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Correlation between Retinal Nerve Fiber Layer Thickness and Anthropometric Parameters in Young Adult Malay Subjects

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Abstract

Introduction: Retinal nerve fiber layer (RNFL) is one of the layers of the retina in our eye that are composed of axons of the retinal ganglion cells which are responsible to transmit our visual input to the brain. Furthermore, there was a study stated that RNFL abnormalities are also linked with obesity. An individual's body composition and general physical attributes are typically evaluated using anthropometric parameters, such as height, weight, body mass index (BMI), waist circumference, and waist-to-hip ratio.

Aim: The goal of the study is to establish a correlation between RNFL thickness and anthropometric measurements in young adult Malay subjects by determine the mean RNFL thickness and anthropometric measurements.

Methodology: Thirty (30) Malay subjects aged 19 to 25 years old and free from any surgery or disease (ocular and systemic) were recruited. RNFL thicknesses were measured using the swept-source optical coherence tomography (SS-OCT), and anthropometric measurements, i.e., height, weight, waists were conducted.

Results: No significance correlations were found between the RNFL thickness and anthropometric measurements (p>0.05).

Conclusion: Our results suggest that there is no relationship between RNFL thickness and anthropometric parameters in Malay subjects.

Keywords: Retinal Nerve Fiber Layer; Anthropometry; Optical Coherence Tomography; Malay; SS-OCT

Abbreviations

RNFL: Retinal Nerve Fiber Layer; BMI: Body Mass Index; SS-OCT: Swept-Source Optical Coherence Tomography; BCVA: Best Corrected Distance Visual Acuity; SER: Spherical Equivalent Refraction.

Introduction

The axons of retinal ganglion cells are found in the retinal nerve fiber layer (RNFL). Damage to the optic nerve causes the ganglion cells to die and lead to the thinning of the RNFL [1]. Localised RNFL abnormalities are uncommon in healthy eyes but have a high diagnostic value for glaucoma [2,3]. RNFL abnormalities, however, are not pathognomonic of glaucoma, as they are seen in patients with various disorders associated with retinal vascular insufficiency, such as nonarteritic anterior ischemic optic neuropathy, diabetic retinopathy, and arterial hypertension [3,4]. Previous research has linked localized RNFL abnormalities to metabolic syndrome components such as obesity [5,6]. To ascertain whether there is a significant correlation between these variables, the goal of this study was to explore a relationship between RNFL thickness measured using the Swept-Source Optical Coherence Tomography (SS-OCT) and various anthropometric parameters. An individual's body composition and general physical attributes are typically evaluated using anthropometric parameters, such as height, weight, body mass index (BMI), waist circumference, and waist-to-hip ratio.

Anthropometry is a non-invasive method of measuring body dimensions [7]. The heart, liver, eyes, and other bodily organs are observed to be impacted by anthropometric measurements. Longer axial lengths in the eyeballs of taller persons modify the eyeball's refractive condition [8,9]. The definition of anthropometry and its effects on various bodily organs are covered in the discussion. Additionally, investigations on RNFL thickness and anthropometric measurements according to various ethnic groups, including Malaysians, are presented. In addition, it examines the literature on the association between RNFL thickness and anthropometric parameters like BMI, height, waist circumference, and waist-to-hip ratio, with some studies demonstrating substantial differences and others not.

Wilkin [10] stated that gaining weight in young people raises their likelihood of having Type 1 diabetes. Diabetic retinopathy is a potentially blinding complication of diabetes mellitus [11]. Diabetic retinopathy is a well-established risk factor for neovascular glaucoma [12]. RNFL thickness decreases with increase in glaucoma severity [13] . The correlation between anthropometry measurement and RNFL thickness is not fully understood because of lack of evidence about this study among Malay subjects. As a result, no study has done regarding the relationship between RNFL thickness and anthropometric parameters in Malay subjects. This renders it impossible to determine if variations in anthropometric parameters affect the RNFL thickness. The aim of the study was to investigate a correlation between RNFL thickness and anthropometric measurements in Malay subjects by determine the mean RNFL thickness in various quadrants and anthropometric measurements.

Materials and Methods

The study followed the tenets of the Declaration of Helsinki, which involved human subjects, and this work has received ethical approval from the IIUM Research Ethics Committee (IREC 2023-KAHS/DOVS8). This study included 30 Malay subjects ranging from 19 to 25 years old. For the inclusion criteria, subjects were healthy (free from any disease), range of age between 19 to 25 years old, best corrected distance visual acuity (BCVA) of 6/6, spherical equivalent refraction (SER) up to -3.00 D, and astigmatism less than 1.00 D. Subjects were excluded if they had glaucoma or any ocular pathologies and diabetes. The protocol of ocular assessment of the subject for this study consisted of battery of examinations for subjects' criteria selections, and for data collections. Subject's information sheets were provided to the subjects and the content together with study objectives which have been explained and elaborated in layman terms. Then, for subjects who were interested and agreed to be involved in this study, an informed consent was obtained by signing the consent form. After they have done signing the consent form, the refractive power of the eye was measured using the auto refractor. Subjects were asked to fixate on the target inside the auto refractor and the measurement was taken 3 times automatically in the right eye to determine subjects' refractive error. The same procedures were repeated for the left eye.

Based on Casadei and Kiel [14], the anthropometric parameters which were height, weight, BMI, waist circumference and waist-to-hip ratio were measured using weight scale, measuring tape and stadiometer. For height measurement, the patient had to stand upright, with the back of the stadiometer being touched by the person's buttocks, shoulder blades, and heels with the feet positioned at a 60-degree angle outward. The palms of the arms were facing the thighs and dangling loosely at the sides. To compress the hair to the crown of the head, the horizontal bar of the stadiometer was lowered. We took off any hair or body parts that could prevent the bar from squeezing the hair to the crown of the head. It was recommended to read the measurement to the nearest 0.1 cm (1/8 inch). To get two readings that are within 0.2 cm or 0.25 inches of one another, we took the measurement twice. The two measurements that are closest to each other have been averaged. BMI is a calculation based on height and weight. The formula for the calculation of BMI is weight (kg)/ [height (m) x height (m)]. Patients had to stand with their arms crossed over their opposing shoulders to measure their waist circumference. The measuring tape was placed snugly at the mid-axillary line, around the lateral aspect of each ilium.

Next, the RNFL thickness was determined from the swept-source optical coherence tomography (SS-OCT) results. The commercial swept-source OCT ophthalmoscope (DRI OCT Triton®, Topcon Europe Medical) was used to image the retinal structures. The SS-OCT was also known as The Deep Range Imaging-OCT. It is a device that uses a wavelengthsweeping laser with a centre wavelength of 1050 nm and a tuning range of approximately 100 nm. According to Mansouri, et al. [15], in the tissue, 100 000 A-scans per second was obtained with an axial resolution of 8 μm. Two Deep Range Imaging-OCT scan modes, wide-angle scan and 3D horizontal (H) disc circle grid scan was used to image all the eyes.

The posterior pole was scanned by using a faster scan setting from Deep Range Imaging-OCT wide-angle 12 × 9 mm. As a result, it was possible to get images of the ONH and macular regions in the same scan. The 12 × 9 mm scan consists of 131,072 axial scans/volume, or 256 B-scans, each of which consists of 512 A-scans. Thus, the total acquisition time was 1.3 seconds per 12 × 9 mm scan.

The inner boundary of the retinal ganglion cell layer and the limits of the RNFL were identified using deep range imaging-OCT segmentation software (version 9.12), and the thickness of the RNFL would be calculated throughout the scan. The deep range imaging-OCT 3D (H) disc circle grid scan used the same 131,072 axial scans (512 A-scans for each of 256 B-scans) to gather pictures from an area of 6 × 6 mm that was focused on the optic disc to quantify peripapillary RNFL thickness. The thickness of the peripapillary RNFL was determined by automatically placing a 3.4-mm-diameter circle in the center of the disc.

The circle's positioning was adjusted manually whenever it seems necessary. The circle would then be sampled using 1024 A-scans. The same segmentation program (version 9.12) was used to calculate the average thicknesses of the superior, inferior, nasal, and temporal quadrants as well as the global peripapillary RNFL. The collected data were analysed using IBM SPSS statistics version 20 (IBM SPSS, Armonk, NY, USA). A two-tailed test was conducted, and it was considered statistically significant if the *p*-value was less than 0.05.

Normal distribution of data was assessed using the Shapiro-Wilk test of normality, skewness value or coefficient of variation. The Pearson coefficient product moment correlation was used to see the correlation between the RNFL thickness and anthropometric parameters in Malay subjects.

Results and Discussion

Thirty (30) Malay subjects were included in this clinical cross-sectional study. The mean average RNFL thickness was 111.33±9.31 μm. The mean, standard deviation and correlation between average RNFL thickness and anthropometric parameters, i.e., waist, waist-hip-ratio, height and BMI are shown in Table 1.

	Mean	Standard Deviation	*p*-value
Waist (cm)	76.39	0.05	0.63
Waist-Hip ratio	0.85	6.73	0.42
Height (cm)	160.1	8.86	0.87
BMI (kgm^{-2})	22.5	4.411	0.91

Table 1: Mean, standard deviation and correlation between average RNFL thickness and anthropometric parameters.

Pearson product-moment correlation was run to examine the relationship between average RNFL thickness, waist circumference, waist-hip ratio, height and BMI. The Pearson correlation test established a negligible linear relationship between RNFL thickness and waist (r=0.09, *p*=0.63), RNFL thickness and waist-hip ratio (r= -0.15, *p*=0.44), RNFL thickness and height (r=0.03, *p*=0.87) and RNFL thickness and BMI (r=0.02, *p*=0.91).

There were various studies that have been conducted on RNFL thickness according to ethnicities. According to Sani, et al. [16], mean RNFL thickness for Africans is 104.17±10.71 μm. For Thai people, 100.00±11.75 μm [17]. As for Japanese, it is 103.5 ± 10.6 μm [18]. However, in Singapore, according to Ho, et al. [19], RNFL thickness measured was 95.7±9.6 μm, 94.9±10.6 μm and 87.3±10.6 μm for Chinese, Malay and Indian respectively. There are also studies in Malaysia made by Ho, et al. [19] that stated that the mean RNFL thickness in Malaysian is 100.91±10.07 μm.

Anthropometry is the quantitative assessment of several physical characteristics, such as height, body mass index (BMI), waist circumference and waist-to-hip ratio. Globally, mean BMI is 27.9±6.2 kgm^{-2} and 26.0±5.2 kg/m^2 for African American and Caucasian respectively [20]. As for mean height, in Japanese it is 172.1±5.7 cm and 165±10 cm in Spaniard [21, 22]. Moreover, Fryar, et al. [23] stated in their studies that mean waist circumference in Caucasian is 94.1±1.18 cm. The waist-to-hip ratio in Thais is 0.88±0.09 [17]. As for Malaysians, according to Aizuddin, et al. [25], the mean BMI is 25.9±6.0 kgm^{-2} [24]. Whereas the waist circumference is 75.13±12.80 cm. Also, the mean height is 163.2±6.77 cm [26]. Finally, the mean waist-to-hip ratio is 0.90 [27].

There were many studies that show the relationship between RNFL thickness and anthropometric parameters; BMI, height, waist circumference, waist-to-hip ratio. According to Karti, et al. [28] there are significant correlation between RNFL thickness and height (p<0.05). There are also studies that show significant correlation between RNFL thickness and BMI [29-31]. Baran, et al. [29] also stated that there is significant correlation between RNFL thickness and waist-to-hip ratio. However, there are also studies that show otherwise. There are studies that show no significant correlation between

RNFL thickness and BMI [17,32]. According to Grundy, et al. [32], there is no significant correlation between RNFL thickness and height.

In this research, a Pearson correlation examined the relationship between RNFL thickness and anthropometric parameters in 30 Malay subjects. The mean for average RNFL thickness was 111.33(SD= 9.308), mean for waist circumference was 76.39(SD= 6.726), mean for waist-hip ratio was 0.85(SD= 0.052), mean for height was 160.13 (SD= 8.86), and mean for BMI was 22.5 (SD= 4.41). The Pearson correlation test established a negligible linear relationship between RNFL thickness and waist (r=0.09, p=0.634), RNFL thickness and waist-hip ratio (r= -0.15, p=0.44), RNFL thickness and height (r=0.03, p=0.87) and RNFL thickness and BMI (r=0.02, p=0.91).

While this research found no significant correlation between RNFL thickness and anthropometric measurements in Malay subjects, future research should expand on these findings by including larger and more diverse sample populations to improve generalizability. It would be beneficial to include participants of different ages and health backgrounds to explore potential variations in RNFL thickness across various demographic groups. Longitudinal studies could provide insights into how RNFL thickness changes over time in relation to anthropometric factors and the development of ocular or systemic diseases. Additionally, combining modern imaging methods with thorough metabolic profiles may reveal subtle correlations and underlying mechanisms that link RNFL thickness to broader health outcomes. Exploring genetic predispositions and environmental effects could improve our understanding of RNFL variants and their clinical implications. This integrated strategy would considerably aid in the early detection, prevention, and treatment of disorders related with RNFL abnormalities.

Conclusion

Despite previous research indicating possible links between RNFL thickness and key anthropometric measurements in various populations, our findings did not reproduce these associations in the Malay group. This disparity could be attributed to ethnic disparities, sample size, or other unaccounted-for factors. Additional study with bigger and more diverse populations is required to better understand the complex link between RNFL thickness and anthropometric characteristics across ethnic groups.

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