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Research Article

# Prevalence of Optic Disc Cupping in Non-Glaucomatous Healthy Saudi Females

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## Abstract

**Purpose:** This study was conducted to assess optic disc size and cupping in non-glaucomatous healthy Saudi females using Topcon Three-Dimensional (3D) Optical Coherence Tomography (OCT) 2000 – Spectral Domain (SD-OCT), to estimate norms of these values for clinical practice application. Also, the average of the vertical integrated rim area of optic disc in these subjects was determined. Furthermore, correlation of retinal nerve fiber layer (RNFL) thickness and optic disc area in all eyes was evaluated.

**Design**: This study was a prospective, non-randomized, cross-sectional, observational, and quantitative study.

**Methods:** The study included 112 eyes of 112 non glaucomatous healthy Saudi females from College of Applied Medical Sciences (CAMS) of King Saud University (KSU). The age range was 18-49 years (mean: 22.50 ± 5.535 years). Stereoscopic disc photographs were reconstructed using Topcon 3D OCT-2000 for all subjects. Optic disc area, cup/disc ratio, and RNFL thickness were measured. Pearson correlation analysis test was used to assess the correlation between C/D ratio and age, IOP, refractive error. Also, it was used to evaluate the correlation between age and superior RNFL, inferior RNFL thickness respectively. In addition, it was used to assess the relationship between disc area and average RNFL thickness. Level of significance was considered as $P < 0.05$.

**Results:** In this study, 100 eyes of 100 subjects enrolled in the analysis of this study. The range of refractive error was from -4.00 to +4.00 D (-0.8000 ± 1.28708 D). The range of IOP was from 11.00 to 21.00 mmHg (18.00 ± 2.503 mm Hg). In this study, the range of the C/D ratio was 0.20 - 0.60 $mm^2$ (0.2976 ± 0.16500 $mm^2$). Small C/D ratio <0.3 showed the highest percent of all cases (51.0 %) while large C/D ratios > 0.6 showed the lowest percent (10.0%). C/D ratio between 0.3-0.6 demonstrated (39.00 %). In the current study, the range of disc area was 1.34-5.29 $mm^2$ (2.2196 ± 0.48084 $mm^2$). Mean total RNFL thickness was 111.39 ± 11.677µm. There was a statistically significant positive correlation between the disc area and the average RNFL thickness ($P = 0.001$ & $r = 0.322$).

**Conclusion:** This study is the first one to assess the prevalence of non-glaucomatous cupping in healthy Saudi females using Topcon 3D OCT-2000. Further studies are recommended to investigate non glaucomatous cupping in normal Saudi males and in different age groups.

**Keywords**: Optical Coherence Tomography, Optic disc, Optic cup, Retinal nerve fiber layer thickness

## Introduction

Optic nerve head analysis is mandatory in the early detection of glaucoma and monitoring progression in patients with recognized glaucoma [1]. Glaucomatous alterations in optic nerve cup are documented by evaluation of the relations between optic disc size, neuroretinal rim, and optic cup [2].

The European Glaucoma Society categorized the disc according to the disc area as small (<1.6$mm^2$), medium (1.6-2.8 $mm^2$), and large (>2.8 $mm^2$) [3]. Jonas 2005 found that optic disc size markedly increases for myopia > -8.00 diopters (D) and considerably decreases for hyperopia > +4.00 [4]. Increased cup/ disc ratio (C/D ratio) is not certainly characteristic for glaucoma. On the other hand early glaucomatous cupping can be unnoticed in small discs with small cups. It was supposed that small optic discs were hardly cupped, and large optic discs were constantly cupped [5].

Optical Coherence Tomography (OCT) is a valuable device in discriminating

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glaucomatous from non-glaucomatous optic cupping. Non-glaucomatous optic cupping has more diffuse RNFL loss configuration compared to glaucomatous optic cupping [6].

The aim of this study was to assess optic disc size and cupping in non-glaucomatous healthy Saudi females using Topcon Three-Dimensional (3D) Optical Coherence Tomography (OCT) 2000 - Spectral Domain (SD-OCT), to estimate norms of these values for clinical practice application. Also, the average of the vertical integrated rim area of optic disc in these subjects was determined. Furthermore, correlation of retinal nerve fiber layer (RNFL) thickness and optic disc area in all eyes was evaluated.

## Study Design

This study was a prospective, nonrandomized, observational, and quantitative study. It got the approval of Research Ethics Committee of College of Applied Medical Sciences (CAMS), King Saud University, Riyadh, Saudi Arabia. It adhered to the tenets of the Declaration of Helsinki. All the participants signed comprehensive consent after explanation of the possible consequences of the study prior to investigations.

## Subjects and Methods

The study included 112 eyes of 112 non glaucomatous Saudi females. All subjects were recruited from CAMS (female section) of King Saud University, Riyadh, Saudi Arabia. This is the place of work of first equal authors.

Inclusion criteria were best correct visual acuity of 6/6 (20/20), no previous ocular history involving the posterior segment, spherical equivalent ≤ ±5.00 diopters, normal visual fields, intraocular pressure of ≤ 21 mm Hg in both eyes, no history of diabetes, and no systemic β blocker medication. Each subject was asked about any history of ocular pathology, any history of family disease such as glaucoma involving a first degree relative. Exclusion criteria were poor OCT quality, retinal pathology such as diabetic retinopathy, macular edema, central retinal vein occlusion, or history of retinal laser treatment.

All subjects had a standard clinical examination included: visual acuity (Snellen visual acuity chart), pupil examination, IOP measurement by non-contact air-puff tonometer, slit-lamp examination and dilated fundus examination.

In this study, optic disc area, cup/disc ratio, and RNFL thickness were measured using Topcon 3D OCT-2000 system (SD-OCT). Stereoscopic disc photographs were reconstructed for all subjects. The red box (4.0×4.0mm) makes it easier to automatically generate RNFL thickness value extracted from a 3.4mm peripapillary circle of data points centered on the optic disc. The green box shows the 6.0×6.0mm scanning area [7] Most OCT machines roll on casters. This is a feature that can make it possible to perform scans on every patient, even the one in a wheelchair. A pupil size > 2mm is recommended. After the patient was instructed to rest her chin on the machine, she has to look into a lens. Blinking is important as it keeps a nice tear film over the cornea and improves clarity of the image [8].

## Statistical Analysis

Statistical analysis was performed with statistical software (SPSS version 22.0, SPSS Inc., USA). Descriptive analysis including mean values and standard deviation (SD) of age, refractive error, IOP, C/D ratio, average RNFL thickness, superior and inferior RNFL thickness. Pearson correlation analysis test was used to assess the correlation between C/D ratio and age, IOP, refractive error. Also, it was used to evaluate the correlation between age and superior RNFL, inferior RNFL thickness respectively. In addition, it was used to assess the relationship between disc area and average RNFL thickness. Level of significance was considered as $P < 0.05$.

## Results

112 eyes of 112 normal Saudi female subjects (non-glaucomatous) participated in this study, 10 eyes were excluded because of their high IOP; another 2 eyes were excluded because of poor image quality. So, 100 eyes of 100 subjects enrolled in the analysis of this study. The age range was 18–49 years (mean: 22.50 ± 5.535 years). The range of refractive error was from -4.00 to +4.00 D (-0.8000 ± 1.28708 D). The range of IOP was from 11.00 to 21.00 mmHg (18.00 ± 2.503 mm Hg) (Table 1).

In this study, the range of the C/D ratio was 0.20 - 0.60 $mm^2$ (0.2976 ± 0.16500 $mm^2$). Small C/D ratio < 0.3 showed the highest percent of all cases (51.0 %) while large C/D ratios > 0.6 showed the lowest percent (10.0%). C/D ratio between 0.3-0.6 demonstrated (39.00 %) (Figures 1 and 2). However, there was a statistically significant positive correlation between C/D ratio and age of all subjects ($P = 0.032$, $r = 0.183$). While there was no statistically significant correlation between C/D ratio and IOP nor refractive error ($P = 0.202$ & $r = - 0.084$) (0.372 & $r = - 0.033$) respectively (Table 2).

In the current study, the range of disc area was 1.34-5.29 $mm^2$ (2.2196 ± 0.48084 $mm^2$). Mean total RNFL thickness was 111.39 ± 11.677µm. There was a statistically significant positive correlation between the disc area and the average RNFL thickness ($P = 0.001$& $r = 0.322$) (Figure 3). Moreover mean superior RNFL thickness was 139.70 ± 19.993µm, and the mean inferior RNFL thickness was 143.79±17.534µm. There was no statistically significant correlation between age and the superior RNFL thickness nor inferior RNFL thickness ($P= 0.320$ &$r = -0.047$) ($P= 0.468$ & $r=0.008$) respectively (Figures 4 and 5).

## Discussion

There is a great challenge in discriminating the normal enlarged cup, from the pathologically altered cup. The purpose of this study was to assess optic disc size and cupping in non-glaucomatous Saudi females using Topcon (3D OCT-2000). This study demonstrated mean C/D ratio of about 0.2976± 0.16500 $mm^2$. In addition, the study showed the highest percent of cases (51.50 %) has a small C/D ratio. C/D ratios can be classified according to many studies such as Zangalli, et al. [9] into three ranges. A C/D ratio < 0.3 usually indicates small cup while a C/D ratio between 0.3 and 0.5 denotes normal sized cup. A C/D ratio > 0.5 signifies large cup which can be considered glaucomatous until proved otherwise.

**Table 1:** Mean values, standard deviation (SD) of age, IOP and refractive error of 100 eyes.

| | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|
| Age | 18 | 49 | 22.50 | 5.535 |
| IOP | 11 | 21 | 18.00 | 2.503 |
| Refractive error | -4.00 | 4.00 | -.8000 | 1.28708 |

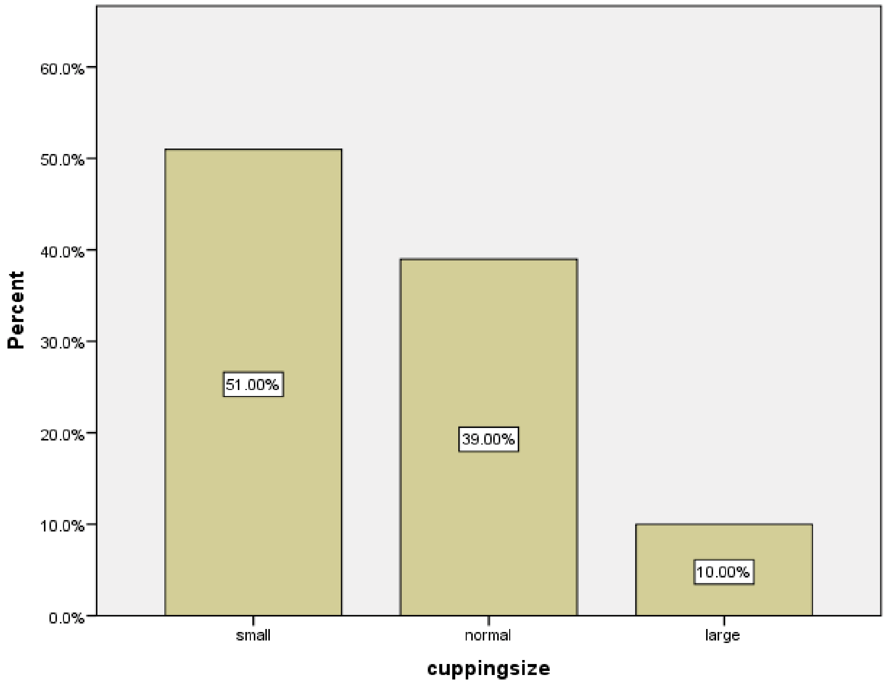


**Figure 1:** Frequency of cup / disc ratio in 100 eyes.

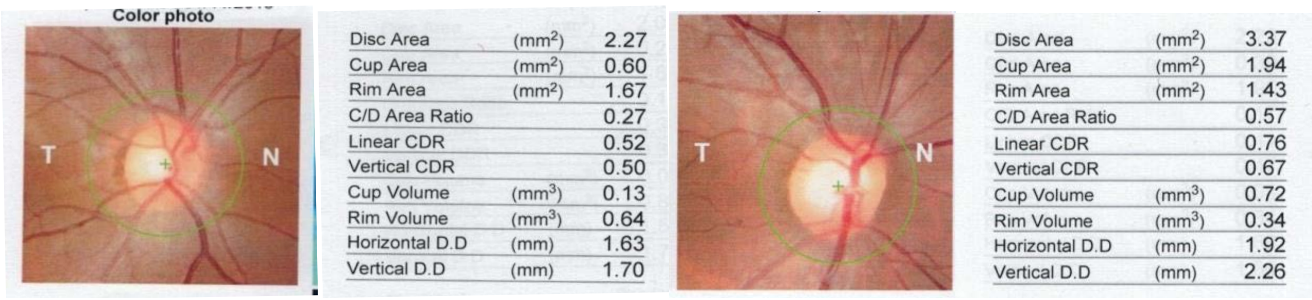


**Figure 2:** Small cup size compared to large cup size in healthy subjects.

**Table 2:** Frequency of C/D ratio in 100 eyes.

| C/D ratio | Frequency | Percent (%) |
|---|---|---|
| Small C/D ratio | 51 | 51% |
| Normal C/D ratio | 39 | 39% |
| Large C/D ratio | 10 | 10% |

This study reported a statistically significant difference between C/D ratio and age of all subjects (P= 0.032). This finding matched with the Blue Mountains Eye Study [10] that documented association between every decade of increased age and 1.4% increase in mean C/D ratio. Similarly, Garway-Heath, et al. [11] reported increase of the mean C/D ratio by nearly 0.1 between ages 30 and 70 years. On the other hand, Ramrattan, et al. [12] and Singapore Malay Eye [13] Studies detected no significant difference between age and C/D ratio.

Regarding correlation between C/D ratio and refractive error, our study showed no statistically significant correlation. This result agreed with Varma, et al. [14] that found no association between refractive error and size of optic disc. In addition, Kim, et al. [15] demonstrated no correlation between C/D ratio and

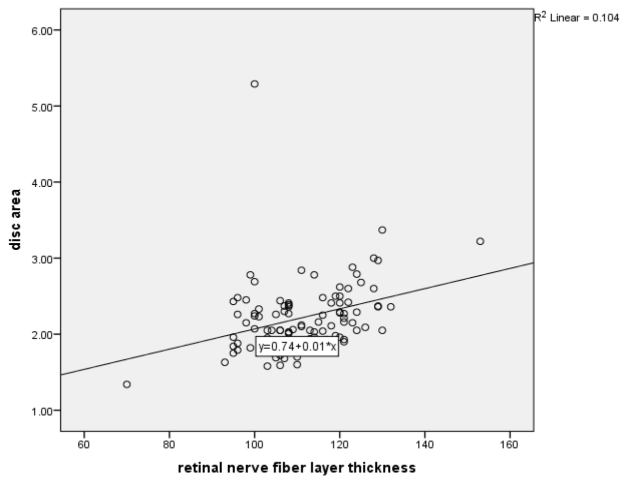


**Figure 3:** Correlation between disc area and retinal nerve fiber layer in 100 eyes.

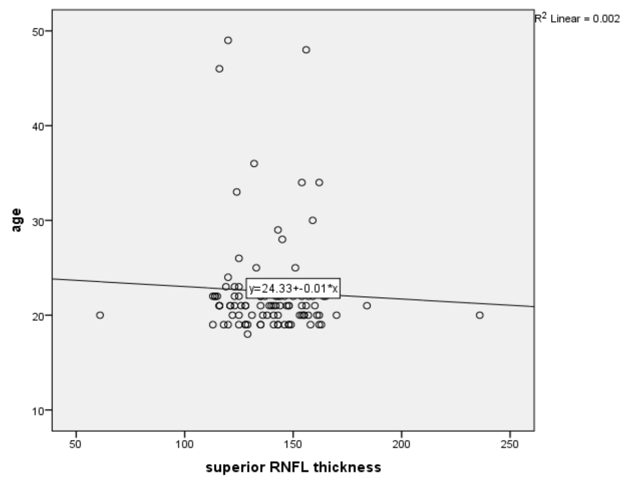


**Figure 4:** Correlation between the superior RNFL thickness and age in 100 eyes.

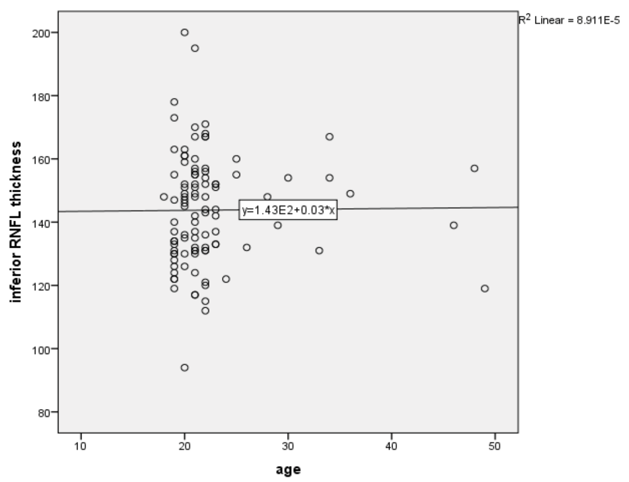


**Figure 5:** Correlation between the inferior RNFL thickness and age in 100 eyes.

refractive error. Conversely, Ramrattan, et al. [12] documented that each diopter increase of myopia leads to a statistically significant increase of disc area by 1.2% (0.15%). Also, Jonas, et al. [16] and Wang, et al. [17] showed significant association between myopia and optic disc size. Moreover, Quigley [18] reported significantly large optic disc size in marked degree of myopia and small disc size in high degree of hyperopia (> +5 D) compared to emmetropic eyes.

Concerning association between C/D ratio and IOP, our study found no statistically significant association. This finding can be explained by inclusion of normal subjects only in this study. On the other hand, the Blue Mountains Eye Study [10] reported that every 10 mmHg increase in IOP causes increase of C/D ratio by 0.04. Additionally, Ramrattan, et al. [12] and the Singapore Malay Eye [13] documented significant association C/D ratio and IOP.

As regards correlation between disc area and average RNFL thickness, this study showed a statistically significant correlation (P=0.001). This result was in agreement with Quigley study [18] that documented linear increase of the nerve fiber count with an increase in optic disc size. Also, Funaki, et al. [19] and Toprak and Yilmaz [20] studies reported a significant positive correlation between optic disc size and mean RNFL thickness.

Regarding association between age and RNFL thickness, our study did not find significant association between age and superior RNFL thickness nor inferior RNFL thickness (P 0.320, 0.468 respectively). This finding agreed with Balazsi, et al. [21]. In opposition, Budenz, et al. [22] and Poinoosawmy, et al. [23] confirmed a significant reduction of RNFL thickness with advanced age. However, Parikh study [24] reported that the inferior quadrant RNFL is more resistant to thinning with age compared to the superior quadrant RNFL. Our study showed a few limitations such as small sample size and narrow age range.

## Conclusion

This study is the first one to assess the prevalence of non-glaucomatous cupping in healthy Saudi females using Topcon 3D OCT-2000 system (SD-OCT). Further studies are recommended to investigate non glaucomatous cupping in normal Saudi males and in different age groups.

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