Journal of Medical and Biomedical Sciences (2016) 5(2): 24-29

doi: http://dx.doi.org/10.4314/jmbs.v5i2.4

ORIGINAL ARTICLE

Refractive and binocular vision status of optometry students, Ghana

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To investigate the refractive and non-strabismic binocular vision status of Optometry students in University of Cape Coast, Ghana and to establish any associations between these conditions. A cross sectional study of 105 Optometry students were taken through a comprehensive optometric examination to investigate the refractive and non-strabismic binocular vision status. Fisher's exact test (IBM SPSS version 21) was used to assess association between these conditions. Prevalence of refractive error and non-strabismic binocular vision dysfunctions were 59.0% and 34.3% respectively. Prevalence of specific refractive errors were 17.1% myopia, 19.0% hyperopia and 22.9% astigmatism. Non-strabismic accommodative and vergence dysfunctions were found to be 21.9% and 12.4% respectively. Specific types of accommodative and vergence disorders were as follows: accommodative fatigue (8.6%), accommodative infacility (6.7%), accommodative insufficiency (4.7%) and accommodative excess (1.9%), convergence insufficiency (1.9%), convergence excess (1.0%), divergence insufficiency (2.9%), basic exophoria (1.9%), and basic esophoria (4.7%). There was a significant association between refractive errors in general and accommodative fatigue (p = 0.030) and between myopia and accommodative excess (p= 0.028). It is critical that potential primary eye care practitioners become aware of their refractive and non-strabismic binocular vision status.
Journal of Medical and Biomedical Sciences (2016) 5(2), 24-29

Keywords: Refractive errors, non-strabismic binocular vision dysfunctions, optometry students, Ghana.

INTRODUCTION

Undiagnosed refractive errors and binocular vision dysfunctions may present with discomforts which can impact negatively on academic performance (Von Noorden and Campos, 2002; Thurston and Thurston, 2013) and thus on the clinical training of optometry students. Several studies have shown higher prevalence of refractive errors especially myopia among optometry students (Septon, 1984; Bullimore *et al.*, 1989; Goss *et al.*, 1997), however few studies have investigated the binocular vision status of optometry students. A study by Richman and Laudon (2002), on optometry students in New England College of Optometry found out that 42% of the participants had binocular dysfunctions (BD), with 25% of the BD group reporting symptoms such as asthenopia, blur after reading and headaches.

As optimum vision may be a prerequisite to accurate optometric clinical judgement and diagnosis, it is important that the binocular and refractive statuses of Optometry students are established before they pass out as optometrists. Again, as students undergoing training as eye care professionals, it would seem reasonable to assume that there would be low prevalence of undiagnosed and untreated refractive and binocular vision anomalies in them. This study sought to investigate these among optometry students of the University of Cape Coast (UCC) to determine the prevalence of refractive errors and non-strabismic binocular vision dysfunctions (NSBVD) among the students. It also sought to establish any associations between refrac-

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tive errors and non-strabismic binocular vision disorders.

MATERIALS AND METHODS

Study Participants

This study participants were all Doctor of Optometry students (from first to sixth year) of the College of Health and Allied Sciences of UCC. UCC is situated at the southern part of Ghana along the coastal area where it adjoins the Atlantic Ocean.

Selection of Participants

All Optometry students of UCC were invited to participate in the study. Optometry students who consecutively attended the eye clinic of the Department of Optometry, UCC, for the purpose of the study were recruited.

Inclusion/Eligibility Criteria

The criteria for inclusion into the study were the absence of: external and internal ocular diseases, unilateral blindness, amblyopia and strabismus.

Ethical considerations

This cross sectional study followed the tenets of the Declaration of Helsinki and was approved by the ethics committee of UCC, Ghana. Informed consent was obtained from each student after the nature of the study was explained to them.

Clinical Procedure

All participants were taken through optometric clinical examination which consisted of the following test: distance and near visual acuities using logarithm of the minimum angle of resolution (LogMAR) chart (Low Vision Resource Centre (LVRC) Bailey-Lovie design), external and internal examination using ophthalmic slit lamp (Topcon SL-2G) and Keeler professional direct ophthalmoscope respectively and refraction using Keeler professional streak retinoscope and manual phoropter (Topcon VT-10). Binocular vision testing (performed over corrected refractive error) involved amplitude of accommodation (AOA) using push-up to blur method; near-point of convergence (NPC) using push-up to break and recovery method with a vertical row of 20/30 Snellen letters as target; von Graefe lateral heterophoria measurement (VGLP) at distance and near; negative fusional vergence (NFV) and positive fusional vergence (PFV) amplitudes at far and near using risley prisms from manual phoropter (Topcon VT-10); positive relative accommodation (PRA) and negative relative accommodation (NRA); gradient AC/A ratio; accommodative lag or lead using monocular estimation method (MEM); and, monocular accommodative facility (MAF) and binocular accommodative facility (BAF) testing using ±2D flipper lenses.

The results obtained from tests namely AOA test, VGLP measurement, gradient AC/A ratio, NFV amplitudes ,PFV amplitudes, NRA and PRA were compared with table of established normative values by the American Optometric Association (2010) referred to as "Expected Values for Accommodation and Vergence testing" (a modification of Morgan Jr (1944) table of expected findings"). The results from test namely MAF, BAF and MEM were compared with normative values from "Table of Expected Values: Accommodative testing" by Scheiman and Wick, (2008).

Expected normal cut off values for NPC break was taken to be 5 cm and NPC recovery was 7 cm (Scheiman *et al.*, 2003). Three or more test results above that deviated from the normative values were grouped together as signs (Porcar and Martinez-Palomera, 1997) to identify the particular NSBVD (Table 1) using criteria by

Scheiman and Wick, (2008); certain signs (Table 1) were mandatory in defining diagnostic criteria for specific disorders (Lara *et al.*, 2001). Diagnosis of refractive error (eye with the highest magnitude of spherical equivalent refractive error) and definition of emmetropia (Table 1) is consistent with earlier study on Optometry students (Septon, 1984).

Statistical methods

Data was analyzed using the IBM SPSS Version 21 (SPSS, Inc., Chicago, IL, USA). Descriptive data was analysed using frequencies, percentages, means and standard deviations. Fisher's exact test was used to test for associations. All analysis was done within 95% confidence interval and a two-tailed p-value ≤ 0.05 was considered statistically significant.

Table 1: Diagnostic signs for visual disorders

Visual Disorder	Diagnostic signs				
Refractive status					
Emmetropia	Subjective refractive power between -0.50 D and +0.50 D				
Myopia	Spherical equivalent power ≥ 0.50 D				
Hyperopia	Spherical equivalent power ≥ 0.50 D				
Astigmatism	Cylinder power ≥ 0.50 DC				
With-the-Rule	if the plus cylinder acts at 90º meridian or 20º on its either side				
Against-the-Rule	if the plus cylinder acts at 180º meridian or at 20º on its either side				
Non-strabismic binocular vision dysfunction					
Accommodative dysfunction	AOA	BAF	MAF	NRA and PRA	MEM
Accommodative Insufficiency	*Low	Fails -	*Fails -	Low PRA	*High
Ill-sustained Accommodation	*Normal	Fails -	Fails-	Low PRA	*High
Accommodative Excess	Normal	Fails +	*Fails +	Low NRA	*Low
Accommodative infacility	Normal	*Fails +/-	*Fails +/-	*Low PRA and NRA	Normal
Vergence Dysfunction	**von Graefe phoria**	**AC/A ratio**	**NPC**	**Vergence Amplitude**	
Convergence Insufficiency	*Exo > N	Low	*Receded	*Low BO at N	
Convergence Excess	*Eso > N	High	Normal	*Low BI at N	
Divergence Insufficiency	*Eso > D	Low	Normal	Low BI at D	
Divergence Excess	*Exo > D	High	Normal	Low BO at D	
Fusional Vergence dysfunction	Low Eso and Exo	Normal	Normal	*Low BO and BI	
Basic Exophoria	*Equal Exo at D and N	Normal	Normal	*Low BO at D and N	
Basic Esophoria	*Equal Eso at D and N	Normal	Normal	*Low BI at D and N	

AOA-Amplitude of accommodation BAF-Binocular accommodative facility MAF-Monocular accommodative facility NRA-Negative relative accommodation PRA-Positive relative accommodation MEM-Monocular estimation method AC/A- Accommodative convergence/accommodation NPC-Near point of convergence Eso-Esophoria Exo-Exophoria D-Distance N-Near *mandatory diagnostic sign

RESULTS

A number of 105 students (from a total of 131 Optometry students, giving a participation rate of 80.2%), with ages ranging from 19 to 27 years (mean age 22.62 SD ± 1.53 years) participated in the study. No participant was excluded from study. Out of this number, 84(80%) were males and 21(20%) were females. A total of 43 (41.0%) participants were emmetropic and 62(59%) were diagnosed with refractive errors which included 18(17.1%) myopia (-0.50 to -3.75 DS), 20(19.0%) hyperopia (+ 0.50 to +0.75 DS) and 24(22.9%) astigmatism (0.50 to 3.00 DC). Considering those with astigmatism, 11(45.8%) had with-the-rule astigmatism and 13(54.2%) had against -the-rule astigmatism. A number of 53 (85.5%) participants with refractive errors (14 with myopia of -0.50 to -1.50 DS, 20 with hyperopia of + 0.50 to +0.75 DS and 19 with astigmatism of 0.50 DC to 0.75 DC) had not received any form of correction and 39 (73.6%) out of this number had no symptoms.

The prevalence of NSBVD among participants was found to be 34.3% (33 males and 3 females). A total of 22 (21.9%) students were diagnosed with accommodative dysfunctions and 13 (12.4%) students with vergence dysfunctions. The prevalence of specific non-strabismic binocular vision dysfunctions were as follows: accommodative insufficiency (4.7%), accommodative fatigue (8.6%), accommodative excess (1.9%), accommodative infacility (6.7%), convergence insufficiency (1.9%), convergence excess (1.0%), divergence insufficiency (2.9%), basic exophoria (1.9%) and basic esophoria (4.7%). There was a significant association between refractive errors and accommodative fatigue ($p = 0.030$) and between myopia and accommodative excess ($p= 0.028$).

DISCUSSION

None of the participants in the present study exhibited marked anisometropia which is comparable to one study by Bullimore *et al.* (1989) on Optometry students in Aston University in UK. Reports on prevalence of refractive error among optometry students in other settings, show higher prevalence of myopia and lower prevalence of hyperopia than that reported in the present study. Goss *et al.* (1997), found 65.3% myopia, 30.1 % emmetropia and 4.5% hyperopia among a first-year optometry class at Northeastern State University in USA. Also, Septon, (1984), conducted a study among 447 second-year optometry students at Pacific University and found out that 74.3% had myopia, 17% had emmetropia and 8.7 % had hyperopia. Similarly, Bullimore *et al.* (1989), found among 189 Aston University optometric undergraduates that 55.6 % had myopia while 6.3 % had hyperopia. In these other studies above (Septon, 1984; Bullimore *et al.*, 1989; Goss *et al.*, 1997), it was suggested that myopic students may have been motivated to study Optometry because of their condition and frequent visits to optometrists. Bullimore *et al.* (1989), attributed this higher frequency of myopia among optometry students possibly to a high level of intelligence or the more years of education on average by Optometry students in USA.

Currently no study has however assessed level of intelligence among optometry students in Ghana. Again optometry students in Ghana enter optometry school after senior high school and thus may have spent fewer years in school compared to optometry students in USA. Also among general USA population, Vitale *et al.* (2009), found that the prevalence of myopia has increased 66% between 1971 to 1972 and 1999 to 2004. This prevalence value is very high in comparison to the prevalence of 33.5% in general Ghanaian population (Foster *et al.*, 2008) and thus could account for the lower prevalence of myopia in the present study. In contrast to present study, early studies on Optometry students (Septon, 1984; Bullimore *et al.*, 1989; Goss *et al.*, 1997) did not report on astigmatism; all prescriptions were converted to their spherical equivalents thus only frequencies for myopia, hyperopia and emmetropia were reported. Even though a greater percentage of participants with refractive errors had not received any form of correction, their reasons could not be indicated because the study was limited in terms of designing a reliable tool to measure this.

It can also be observed that the prevalence of NSBVD among optometry students was lower

compared to 42% reported by Richman and Laudon (2002), but almost similar to the 32.3% in a study on general university students by Porcar and Martinez-Palomera (1997). (Richman and Laudon (2002)), in addition to including two clinical signs in diagnosing accommodative and binocular vision disorders also performed binocular and accommodative function tests over habitual spectacle prescription which could have accounted for the higher prevalence in their study. Presence of uncorrected ametropia could impact the accommodative and binocular system negatively leading to disorders of these systems (Shin *et al*., 2009).

Porcar and Martinez-Palomera, (1997), consistent with the present study used similar diagnostic criteria (three or more diagnostic signs) for accommodative and binocular disorders which may have accounted for similar prevalence values between their study and present study even though the study populations were different. The prevalence values for binocular vision disorders turn to increase as the number of diagnostic signs decrease (Porcar and Martinez-Palomera, 1997; Lara *et al*., 2001). However, contrary to present study, Porcar and Martinez-Palomera (1997), reported accommodative excess (10.8%) as the most prevalent accommodative dysfunction and basic esophoria (1.5%) as among the least vergence dysfunction in their study.

Refractive errors are known to influence binocular vision and accommodative status (Shin *et al*., 2009). The present study comparable to Dwyer (1992), found an association between refractive errors and NSBVD. The present study found specifically association between refractive error in general and accommodative fatigue and between myopia and accommodative excess whilst Dwyer (1992), found an association between hyperopia and convergence insufficiency. Latter study (Dwyer, 1992) was however conducted on a paediatric population in contrast to this present study (university students) and diagnostic criteria for refractive errors and NSBVD differ from that in the present study.

CONCLUSION

Rrefractive error and NSBVD are prevalent among Optometry students enrolled in University of Cape Coast. These findings suggest that in Optometry students, it is important to conduct thorough eye examination to detect refractive error and non-strabismic binocular vision dysfunctions so that potential primary eye care practitioners become aware of their visual status.

ACKNOWLEDGEMENT

The authors are very grateful to the Optometry Department of University of Cape Coast for their support by way of ophthalmic instruments.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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ISSN 2026-6294