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The Relationship Between Axial Ocular Measurements And Corneal Endothelial Cells In Emmetropic Eyes Of Healthy Children Of Palestine

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Abstract

Objective: Firstly, to investigate the impact of central corneal thickness (CCT), anterior camber depth (ACD), lens thickness (LT), and axial length (AL) on characteristics of corneal endothelial cells in emmetropic eyes of healthy children. Secondly, to explore the normal distribution values of endothelial cell density (ECD) and morphology, as well as the effect of gender on study parameters.

Method: The school-based cross-sectional study included 118 children, aged 15. The subjects' left eyes were examined with a non-contact specular microscope, an ultrasound pachymeter, and an ultrasound A-scan. The following parameters were measured: ECD, CCT, AL, ACD, LT, mean cell area (MCA), the coefficient of variation (CV), and the percentage of regular hexagonal cells (hexagonality). SPSS 22.0 was used for statistical analysis.

Results: The mean values in cell density (cell/mm2), MCA (μm2), CV (%), hexagonality (%), AL (mm), ACD (mm), LT (mm), and CCT (μm) in the examined eye were 2955.39 ± 227.7, 342.27 ± 25.6, 35.99 ± 7.3, 57.47 ± 9.3, 23.08 ±0.68, 3.46 ± 0.27, 3.53 ± 0.18, and 539.99 ± 36.7, respectively. A significant positive correlation was observed between ACD and hexagonality ($P < 0.008$, $R = 0.26$). Linear regression analysis revealed a 4.37 % increase in hexagonality for every 0.5 mm increase in ACD ($P = 0.008$, $R^2 = 0.067$). No correlation was observed between CCT, AL, and LT, and ECD and morphology ($P > 0.05$). There was a statistically significant difference in CV, hexagonality, and AL between males and females (4.27 ± 1.4%, $P = 0.002 < 0.05$), (5.63 ± 1.75 %, $P = 0.002 < 0.05$), and (0.34 ± 0.13 mm, $P = 0.010 < 0.05$), respectively. Gender did not have a significant effect on the other parameters ($P > 0.05$).

Conclusion: This research reports the normal values of corneal ECD and morphology, and axial ocular measurements in healthy Palestinian children. Eyes with deeper ACD have a more regular corneal endothelium hexagonality and a low CV. There is no correlation between CCT, LT, AL, and ECD and morphology. Male children have a longer AL.

Keywords:
endothelial cells density, endothelium hexagonality, anterior chamber depth, coefficient of variation.

1. Introduction:

The cornea, the avascular transparent connective tissue, along with the conjunctiva, form the outer coat of the eye. It's the main ocular refractive component and is an exceptional tissue because it has both viscoelasticity and a high-level of transparency to the visible spectrum (Meek, 2009). It histologically consists of five layers: stratified squamous epithelium, Bowman's membrane, stroma, Descemet's membrane and the endothelium (Bikas Bhattacharyya, 2009). One of the major factors participating in corneal transparency is healthy corneal endothelial cells characteristics (Elbaz et al., 2017). The corneal endothelial cells are evenly 4-6μm thick and 20μm wide and most of them have a regular hexagonal shape (Kochar, Bhargava, Agarwal, & Maurya, 2016a). The endothelial cells density is about 3500/mm^2, decreasing with age at a rate of 0.6% per year (DelMonte & Kim, 2011). Consequently, the remaining cells overlap and cover the resulting gaps (Galgauskas, Norvydaite, Krasauskaite, Stech, & Ašoklis, 2013). The study of endothelial cells characteristics has passed by several developments throughout the last decades. Diverse methods, including the contact and non-contact techniques, have been developed for the clinical observation and evaluation of the corneal endothelium. Specular microscopy is used for the study and analysis of the corneal endothelium characteristics noninvasively, giving data about the endothelial cell density (ECD), hexagonality, mean cell area (MCA), and central corneal thickness (CCT). Distributions of corneal endothelial cells density and morphology have been reported by several studies (Duman, Tok Çevik, Görkem Çevik, Duman, & Perente, 2016; Galgauskas et al., 2013; Hashemian, Moghimi, Fard, Fallah, & Mansouri, 2006a). Many studies, as well, investigated the relationship between endothelial cells density and morphology, and axial ocular measurements as axial length (AL) (Müller, Craig, Grupcheva, & McGhee, 2004a), anterior chamber depth (ACD) (Patel, Patel, & McGhee, 2009), and CCT (Müller, Craig, Grupcheva, & McGhee, 2004b) in different ethnic and age groups. However, few studies were reported on distributions of corneal endothelial cells density and morphology, and their associations with ocular parameters in children. To the best of our knowledge, there is no available data in the published literature about normative database of endothelial cells density and morphology and their associations with ocular parameters in children of Palestine. Therefore, this study was primarily conducted to investigate the relationship between axial ocular parameters and endothelial cells density and morphology in children. A second objective was to explore the normal distribution values of endothelial cells density and morphology, as well as the effect of gender on study parameters.

2. METHODOLOGY:

SUBJECTS AND STUDY DESIGN

This cross-sectional study was performed on school children of an age of 15 years. The 118 subjects were selected randomly from the 10th grade of government schools of different areas in Gaza Strip. In this study, the left eye was only included. The study sample and data collection criteria are illustrated in a flowchart presented in figure 1.

REFRACTION EXAMINATION

First, all enrolled students underwent the measurement of distance uncorrected visual acuity using Snellen E-chart (Good-lite Co., Elgin, IL, USA) in special rooms at schools, and only those who attained 6/6 vision or better in each eye were included in the study. The students were then transported to the clinic to receive optometric and ophthalmic examinations. All measurements of ocular parameters were taken after complete refraction tests. Non-cycloplegic refraction was then measured with an auto-keratorefractometer (RC-5000 Advanced, Tomey, USA). The average of four reliable readings was considered as the valid reading. To minimize the impact of refractive status of the eye on axial ocular parameters and endothelial cells characteristics, the study included emmetropic eyes of healthy children only. Emmetropia here was defined as those with refractive status between (-0.25Ds to

+0.75Ds and/or -0.25Dc to -0.75Dc) by auto-keratorefractometer and attained 6/6 vision or better in each eye without any optical correction.

SLIT LAMP EXAMINATION

Slit lamp biomicroscopy was performed for all students by one experienced ophthalmologist to examine the anterior segment of the eye. Biomicroscopic indirect ophthalmoscopy using Volk 78 double aspheric lens was also performed for all students to examine the posterior segment of the eye in details. The same ophthalmologist measured the intraocular pressure (IOP) by using the Goldmann applanation tonometer.

MEASUREMENT OF CORNEAL ENDOTHELIAL CELLS DENSITY AND MORPHOLOGY

Each subject underwent a non-contact specular microscope examination (TOMY, EM-3000 Specular Microscope). The subject was asked to focus on the target shown in the device while the photo was being captured, and the test included the study of the endothelial cells density, hexagonally, and mean cell area. A data profile for each subject was created and all measurements were recorded accordingly.

MEASUREMENT OF AXIAL OCULAR PARAMETERS

The CCT was measured by contact method using ultrasound pachymeter (Sonomed Pacscan 300A+, USA). The subjects were advised to set properly on a chair, then had an anesthesia drops installed on their eyes, and the pachymeter probe was sterilized using an Alcohol pad. Each subject was requested to fixate on a target viewed on the opposite wall and the probe was gently introduced to the central cornea without pressure. Five scans were taken and the average value was documented. A one qualified optometrist, using contact method ultrasound A-scan (Tomy, Al -100 Biometer), performed the other axial ocular measurements; AL, ACD, and LT measurement. The probe was directed perpendicularly to the central cornea. The average of four reliable readings was considered as the valid reading and was recorded accordingly. All measurements of axial ocular parameters and endothelial cells characteristics were taken between 11:00 am -13:00 pm at different days and within a two-month period.

INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria of this study included the following: no previous ocular surgery, absent previous history of an ocular or systemic disease, and emmetropia. Exclusion criteria included a positive history of any type of prior systemic or ocular medical or surgical treatment, positive history of head or eye trauma, uncorrected visual acuity < 6/6 in either eye, refractive errors outside the limits of (-0.25Ds to +0.75Ds and/or -0.25Dc to -0.75Dc), measured IOP >21 mmHg in either eye, and previous contact lens use.

COMPLIANCE WITH ETHICS GUIDELINES

The ethics committee of Palestinian health research council has approved the proposal of the study and provided a written ethical approval (No. PHRC/HC/161/16-Helsinki Approval). The study protocol was conducted in accordance with the tenets of Declaration of Helsinki. Written informed consent was obtained from either parents or the legal guardian of the child. Of importance, any child brought a signed informed consent from his or her parents or legal guardian but did not cooperate well or simply refused to complete the examination was not included in the current study and was transported back to his or her school. In other words, children's assent to participation in the current study was properly obtained.

STATISTICAL ANALYSIS

SPSS software, version 22.00 (SPSS, Inc., Chicago, IL), was used for data analysis. Frequencies and percentile were used to represent demographics as age, gender. Histogram chart was used to represent quantitative and qualitative data of anterior chamber depth and hexagonality variables. Values are reported as means ± standard deviation, and P-value < 0.05 was considered statistically significant. The independent sample t-test was used to compare values of study parameters between male and female groups. Pearson correlation coefficient was used for measuring the relationship between measurements of axial ocular parameters and corneal endothelial cells density and morphology. Simple linear regression analysis and coefficient of determination R^2 were used to measure the effect of anterior chamber depth on endothelium hexagonality for the left eye.

3. RESULTS:

DEMOGRAPHIC CHARACTERISTICS

Overall, 118 school children were considered for enrollment, however, 14 (11.86%) children were excluded due to the criteria outlined above. Reasons for exclusion from analysis were: refractive errors (8 subjects), ocular trauma (2 subjects), informed consent disapproval or poor assent (2 subjects), and systemic pathology (2 subjects). In total, the study included 104 eyes of 104 emmetropic healthy school children (88.13%) aged 15 years old. Detailed demographic characteristics of the study population are described in table 1, and figure 2. Mean age was 15 years. The study population consisted of 46 (44.23%) males and 58 (55.77%) females. Mean axial ocular measurements values of CCT, ACD, LT, and AL were 539.99 ± 36.7 µm, 3.46 ± 0.27 mm, 3.53 ± 0.18 mm, 23.08 ±0.68 mm, respectively. Mean corneal endothelial cells measurements values of cell density, mean cell area, CV, and hexagonality were 2955.39 ± 227.7 cell/mm^2, 342.27 ± 25.6 µm^2, 35.99 ± 7.3 %, and 57.47 ± 9.3%, respectively. More details are shown in table 1.

DISTRIBUTION OF CORNEAL ENDOTHELIAL CELLS DENSITY AND MORPHOLOGY

Distribution of endothelial cells characteristics due to gender is presented in table 2. In males, mean values for cell density, mean cell area, CV, and hexagonality were 2969.37 ± 219.5 cell/mm^2, 340.43 ± 24.1 µm^2, 33.61 ± 6.3 %, and 60.61 ± 8.9 %, respectively. In females, mean values for cell density, mean cell area, CV, and hexagonality were 2944.31 ± 235.4 cell/mm^2, 343.72 ± 27 µm^2, 37.88 ± 7.5 %, and 54.98 ± 8.8 %, respectively. Using independent sample t-test, there was a statistically significant difference in CV between males and females (4.27 ± 1.4%) for sake of females p= 0.002< 0.05. A statistically significant difference was also observed in hexagonality between males and females (5.63±1.75 %) for sake of males (P= 0.002< 0.05). Another difference was also observed in AL between males and females (0.34± 0.13 mm) for the sake of males (p= 0.010< 0.05).

DISTRIBUTION OF AXIAL OCULAR MEASUREMENTS

Distribution of axial ocular measurements due to gender is presented in table 1. In males, mean axial ocular measurements values of CCT, ACD, LT, and AL were 539.43 ± 36.2 µm, 3.50 ± 0.29 mm, 3.50 ± 0.20 mm, and 23.27 ± 0.59 mm, respectively. In females, mean axial ocular measurements values of CCT, ACD, LT, and AL were 540.43 ± 37.4 µm, 3.42 ± 0.25 mm, 3.55 ± 0.17 mm, and 22.93 ± 0.71 mm, respectively. Using independent sample t-test, there was a statistically significant difference in AL between males and female (0.344 ±0.13 mm) for the sake of males, p=0.01<0.05. No statistically significant differences were observed in CCT, ACD, and LT between males and females, p > 0.05. More details are shown in table 2.

CORRELATION BETWEEN CORNEAL ENDOTHELIAL CELLS DENSITY AND MORPHOLOGY, AND AXIAL OCULAR PARAMETERS

Using Pearson correlation coefficient, a positive correlation was observed between ACD and hexagonality (P= 0.008, R= 0.26) for the total subject population. Linear regression analysis yields a nonzero slope with a slope value of 4.37 % increase in hexagonality for every 0.5 mm increase in ACD of the left eye ($P = 0.008$, $R^2 = 0.067$), as can be seen in figure 3. However, this correlation was not observed in male or female subjects alone. In addition, there were no additional correlations observed between other axial parameters and endothelial cells parameters, $p < 0.05$, as can be seen in table 3.

4. DISCUSSION:

In 1975, the corneal endothelium was first inspected using specular microscopy. Since then, a variety of methods for investigating the corneal endothelium have been significantly improved. Many investigations (Galgauskas, Krasauskaite, Pajaujis, Juodkaite, & Asoklis, 2012b; Kochar, Bhargava, Agarwal, & Maurya, 2016b; Sheng, Bullimore, Zadnik, & Fink, 2006) have studied the corneal endothelial cells density and morphology to demonstrate their clinical significance and association of their values with eye diseases, age, and gender. The corneal endothelial cells don't have regenerative ability. therefore, a decrease in corneal endothelial cells density is compensated by cells spreading which increase cellular polymegathism and decrease the percentage of endothelium Hexagonality (Duman et al., 2016). Several studies have reported the relationship between endothelial cells density and morphology with age, gender, and ethnicity. It is clear that corneal endothelial characteristics significantly differ among races and ethnic groups (Arıcı, Arslan, & Dikkaya, 2014a). Therefore, it is important for populations of different racial and ethnic backgrounds to establish normative data on which clinical decisions regarding endothelium function are made. This school-based cross-sectional study is the first study to report on the corneal endothelial cells characteristics and axial ocular parameters in the Palestinian children.

NORMATIVE DISTRIBUTION OF ENDOTHELIAL CELLS DENSITY AND MORPHOLOGY, AND AXIAL LENGTH MEASUREMENTS

Our study showed that the mean values in endothelial cells density, mean cell area, CV in cell size, and hexagonality in school children aged 15 years old were 2955.39 ±227.7cell/mm^2, 342.27±25.6µm^2, 35.99 ±7.3%, and 57.47 ±9.3%, respectively. Direct comparisons of our results with those reported by other studies are difficult due to the variations in the measuring method, age, and ethnicity. However, a study performed on 104 healthy Turkish children aged 6-20 years old showed that ECD, MCA, CV, and hexagonality were 3101 ± 268cell/mm^2, 325 ± 28 µm^2, 43 ±9 %, and 52 ±10%, respectively (Duman et al., 2016). Our result revealed higher values of MCA, hexagonality, and CCT, but lower values of ECD and CV than Turkish population, which can be attributed to the age difference and the use of a non-contact method in measuring CCT. By contrast, another study from Turkey performed on 42 participants aged 20-30 years old reported different results in mean cell density, CV in cell size, and Hexagonality (Arıcı, Arslan, & Dikkaya, 2014b). These studies demonstrated similar CCT values (536.1± 31.9µm and 527 ± 51µm, respectively), which is slightly lower than our results (539.99 ± 36.7µm). The difference in the CCT is most likely due to the different measurement technique. A study performed on 102 normal Iranian subjects aged 20-30 years revealed lower values in ECD 2407±399mm^2 and CV 20.4±5.5% with higher values of MCA 427.8±74.9 µm^2 than our results (Hashemian, Moghimi, Fard, Fallah, & Mansouri, 2006b). The variation might be due to different ethnic and age groups. The current study is the first to provide normative values of axial ocular measurements in Palestinian children. The mean values of AL (mm), ACD (mm), and LT (mm) in the examined eye were 23.08 ±0.68, 3.46 ± 0.27, and 3.53 ± 0.18, respectively. A study performed in Saudi Arabia (Osuobeni, 1999a) showed higher values of AL 23.48±1.06 mm and LT 3.72±0.27 mm with lower values of ACD 3.20±0.38 mm. This difference is possibly attributed to a wider range of age group in the Saudi study.

CORRELATION BETWEEN ENDOTHELIAL CELL DENSITY AND MORPHOLOGY, AND AXIAL OCULAR MEASUREMENTS

One of the study objectives was to observe the relationship between axial ocular measurements and specular microscopic parameters. A positive correlation was observed between ACD and hexagonality (P= 0.008, R= 0.26) for the total subject population of the study. To the best of our knowledge, there is no available data in the literature about the correlation between axial ocular measurements and specular microscopic parameters in normal subjects. Patel (Patel et al., 2009) reported a study on 62 healthy young adults that showed no statistical significance between ACD and ECD (r=0.15, P=0.30) which comes in agreement with our study (r=0.15, P=0.127). Our study found that CCT doesn't significantly correlate to ECD (r=0.01, P=0.855) which is inconsistent with a study performed on 75 elderly participants and demonstrated that ECD was significantly correlated to CCT (P=0.021) where ECD was increased by 212 cells/mm^2 for every 0.1 mm increase in corneal thickness (Müller et al., 2004b). This study showed a statically significant negative correlation between AL and ECD (r=−0.235, P=0.04) being also inconsistent with our study results (r=0.99, P=0.318). This may be a result of older age group and different measurement techniques.

THE EFFECT OF GENDER ON STUDY PARAMETERS

The impact of gender on endothelial cell density and morphology and axial ocular parameters is still controversial. Several studies (Delshad, 2013; Hashemian et al., 2006a; Hatipoglu et al., 2014) have concluded that there is no statistically significant difference in endothelial cell density and morphology between males and females. In our study, we found a significant difference in CV due to gender (males: 33.61 ± 6.3%, females: 37.88 ± 7.5%, P= 0.003) which is agreement with a previous study (Sopapornamorn, Lekskul, & Panichkul, 2008) performed on 404 subjects aged 41.73±18.21 years (males: 37.94±7.13%, females: 40.62±8.86%, P=0.001). In addition, our study has agreed with a study performed on 101 participant in Lithuania (Galgauskas, Krasauskaite, Pajaujis, Juodkaite, & Asoklis, 2012a) which showed that hexagonality differs significantly due to gender (males 65.11±10.2, females 60.63 ±10.4, P=0.03), giving similar results to ours (males: 60.61 ± 8.9, females: 54.98 ± 8.8, P=0.002). Our study revealed a significant association between AL and gender (males: 23.27 ± 0.59mm, females: 22.93 ± 0.71mm, P= 0.010), which is in agreement with a study performed on 152 subjects aged 22.68 years in Saudi Arabia (males: 23.81±0.99mm, females 23.16±1.03mm, P=0.000) (Osuobeni, 1999b). In contrast, a Population-based study comprised 4711 subjects (aged > 30 years) in a rural region of central India (Nangia et al., 2010) did find any significant correlation between AL and gender (P=0.57). This might be due to the difference in ethnicity, age group, and measuring technique. Many studies (Durkin, Tan, Casson, Selva, & Newland, 2007; Landers, Billing, Mills, Henderson, & Craig, 2007; Wong, Wong, Yuen, & Hui, 2002) did not find a significant correlation between CCT and gender which is in agreement with our study (males 539.43± 36.2 µm, females 540.43 ± 37.4 µm, P=0.891).

Our study showed that both ACD (males 3.50 ± 0.29mm, females: 3.42 ± 0.25mm) and LT (males: 3.50 ± 0.20mm, females 3.55 ± 0.17mm) are not affected by gender (P=0.17 and P=0.16, respectively).This result is inconsistent with a study performed in china (Jingjing Huang, 2012) on 150 subjects aged 62±18 years old which showed that ACD differs significantly with gender (males: 2.85±0.29mm, females: 2.56±0.33mm, P<0.05), but the LT doesn't (P>0.05). This can be attributed to many factors as ethnicity, older age group and different measuring technique.

There are some limitations that should be mentioned. First, this study is not representative for whole children population in Palestine and is only limited to children aged 15 years old in Gaza strip. Second, lack of similar studies in the published literature made comparisons very limited. Third, small sample size of the study could affect the results of the current study.

5. CONCLUSIONS:

This study reports the normal values of corneal endothelial cells density and morphology, and axial ocular measurements in healthy Palestinian children(15 years old). Eyes with deeper ACD have a more regular corneal endothelium hexagonality and a lower coefficient of variation in cell area. There is no correlation between CCT, LT, AL, and corneal endothelial cells density and morphology. Male children have a longer AL.

6. ACKNOWLEDGEMENT:

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7. TABLES:

Table 1: Demographic characteristics of the study Parameters

Gender	Male	Female	Total
Participants (n) %	**(46) 44.23%**	**(58) 55.77%**	**(104) 100%**
Endothelial Cells Characteristics Mean ± SD			
Cell density (cell/mm^2)	2969.37 ± 219.5	2944.31 ± 235.4	**2955.39 ± 227.7**
Cell area (µm^2)	340.43 ± 24.1	343.72 ± 27	**342.27 ± 25.6**
CV in cell size (%)	33.61 ± 6.3	37.88 ± 7.5	**35.99 ± 7.3**
Hexagonality (%)	60.61 ± 8.9	54.98 ± 8.8	**57.47 ± 9.3**
Axial Ocular Measurement Parameters Mean ± SD			
AL (mm)	23.27 ± 0.59	22.93 ± 0.71	**23.08 ±0.68**
ACD (mm)	3.50 ± 0.29	3.42 ± 0.25	**3.46 ± 0.27**
LT (mm)	3.50 ± 0.20	3.55 ± 0.17	**3.53 ± 0.18**
CCT (µm)	539.43 ± 36.2	540.43 ± 37.4	**539.99 ± 36.7**

n: number of the sample, AL (mm): axial length of the eyeball, ACD (mm): anterior chamber depth, LT(mm): lens thickness, CCT (µm): central corneal thickness measured by ultrasound, cell density(cell/mm^2): number of endothelial cells per mm^2, CV (%): coefficient of variation.SD: standard deviation.

Table 2: Differences in study parameters due to gender

Gender	Male	Female	
N	46	58	
Endothelial Cells Characteristics Mean ± SD			**P - value**
Cell density (cell/mm2)	2969.37 ± 219.5	2944.31 ± 235.4	**0.58**
Cell area (μm2)	340.43 ± 24.1	343.72 ± 27	**0.519**
CV in cell size (%)	33.61 ± 6.3	37.88 ± 7.5	**0.003***
Hexagonality (%)	60.61 ± 8.9	54.98 ± 8.8	**0.002***
Axial Ocular Measurement Parameters Mean ± SD			**P - value**
AL (mm)	23.27 ± 0.59	22.93 ± 0.71	**0.010***
ACD (mm)	3.50 ± 0.29	3.42 ± 0.25	**0.17**
LT (mm)	3.50 ± 0.20	3.55 ± 0.17	**0.16**
CCT(μm)	539.43 ± 36.2	540.43 ± 37.4	**0.891**

n: number of the sample, AL (mm): axial length of the eyeball, ACD (mm): anterior chamber depth, LT(mm): lens thickness, CCT (μm): central corneal thickness measured by ultrasound, cell density(cell/mm^2): number of endothelial cells per mm^2, CV (%): coefficient of variation. SD: standard deviation *mean standard deviation was attained by independent sample t-test and considered as significant when p<0.05.

Table 3: Correlation between axial ocular parameters and corneal endothelial cells

Characteristic		**CD/mm^2**		**AVG/μm^2**		**CV**		**Hexagonality**	
		R	**p-value**	**R**	**p-value**	**R**	**p-value**	**R**	**p-value**
Male n=46	**AL**	0.01	0.899	0.09	0.512	0.13	0.383	0.13	**0.379**
	ACD	0.12	0.407	0.21	0.157	0.11	0.449	0.2	**0.134**
	LT	0.15	0.291	0.22	0.125	0.25	0.091	0.03	**0.799**
	CCT(us)	0.08	0.570	0.05	0.694	0.12	0.402	0.08	**0.585**
Female n=58	**AL**	0.13	0.330	0.22	0.098	0.07	0.579	0.11	**0.374**
	ACD	0.19	0.154	0.11	0.401	0.07	0.593	0.24	**0.069**
	LT	0.01	0.932	0.08	0.523	0.02	0.838	0.18	**0.165**
	CCT(us)	0.03	0.815	0.02	0.852	0.02	0.862	0.07	**0.565**
Total n=104	**AL**	0.99	0.318	0.11	0.246	0.01	0.886	0.09	**0.346**
	ACD	0.15	0.127	0.14	0.141	0.04	0.638	0.26	***0.008**
	LT	0.07	0.474	0.13	0.161	0.07	0.436	0.11	**0.248**
	CCT(us)	0.01	0.855	0.03	0.702	0.05	0.567	0.08	**0.420**

n: number of the sample, AL (mm): axial length of the eyeball, ACD (mm): anterior chamber depth, LT(mm): lens thickness, CCT (μm): central corneal thickness measured by ultrasound, cell density(cell/mm^2): number of endothelial cells per mm^2, CV (%): coefficient of variation. SD: standard deviation. *P-value was attained by Person Correlation Coefficient, significant at p< 0.05.

8. FIGURES:

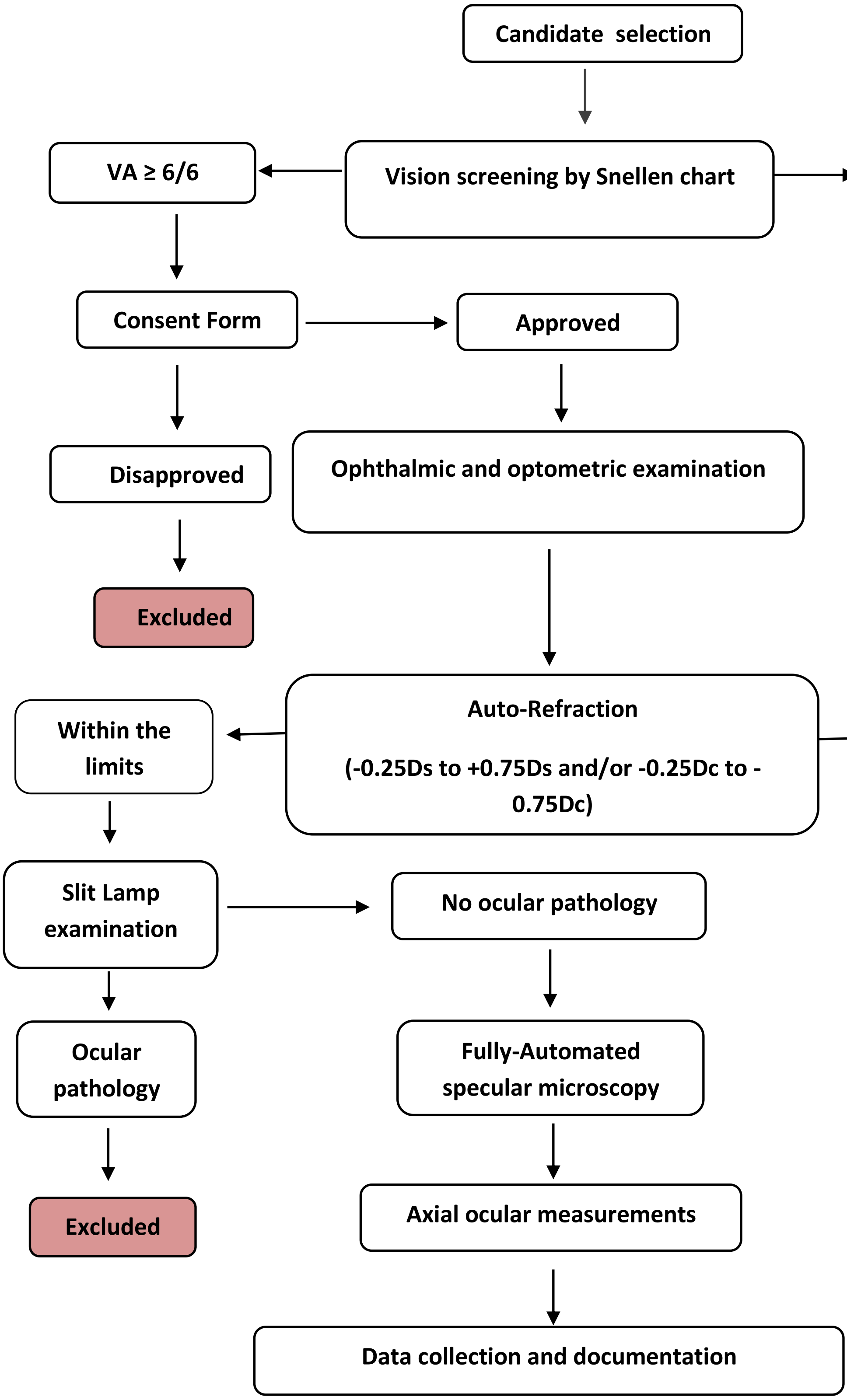

Figure 1: Flowchart of inclusion and exclusion criteria

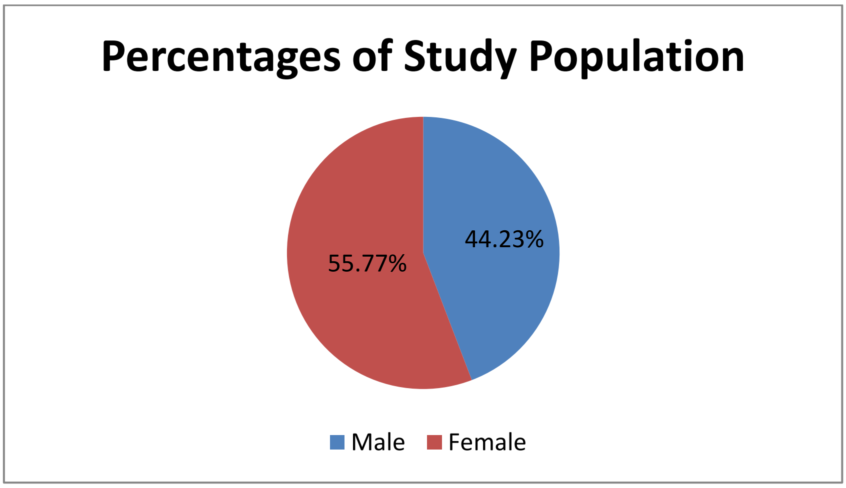

Figure 2: Percentages of the study population (n=104)

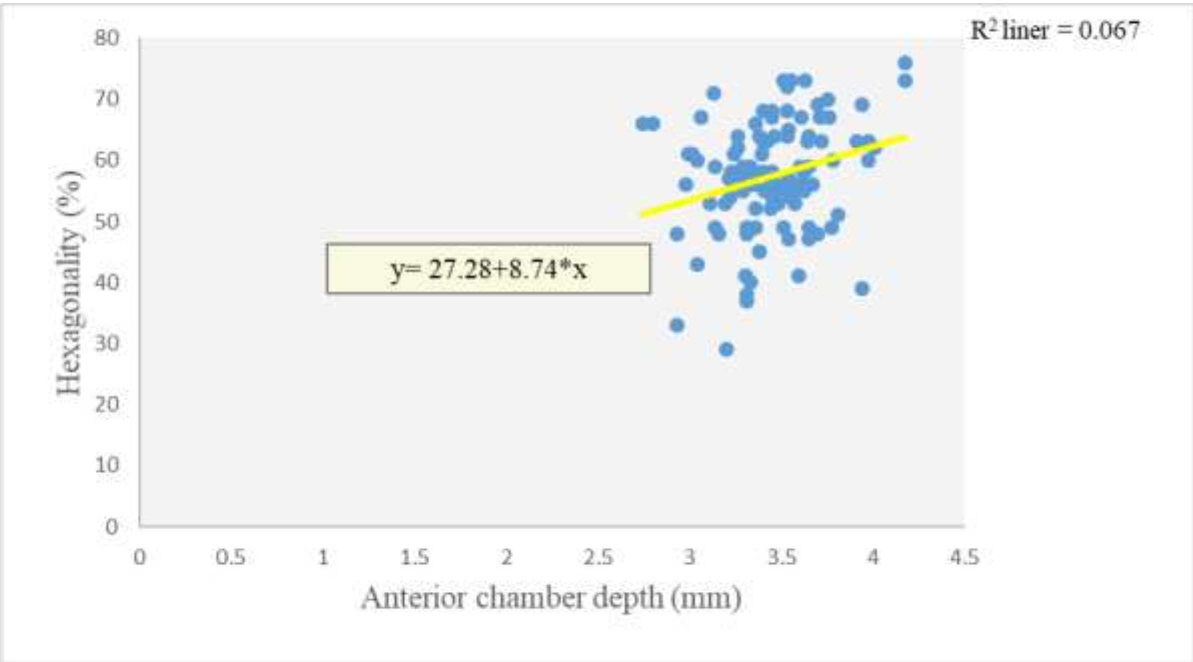

Figure 3: Scattergrams of the anterior chamber depth (ACD) as an independent variable, versus the endothelial cells hexagonality as a dependent variable, of the left eye in school children of Palestine (n=118). ACD was measured by ultrasound pachymeter, and hexagonality was measured by a specular microscope. Linear regression analysis yields a nonzero slope with a slope value of 4.37 % increase in hexagonality for every 0.5 mm increase in ACD of the left eye ($P = 0.008$, $R^2 = 0.067$).

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