inferonasal quadrant (μm)	80.7	9.4	22-115
Inferior quadrant (μm)	78.0	8.9	26-101
Inferotemporal quadrant (μm)	79.3	8.3	22-99

CDR = cup-to-disc ratio; GC-IPL = ganglion cell–inner plexiform layer; ONH = optic nerve head; RNFL = retinal nerve fiber layer; SD = standard deviation.

TABLE 3. Univariate and Multivariate Regression Models Showing the Effect of Determinants on Average Retinal Nerve Fiber Layer Thickness

	Univariate Analysis		Multivariate Analysis	
	Coefficient (95% CI)	*P* Value	Coefficient (95% CI)	*P* Value
Age	-0.18 (-0.25, -0.11)	<.001*	-0.18 (-0.26, -0.11)	<.001*
Sex	-0.79 (-1.91, 0.33)	.16		
IOP	-0.24 (-0.48, -0.001)	.05*	-0.21 (-0.44, -0.02)	.08
CCT	0.01 (-0.01, 0.02)	.44		
AXL	-0.92 (-1.72, -0.13)	.02*	-0.52 (-1.29, 0.24)	.18
Disc area	4.99 (3.44, 6.53)	<.001*	5.48 (3.95, 7.01)	<.001*
Signal strength	1.60 (1.07, 2.13)	<.001*	1.26 (0.73, 1.79)	<.001*

AXL = axial length; CI = confidence intervals; CCT = central corneal thickness; IOP = intraocular pressure.
Asterisk denotes statistically significant *P* values.

Table 3 shows the associations between the determinants and RNFL thickness in univariate and multivariate analysis. Age, IOP, AXL, DA, and SS were associated with RNFL thickness in univariate analysis. Age, DA, and SS were statistically significantly associated with RNFL thickness in multivariate analysis. RNFL thickness decreased by 0.18 μm for every year increase in age. RNFL thickness increased by 4.90 μm for every 1 mm^2 increase in disc area. The RNFL thickness increased by 1.6 μm for every unit increase in SS. Figures 2-5 show the relationship of RNFL thickness with age, AXL, disc area, and SS of the scan, respectively.

Table 4 shows the associations between the determinants and RA in univariate and multivariate regression models. IOP, AXL, DA, and SS were significantly associated with RA in univariate analysis while only AXL, DA, and SS were associated with RA in the multivariate model. The RA reduced by 0.05 mm^2 for every 1 mm increase in

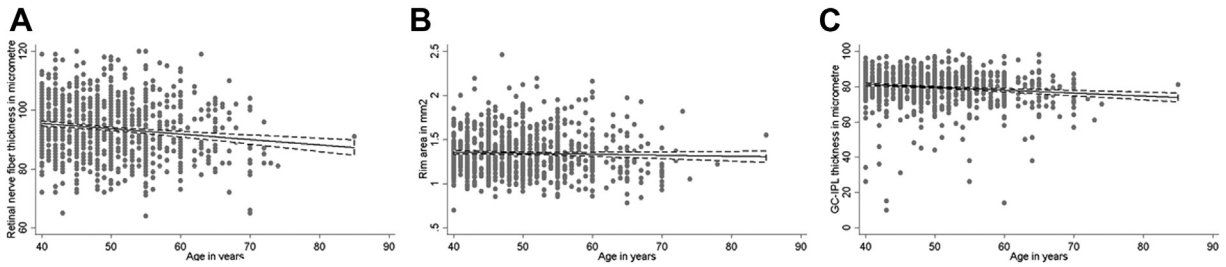

FIGURE 2. Scatterplots showing the relationship between age and retinal nerve fiber thickness (A), rim area (B), and ganglion cell–inner plexiform layer (GC-IPL) thickness (C). Univariate and multivariate regression analysis showed statistically significant negative associations between age and retinal nerve fiber thickness (coefficient: −0.18, $P < .001$) and between age and GC-IPL thickness (−0.17, $P < .001$).

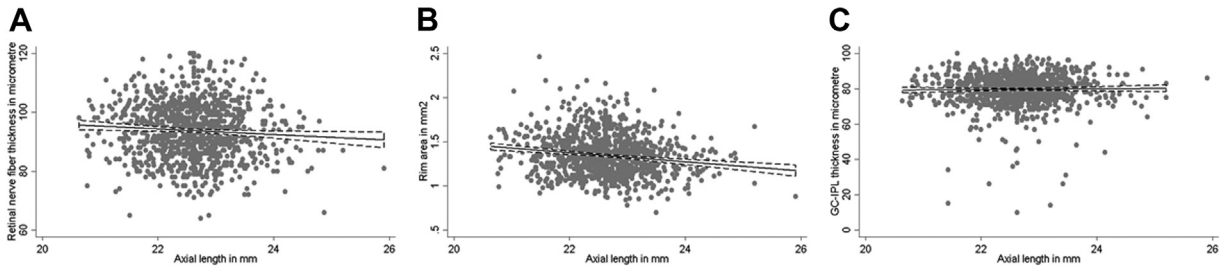

FIGURE 3. Scatterplot showing the relationship between axial length and retinal nerve fiber thickness (A), rim area (B), and ganglion cell–inner plexiform layer (GC-IPL) thickness (C). Univariate and multivariate regression analysis showed statistically significant negative association between axial length and rim area (coefficient: −0.05, $P < .001$).

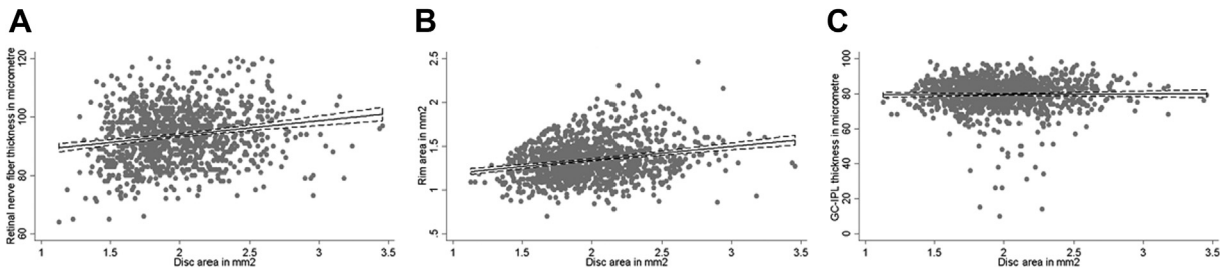

FIGURE 4. Scatterplot showing the relationship between disc area and retinal nerve fiber thickness (A), rim area (B), and ganglion cell–inner plexiform layer (GC-IPL) thickness (C). Univariate and multivariate regression analysis showed statistically significant positive association between disc area and retinal nerve fiber thickness (coefficient: 4.90, $P < .001$) and between disc area and rim area (0.15, $P < .001$).

AXL. For every 1 mm^2 increase in DA, RA increased by 0.15 mm^2. As SS increased by 1 unit, RA reduced by 0.02 mm^2. Figures 2-5 show the relationship of RA with age, AXL, DA, and SS of the scan, respectively.

Table 5 shows the results of univariate and multivariate analysis evaluating the associations between the determinants and average GC-IPL thickness. Age, sex, IOP and SS were associated with GC-IPL thickness in univariate analysis. In multivariate analysis, age and sex were the only factors statistically significantly associated with average GC-IPL thickness. GC-IPL thickness decreased by an average of 0.18 μm for every year increase in age. Average GC-IPL thickness was thinner in female subjects by an average of 1.05 μm. Figures 2-5 show the relationship of GC-IPL thickness with age, AXL, DA, and SS of the scan, respectively.

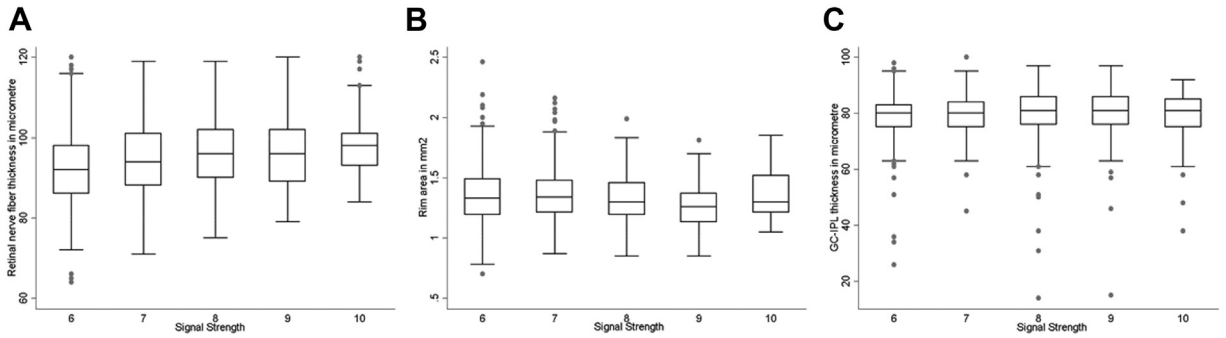

FIGURE 5. Box plot showing the relationship between signal strength and retinal nerve fiber thickness (A), rim area (B), and ganglion cell–inner plexiform layer (GC-IPL) thickness (C). Statistically significant positive association was seen between signal strength and retinal nerve fiber thickness (coefficient: 1.60, $P < .001$) and statistically significant negative association between signal strength and rim area (−0.02, $P < .001$). Horizontal line inside the box depicts the median value and the horizontal lines at the lower and upper end of the box denote the 25th and 75th percentile values, respectively.

TABLE 4. Univariate and Multivariate Regression Models Showing the Effect of Determinants on Neuroretinal Rim Area

	Univariate Analysis		Multivariate Analysis	
	Coefficient (95% CI)	*P* Value	Coefficient (95% CI)	*P* Value
Age	-0.001 (-0.002, 0.006)	.21		
Sex	0.014 (-0.012, 0.04)	.29		
IOP	-0.004 (-0.01, 0.001)	.13	-0.004 (-0.01, -0.001)	.13
CCT	0.0004 (-0.0001, 0.001)	.05*	0.001 (0.0001, 0.001)	.03
AXL	-0.05 (-0.07, -0.03)	<.001*	-0.04 (-0.07, -0.03)	<.001*
Disc area	0.15 (0.11, 0.19)	<.001*	0.14 (0.10, 0.17)	<.001*
Signal strength	-0.02 (-0.03, -0.01)	<.001*	-0.02 (-0.03, -0.01)	<.001*

AXL = axial length; CI = confidence intervals; CCT = central corneal thickness; IOP = intraocular pressure.
Asterisk denotes statistically significant *P* values.

DISCUSSION

IN THIS STUDY, WE REPORT THE DETERMINANTS OF ONH and RNFL parameters along with macular GC-IPL parameters measured by SDOCT in a population-based study. To the best of our knowledge, this is the first population-based study looking at OCT parameters and their determinants in an Indian population. The average RNFL thickness was 93.7 ± 9.3μm, which was comparable to the Indian subset of a multiethnic population study[17] (study subjects were aged 60.7 ± 8.1 years) and also with the Australian subjects in a study by Tariq and associates.[18] The average RNFL thickness found in our study is also comparable to that seen in 2 Indian population-based studies, 1 by Ramakrishnan and associates[11] (average RNFL thickness = 105 ± 38.79 μm) and the other by Sony and associates[19] (104.27 ± 8.5 μm), both of which were done with Stratus OCT, and to that seen in the study by Appukuttan and associates[5] (average RNFL thickness = 101.4 ± 8.6 μm), which was done with SDOCT. The superior and inferior sectors showed comparable thickness in our study, while other studies[5,9,12,18,20] have reported the inferior sector to be thickest.The rim area found in our study was comparable to that reported by Cheung and associates[7] (RA = 1.29 ± 0.2 mm^2). GC-IPL thickness was thickest in the superonasal and thinnest in the inferior sector, similar to that reported in previous studies.[21–23]

Older age was associated with significantly thinner RNFL and GC-IPL thickness in our study. When we divided age into decade-wise categories, we found that the average RNFL thickness in those aged between 51 and 60 years was on average 1.85 μm thinner than those aged between 40 and 50 years. RNFL thickness in those aged above 60 years was on average 4.2 μm thinner than those aged between 40 and 50 years. Most previous studies[5,6,10,24,25] have also shown a reduction in RNFL thickness with advancing age ranging between 1.1 μm/decade to approximately 2 μm/decade. Similarly, average GC-IPL thickness in those aged between 51 and 60 years was 1.2 μm thinner than those aged between 40 and 50 years. GC-IPL thickness in those aged above 60 years was on average 4.6 μm thinner than those aged between 40

TABLE 5. Univariate and Multivariate Regression Models Showing the Effect of Determinants on Average Ganglion Cell–Inner Plexiform Layer Thickness Measurements

	Univariate Analysis		Multivariate Analysis	
	Coefficient (95% CI)	*P* Value	Coefficient (95% CI)	*P* Value
Age	-0.17 (-0.22, -0.11)	<.001*	-0.18 (-0.24, -0.12)	<.001*
Sex	-1.05 (-1.97, -0.14)	.02*	-1.64 (-2.55, -0.73)	<.001*
IOP	-0.13 (-0.33, 0.06)	.18		
CCT	0.006 (-0.00, 0.02)	.36		
AXL	-0.06 (-0.70, 0.57)	.83		
Disc area	0.37 (-0.88, 1.63)	.55		
Signal strength	0.40 (0.03, 0.77)	.03*	0.15 (-0.22, 0.52)	.43

AXL = axial length; CI = confidence intervals; CCT = central corneal thickness; IOP = intraocular pressure.
Asterisk denotes statistically significant *P* values.

and 50 years. Previous studies[23,26] have reported similar negative association of GC-IPL thickness with advancing age, with the GC-IPL thinning from 1 to 2 μm/decade. Age was not associated with RA in our study. In contrast to our study, previous studies[7,25] have noted age to have a negative association with RA.

Our study also found that women had significantly thinner GC-IPL thickness compared to men; GC-IPL was 1.05 μm thinner in women. RNFL thickness was also thinner in women compared to men, but this association was not statistically significant. Gupta and associates have also noted thinner GC-IPL in older age and female sex,[26] similar to our study, while some studies[12,23] have found no association between sex and GC-IPL thickness.

The AXL of the eye was negatively associated with RNFL thickness and RA, with these OCT parameters decreasing in eyes with longer AXL. Previous studies[6–8,24,25] have noted a reduction in RNFL thickness with increasing AXL ranging from 1.3 μm to 4.79 μm, while few studies have not seen any association of RNFL thickness with AXL.[5,10,23] Cheung and associates[7] have reported a similar association of AXL with RNFL thickness and neuroretinal rim area, as seen in our study.

We analyzed the association of DA with RNFL thickness and RA by categorizing DA into 3 groups: small discs with (mean ± SD) 1.63 ± 0.13 mm^2 DA (range 1.13-1.8 mm^2), medium discs with 1.95 ± 0.08mm^2 DA (range 1.81-2.11 mm^2), and large discs with 2.38 ± 0.23 mm^2 DA (range 2.12-3.46 mm^2). Larger DA was associated with thicker RNFL thickness and increased neuroretinal rim area. It was noted that medium-size disc had 2.7 μm and large disc had 3.8 μm thicker RNFL than the small disc. This measurement means when a fixed-diameter circle is used to measure peripapillary RNFL thickness, an artefact is created in measurement showing thicker RNFL in large discs, as the sampling is done closer to disc margin, and vice-versa in the small disc. Medium disc had 0.07 mm^2 and large disc had 0.12 mm^2 larger RA compared to the small disc. Cheung and associates[7] also reported DA to be independently associated with ONH measurements and that small disc has small CD, thin RA, thinner RNFL, and smaller cup-to-disc ratio.

Increased OCT signal strength was associated with thicker RNFL and reduced neuroretinal rim area. It was also positively associated with GC-IPL thickness, but this association was not statistically significant. Rao and associates[12] have shown a positive association of SS with all ONH parameters but not with RNFL and macular parameters. They found that ONH rim measurements increased and cup measurements decreased with increase in SS. Samarawickrama and associates[27] have reported a small but significantly increased macular thickness with increased SS. These differences between studies could be owing to different OCT devices used in these studies. Rao and associates[13] have also demonstrated that the diagnostic ability of OCT parameters is reduced in scans with lower SS. Hence a good-quality scan with good SS is of paramount importance for longitudinal follow-up of subjects with glaucoma and other retinal pathologies.

Higher IOP was associated with thinner neuroretinal rim area, thinner RNFL thickness, and thinner GC-IPL layer, but the association was seen only on univariate analysis.

All OCT devices have in-built reference databases to flag off abnormalities in RNFL, ONH, and GC-IPL parameters. Reference databases are also used to detect progressive reduction in OCT parameters while evaluating disease progression. Currently available reference databases in OCT devices are adjusted only for age. Our study demonstrates that factors like sex, AXL, DA, and SS of the scan also affect the RNFL, ONH, and GC-IPL parameters and should be considered as determinants while detecting structural abnormalities in glaucoma and other retinal diseases.

The strengths of this study include its large population-based sample size, which reduces selection bias, and standardized ocular examination and imaging techniques by a

trained person. There are some limitations to our study. Since it is a cross-sectional observational study, the causal relationship between determinants and OCT parameters cannot be extrapolated from the data. Although we have included all subjects over 40 years of age, decade-wise clustering of age is uneven (most subjects between 40 and 60 years, and very few over 60 years), which can skew the results.

In conclusion, age, sex, AXL, disc size, and signal strength of the scan are associated with OCT parameters. These results may need to be considered while interpreting the OCT measurements in glaucoma and other retinal diseases.

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