Accommodative Anomalies in Symptomatic School Children in Cape Coast Metropolis, Ghana.

Darko-Takyi C.,[1] Ntodie M.,[1] Alex Azuka Ilechie A.A.,[1] Abokyi S.,[1] Kyei S.,[1] Aful H.K.,[2] Nti, N.A.[3] and Okae-Asante D.[4]

1 Department of Optometry, University of Cape Coast, Ghana
2 Ghana Red Cross Eye Care Services, Wa, Ghana
3 Newlands Medical Center, Koforidua, Ghana.
4 Inter-Star Eye Hospital, Tamale, Ghana

Corresponding Author: Charles Darko-Takyi | Email: cdarko-takyi@ucc.edu.gh | Phone: +233545063571

Abstract

Accommodative anomalies even though have been associated with an increased risk of academic failure in the pediatric population, yet have been underappreciated in African populations. This prospective cross sectional study which conformed to the Code of Ethics of the World Medical Association (Declaration of Helsinki) aimed to determine the frequencies of accommodative anomalies among symptomatic Junior High school children in the Cape Coast metropolis, Ghana.

Accommodative assessment (testing for amplitude of accommodation, accommodative lag, accommodative facility, and negative and positive relative accommodation) was conducted over best corrected refraction results in a multistage sample of 202 symptomatic school children age ranged 12 to 17 years old. Descriptive data was analyzed using frequencies, percentages, means and standard deviations. Binary logistic regression was used to test associations between outcome variables. Of the symptomatic participants (202) assessed, 38 (18.8%) were diagnosed with ametropia, with the most frequent type being astigmatism 19 (9.4%). A number of 104 (51.5 %) symptomatic participants were diagnosed with accommodative anomaly. The frequency of specific accommodative anomalies among symptomatic Junior High school children was as follows: accommodative insufficiency, 45 (22.3%); accommodative infacility, 22(10.9%); accommodative excess, 27(13.4%) and accommodative fatigue, 10 (5%). Participants with accommodative anomalies had greater odds of experiencing symptoms of visual fatigue associated with near work (OR =0.530, p= 0.001) compared with other symptoms. The study results indicate a high prevalence of accommodative anomalies on this symptomatic school going population in Ghana and this can impact negatively on their academic performance.

Keywords: Accommodative disorders, ametropia, asthenopic symptom, school children, Ghana

Introduction

Millions of school-going children unjustifiably suffer from accommodative anomalies because it remains undiagnosed[1] and this is especially so in African paediatric populations where these anomalies are underappreciated. These may be due to the decreased participation of practitioners in binocular vision examination, analysis and management[2] and the paucity of evidenced-based studies in this area.Accommodative anomaly (inadequate accommodative accuracy and sustainability, inadequate amplitude, flexibility and

1. Maino D M. The Binocular vision Dysfunction Pandemic. Optom Vis Dev 2010; 41(1):6-13.
2. Opoku-Baah C , Mohammed A K, Afari C, Addai R, Yemanyi F, Adade S, Bonsu K. The management of Binocular Vision Anomalies by Eye Care Facilities in the Accra and Kumasi Metropolises (Ghana). Int J Innovat Appl Stud. 2014; 9(3): 1401- 1408.

facility and non-refractive and non-aging neuromuscular abnormalities of the visual apparatus[3]) being part of the binocular vision dysfunctions, in clinically significant forms presents with asthenopia.[4] This is especially so in the high school age where the child puts more effort into reading and school work[5] and thus can impact negatively on academic performance.[6,7]

Studies by Scheiman et al.[8], Dwyer[9] and Metsing and Ferreira[10] in pediatric populations indicated specific prevalence of accommodative anomalies. Scheiman et al. found accommodative anomalies to be 5.4% among a 2,023 consecutive paediatric population and 6.5% in a school age population.[8] Among 144 consecutive paediatric patients, Dwyer found the prevalence of accommodative anomalies to be 57%.[9] In 112 school-going children, Metsing and Ferreira found 12.3% to have poor accommodation facility (the latency and speed of accommodative response under binocular conditions[5]) and 10% had poor accommodative amplitude (the maximum potential increase in optical power that an eye can achieve in adjusting its focus[5]).[10] Similarly, studies on accommodative anomalies in other populations have also been high. Hokoda found a prevalence of 16.8% accommodative anomalies among his sample of children and adults.[11] Lara et al found the overall prevalence of accommodative anomalies at 9.4% in a study size of 265 symptomatic clinic patients with the greatest proportion (6.4%) found to have accommodative excess (an incessantly higher accommodative amplitude than age expected norms due to spasms of the ciliary muscle[3]).[12] In a recent pilot study of 65 black high school children, the prevalence of accommodative insufficiency (a persistently lower accommodation than expected for age[3]) was 1.6%, accommodative infacility (slowdown in accommodative dynamics, that is, latency, time constant, and peak velocity[3]) was 1.6%, poor monocular accommodative facility was 25% and poor binocular accommodative facility was 6.7%.[13] The differences in prevalence values among these different studies apart from differences in methodology may be due to the disparities in the various study population's characteristics especially differences in demographics and socio-economic status.[14]

The population characteristics of Ghanaians in terms of demographics and socio-economic status differ significantly from that in populations reported in previous studies on prevalence of accommodative anomalies. It is likely that the trend of disorders and health outcomes in general will differ from that reported in other settings [15,16] due to the possible causal link between risk of disease and the social environment.[14] In Ghana, there are several studies on ametropia and ocular diseases but a dearth of information on accommodative anomalies. An earlier study in Ghana examined accommodative anomalies specifically accommodative insufficiency and accommodative infacility using only one clinical sign and the study included a convenient sample of 204 children.[17] In this present study, we report the prevalence of accommodative anomalies in symptomatic junior high school (JHS) going children in Cape Coast, Ghana using a widely accepted diagnostic criteria.

3. Darko-Takyi C, Naimah E K, Urvashni N. A review of the classification of nonstrabismic binocular vision anomalies. Optometry Reports 2016; volume 6:5626
4. Garcia-Munoz A, Carbonell-Bonete S, Cacho-Martinez P. Symptomatology associated with accommodative and binocular vision anomalies. J Optom 2014;7(4): 178- 192.
5. American Optometric Association. Optometric clinic practice guidelines: care of the patient with Accommodative and Vergence Dysfunction. [Internet].2010 [cited 2013 Feb 09]. p. 7-9, 27-40. Available from :http://www.aoa.org/documents/CPG-18.pdf
6. Von Noorden GK, Campos EC. Binocular Vision and Ocular Motility: Theory and management of strabismus. 6th ed. Optom Vis Sci 2002.
7. Rouse M, Borsting E, Mitchell GL, Kulp MT, Scheiman M, Amster D,Coulter R, Fecho G, Gallaway M; The CITT Study Group. Academic Behaviors in Children with Convergence Insufficiency with and without Parent-Reported ADHD. Optom Vis Sci. 2009; 86(10):1169-77.
8. Scheiman M, Gallaway M, Coulter R, Reinstein F, Ciner E, Herzberg C, Parisi M. Prevalence of vision and ocular disease conditions in a clinical pediatric population. J Am Optom Assoc 1996;67(4):193–202.
9. Dwyer P. The prevalence of vergence accommodation disorders in a school-age population. Clin Exp Optom 1992;75(1):10–8.
10. Metsing I, Ferreira J. Accommodation and vergence status among the 3rd and 4th graders in a mainstream school in Gauteng. S Afr Optom 2012;71(1):22–31.
11. Hokoda SC. General binocular dysfunctions in an urban Optometry clinic. J Am Optom Assoc 1985;56(7):560-2
12. Lara F, Cacho P, García A, Megías R. General binocular disorders: prevalence in a clinic population. Ophthalmic Physiol Opt 2001; 21(1):70–4.
13. Wajuihian S O, Hansraj R. Near vision anomalies in Black high school children in Empangeni, South Africa. S Afr Optom 2014;73(1):21-32.
14. Du P, Coles F B, O'Campo P, McNutt L. Changes in population characteristics and their implication on public health research. Epidemiologic Perspectives and Innovations 2007;4:6
15. English PB, Kharrazi M, Davies S, Scalf R, Waller K, Neutra R. Changes in the spatial pattern of low birth weight in a southern California county: the role of individual and neigbourhood level factors. Soc Sci Med 2003;56(10):2073-88
16. 15 Pickett KE, Ahern JE, Selvin S, Abrams B. Neighbourhood socio-economic status, maternal race and preterm delivery: a case-control study. Ann Epidemiol 2002;12(12):410-8
17. Abdur-Kabir M, Kumah D A, Koomson N Y, Afari C. Prevalence of accommodative insufficiency and accommodative infacility among junior high school students in a Ghanaian town. J Sci Technol 2014; 34(2):60-64.

MATERIALS AND METHODS

Study design and ethics

This prospective cross-sectional study was carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) and ethics approval was obtained from the Ethics review committee of the Ghana Health Service. Permission was sought and granted by the Cape Coast Metro Education Directorate, Ghana and head teachers of sampled schools. Inform consent was obtained from parents and guardians and school children gave their assent prior to the commencement of the study.

Study subjects and sampling procedure

This study reports part of the results in a major study on the prevalence of binocular vision disorders among JHSs in Cape Coast, Ghana. The sampling technique (multistage) and sampling procedure for entire participants have been described in an earlier publication.18 The study sampled 636 JHS students in Cape Coast metropolis of the Central Region of Ghana. The 73 JHSs in the metropolis are clustered under six educational circuits by the metropolitan education office. Two schools were randomly selected from each of these clusters and averages of 53 students were randomly selected from each school. The expression N = Z2α/2/4d2 [where Zα/2 is confidence level at 95% confidence interval (significance level α =0.05), d is estimated deviation (0.1)] was used to estimate minimum sample size considering attrition rate (10%) and design effect (3).

Inclusion Criteria

Symptomatic JHS children from age range of 12 to 17 years, with no ocular disease, no strabismus and no nystagmus and visual acuity equal to or better than 0.2 logarithm of the minimum angle of resolution (LogMAR) were included into the study.

Procedure

Visual acuity

Using (LogMAR) chart (Low Vision Resource Centre (LVRC) Bailey-Lovie design), visual acuity (VA) was measured for each participant.

Ocular examination

Hand held slit lamp biomicroscope (HANGUA MODEL SLM -6M) was used to assess external ocular tissues and Keeler professional direct ophthalmoscopes were used to assess internal ocular tissues.

Administration of Questionnaire

Participants were guided by the study team to fill a 20-point reliable asthenopic symptom questionnaire (good internal consistency with Cronbach's α = 0.866; all fifteen items worthy of retention) with symptom severity measured on a grading scale of 0 – never, 1 – mild, 2 – moderate, 3 – severe, and 4 – very severe.[18] The questionnaires were collected on the same day of administration. Symptomatic participants (children with two or more symptoms[19] which were severe or very severe on the reliable questionnaire) were taken through accommodative assessment.

Refraction

Keeler professional streak retinoscope with trial lenses from manual phoropter (Topcon VT-10) was used to assess refractive status objectively and subjective refraction was performed using ophthalmic trial lens set. Final refractive results were "maximum plus lenses for best-corrected visual acuity". Definition of specific ametropia is indicated (Table 1).

Testing for accommodative anomalies

Accommodative testing was as follows: amplitude of accommodation (AA) using Donder's push-up-to-blur method; accommodative lag using monocular estimation method (MEM); binocular accommodative facility (BAF)

18. Darko-Takyi C, Khan N E, Nirghini U. Symptomatic vergence disorders in junior high school children in Ghana. Afr Vision Eye Health. 2016;75(1):a333.8 pages Available at http://dx.doi.org/10.4102/aveh.v751i1.333.
19. Bhanderi D J, Choudhary S. Doshi V G. A community-based study of asthenopia in computer operators. Indian J Ophthalmol. 2008;56(1):51-55.

and monocular accommodative facility (MAF) testing using +/−2.00D flipper lenses, negative relative accommodation (NRA) and positive relative accommodation (PRA). These tests were done over maximum plus lenses for best corrected visual acuity results.[9,10,12,13,20,21] Each of the test results were compared to established clinical norms (Modified Morgan's table of expected values for accommodative and vergence testing[5]) and three or more abnormal signs were grouped together as syndrome to identify specific accommodative anomalies[9,12,20,21] using Scheiman and Wick's criteria[22] and maintaining some signs as mandatory (Table 1). Participants were diagnosed as having only ametropia if with results of refraction in place; they presented normal results in accommodative testing.[12]

Data Analysis

The IBM SPSS Version 21 (SPSS, Inc., Chicago, IL, USA) was used to analyze data. Frequencies, means and standard deviations were computed for descriptive data. Pearson's chi square test and binary logistic regression test were used to investigate associations between variables. A p-value of ≤ 0.05 was considered statistically significant.

RESULT

Presented in an earlier publication[18] are the demographic parameters of entire participants for the study. As a repeat, participants numbering 627 (47.2% males and 52.8% females) with mean age 14.1±1.5 years answered the reliable asthenopic symptoms questionnaire and 220 were found to be symptomatic (with symptoms such as head-aches, eye pain; visual fatigue, blur vision, eyestrain, burning sensations, difficulty tracking objects or prints etc. that were associated with either distance or near work) and eligible for accommodative system assessment. Out of the 220 symptomatic participants, 202 consisting 36.6% males and 63.4% females reported for the accommodative system assessment through maximum plus for best corrected visual acuity results. No statistically significant difference in age was determined between male and female participants (t = 1.017, p = 0.31); participants ages were normally distributed. Among symptomatic participants (n =202), the frequency of ametropia was 38 (18.8%) with specifics as follows: myopia 9 (4.5%), hyperopia 10 (5.0%) and astigmatism 19 (9.4%).

The descriptive measures of the various parameters of accommodation for symptomatic participants in general are indicated (Table 2) and the accommodative parameters for each specific accommodative anomaly are indicated (Table 3). Among symptomatic participants, 104 (51.5%) were diagnosed with accommodative anomalies; 37.5% of participants with accommodative anomalies were males and 62.5% were females. A number of 85 (81.7%) participants diagnosed with accommodative anomalies had no ametropia (Table 4). For specific accommodative anomalies, the prevalence among symptomatic JHS participants was as follows: accommodative insufficiency, 45 (22.3%); accommodative infacility, 22 (10.9%); accommodative excess, 27 (13.4%) and accommodative fatigue, 10 (5%). The distribution of specific accommodative anomalies among participants diagnosed with accommodative disorders only is indicated (Figure 1). There was no significant association between accommodative anomalies and gender (X^2= 0.069 p= 0.792). Participants with accommodative anomalies had greater odds of experiencing symptoms of visual fatigue associated with near work (OR =0.530, p= 0.001) compared with other symptoms.

5. American Optometric Association. Optometric clinic practice guidelines: care of the patient with Accommodative and Vergence Dysfunction. [Internet].2010 [cited 2013 Feb 09]. p. 7-9, 27-40. Available from :http://www.aoa.org/documents/CPG-18.pdf
9. Dwyer P. The prevalence of vergence accommodation disorders in a school-age population. Clin Exp Optom 1992;75(1):10–8.
10. Metsing I, Ferreira J. Accommodation and vergence status among the 3rd and 4th graders in a mainstream school in Gauteng. S Afr Optom 2012;71(1):22–31.
12. Lara F, Cacho P, García A, Megías R. General binocular disorders: prevalence in a clinic population. Ophthalmic Physiol Opt 2001; 21(1):70–4.
13. Wajuihian S O, Hansraj R. Near vision anomalies in Black high school children in Empangeni, South Africa. S Afr Optom 2014;73(1):21-32.
18. Darko-Takyi C, Khan N E, Nirghini U. Symptomatic vergence disorders in junior high school children in Ghana. Afr Vision Eye Health. 2016;75(1):a333.8 pages Available at http://dx.doi.org/10.4102/aveh.v751i1.333.
20. Montes-Mico R. Prevalence of general dysfunctions in binocular vision. Ann Ophthalmol 2001;33(3):205–8.
21. Porcar E, Martinez-Palomera A. Prevalence of general binocular dysfunctions in a population of university students. Optom Vis Sci 1997;74(2):111–3.
22. Scheiman M, Wick B. Clinical Management of Binocular Vision: Heterophoric, Accommodative, and Eye Movement Disorders. Baltimore: Lippincott Williams & Wilkins; 2008.

DISCUSSION

Prevalence estimate for accommodative anomalies in the present study was higher compared to a study on a symptomatic clinical population between age of 10 and 35years.[12] This result is however lower compared to a study on a symptomatic school aged optometric clinic population[9] and another study on a symptomatic young adult clinic population.[20] Accommodative insufficiency being the most prevalent accommodative anomaly among symptomatic individuals in the present study is comparable to some studies[8,9,20] and inconsistent with other studies.[12,21] A study on a similar population of black African high school children found the prevalence of accommodative insufficiency and accommodative infacility to be the same and this is not consistent with results of the present study.[13] Differences in diagnostic criteria for accommodative anomalies may account for the dissimilarity in results between latter study[13] and present study.

In the present study, a greater frequency of symptomatic children (81.2%) did not have ametropia, however, more than half (51.5%) were diagnosed with accommodative anomalies. The result in present study is comparable to a study among school age population presenting to an optometric clinic in which accommodative anomalies were more prevalent than ametropia[9] but however inconsistent with a study among symptomatic clinic population[12] and on a similar black high school children population.[13] It should be noted that the first two most likely conditions Optometrist are likely to encounter in a paediatric population are binocular or accommodative anomalies and ametropia.[8] Most studies have been conducted to investigate ametropia among school age population in the central region of Ghana,[23,24,25] however none has reported the frequency of ametropia among symptomatic individuals. Comparable to present study, some of these studies reported astigmatism as the most frequent ametropia[24,25] whiles others had contrasting results.[23] The causes of asthenopia are diverse[26] and require comprehensive optometric examinations to illicit the specifics.

It can clearly be seen that some accommodative parameters are more affected in some specific accommodative anomalies than others (Table 3) and can clearly point out to a diagnosis of these anomalies (Table 3). Low AOA with high MEM values clearly discriminates accommodative insufficiency from other types of accommodative anomalies. Reduced NRA and PRA with low MAF and BAF clearly distinguish accommodative infacility from other accommodative anomalies. A Low MEM value clearly distinguishes accommodative excess from other accommodative anomalies. Normal AOA with high MEM values is seen to distinguish accommodative fatigue from other accommodative anomalies.

5. American Optometric Association. Optometric clinic practice guidelines: care of the patient with Accommodative and Vergence Dysfunction. [Internet].2010 [cited 2013 Feb 09]. p. 7-9, 27-40. Available from :http://www.aoa.org/documents/CPG-18.pdf
8. Scheiman M, Gallaway M, Coulter R, Reinstein F, Ciner E, Herzberg C, Parisi M. Prevalence of vision and ocular disease conditions in a clinical pediatric population. J Am Optom Assoc 1996;67(4):193–202.
9. Dwyer P. The prevalence of vergence accommodation disorders in a school-age population. Clin Exp Optom 1992;75(1):10–8.
10. Metsing I, Ferreira J. Accommodation and vergence status among the 3rd and 4th graders in a mainstream school in Gauteng. S Afr Optom 2012;71(1):22–31.
12. Lara F, Cacho P, García A, Megías R. General binocular disorders: prevalence in a clinic population. Ophthalmic Physiol Opt 2001; 21(1):70–4.
13. Wajuihian S O, Hansraj R. Near vision anomalies in Black high school children in Empangeni, South Africa. S Afr Optom 2014;73(1):21-32.
18. Darko-Takyi C, Khan N E, Nirghini U. Symptomatic vergence disorders in junior high school children in Ghana. Afr Vision Eye Health. 2016;75(1):a333.8 pages Available at http://dx.doi.org/10.4102/aveh.v751i1.333.
20. Montes-Mico R. Prevalence of general dysfunctions in binocular vision. Ann Ophthalmol 2001;33(3):205–8.
21. Porcar E, Martinez-Palomera A. Prevalence of general binocular dysfunctions in a population of university students. Optom Vis Sci 1997;74(2):111–3.
22. Scheiman M, Wick B. Clinical Management of Binocular Vision: Heterophoric, Accommodative, and Eye Movement Disorders. Baltimore: Lippincott Williams & Wilkins; 2008.
23. Abu EK, Yeboah AA, Ocansey S, Kyei S, Abokyi S. Epidemiology of ocular disorders and visual impairment among school pupils in the Cape Coast Metropolis, Ghana. B J Vis Impair 2014, 33(3):45–53
24. Ovenseri-Ogbomo GO, Omuemu VO. Prevalence of refractive errors among school children in Cape Coast municipality, Ghana. Clinical Optometry 2010;2:59-66
25. Ovenseri-Ogbomo GO, Asien R. Refractive error in school children in Agona Swedru, Ghana. S Afr Optom 2010;69(2):86-92
26. Abdi S, Rydberg A. Asthenopia in school children, Orthoptic and Ophthalmological findings and treatment. Documenta Ophthalmologia. 2005;111(2):65-72.

CONCLUSIONS

In present study, only participants with severe and very severe asthenopic symptoms were considered symptomatic and were investigated for accommodative anomalies over the maximum plus for best corrected visual acuity refractive correction. There is a likelihood that other participants with no symptoms or with mild to moderate symptoms could have their primary etiologies being accommodative anomalies.[27] This study indicates a high prevalence of accommodative anomalies on symptomatic school children in Ghana. It is recommended that school children with asthenopic symptoms are taken through comprehensive binocular vision examinations in optometric centers to diagnose and manage these anomalies to relief asthenopic symptoms and impact positively on academic performance.

ACKNOWLEDGEMENT

Authors wish to acknowledge the Optometry Department of University of Cape Coast, Ghana who supported this work with ophthalmic instruments.

CONFLICT OF INTEREST: None

27. Michaud L, Forcier P. Prevalence of asymptomatic ocular conditions in subjects with refractive-based symptoms. J Optom 2014;7(3):153-160

Table 1
Diagnostic criteria for ametropia and accommodative anomalies

Disorder	Diagnostic criteria
Ametropia	
Myopia	> 0.50 D Spherical equivalent in one or both eyes
Hyperopia	≥ 1.25 D Spherical equivalent in one or both eyes
Astigmatism	≥ 0.75 DC in one or both eyes
Accommodative Anomaly	
Accommodative insufficiency	1. *AOA less than Hofstters minimum with age 2. High MEM values (> +1.00 D) 3. PRA findings (-0.25 D to -1.50D) 4. Difficulty clearing minus lenses with MAF testing 5. Difficulty clearing minus lenses with BAF testing
Accommodative fatigue	1. *Normal AOA with age (Hofstteters calculations) 2. *High MEM values (> +1.00 D) 3. Reduced PRA (-0.25 D to -1.50D) 4.Difficulty clearing minus lenses with MAF 5.Difficulty clearing minus lenses with BAF testing.
Accommodative excess	1. Normal AOA (Hofstteters calculations) 2. *Low MEM values (≤ + 0.25 D) 3. Reduced NRA (+0.25 D to +1.50 D) 4. Difficulty clearing plus lenses with MAF 5. Difficulty clearing plus lenses with BAF
Accommodative infacility	1. Normal AOA with age(Hofstteters calculations) 2. *Fails MAF test (< 6 cpm) 3. *Fails BAF test (< 5 cpm) 4. Reduced NRA (+0.25 D to +1.50 D) 5. Reduced PRA (-0.25 D to -1.50D) 6. Normal MEM (+0.50 D to +1.00 D)

*mandatory signs, AOA-amplitude of accommodation, MEM- Monocular estimation method, PRA- positive relative accommodation, MAF-monocular accommodative facility, BAF-binocular accommodative facility, NRA-negative relative accommodation

Table 2
Descriptive measures of accommodative parameters for symptomatic participants

Diagnostic parameter	Minimum value	Maximum value	Mean	Standard Deviation (±)
AOA (right eye)	3.00 D	17.00 D	11.37 D	3.25 D
AOA (left eye)	3.52 D	18.00 D	11.34 D	3.25
MEM (right eye)	-0.75 D	+ 3.00 D	+ 0.86 D	0.58 D
MEM (left eye)	-0.75 D	+3.00 D	+0.87 D	0.57 D
NRA (+)	+0.25 D	+5.50 D	+1.95 D	0.90 D
PRA (-)	-0.50 D	-5.50 D	-2.04 D	1.10 D
MAF	1 cpm	15 cpm	6.50 cpm	3.45 cpm
BAF	1 cpm	15 cpm	6.80 cpm	3.24 cpm

AOA- Amplitude of accommodation, MEM- Monocular estimation method, NRA- Negative relative accommodation, PRA-Postive relative accommodation, MAF- Monocular accommodative facility, BAF- Binocular accommodative facility

Table 3
Descriptive measures of accommodative parameters for specific accommodative anomalies

Parameters	Accommodative Anomalies							
	Accommodative Insufficiency		Accommodative Infacility		Accommodative Excess		Accommodative Fatigue	
	Mean	SD(±)	Mean	SD(±)	Mean	SD(±)	Mean	SD(±)
AOA (Right Eye)	7.56D	2.623D	11.94D	2.960D	13.17D	1.915D	12.97D	1.894D
AOA (Left Eye)	7.37D	2.552D	11.97D	2.796D	13.25D	1.986D	13.08D	1.833D
MEM (Right Eye)	1.45D	0.435D	0.74D	0.273D	0.03D	0.263D	1.53D	0.583D
MEM (Left Eye)	1.45D	0.419D	0.75D	1.227D	0.03	0.263D	1.53D	0.583D
NRA	2.18D	0.830D	1.23D	0.361D	1.18D	0.541D	2.63D	0.690D
PRA	1.30D	0.290D	1.26D	0.537D	2.44D	0.959D	1.50D	0.553D
MAF	5.02cpm	2.650cpm	3.32cpm	1.701cpm	5.56cpm	3.117cpm	6.10cpm	3.725cpm
BAF	5.58cpm	2.850cpm	2.31cpm	2.308cpm	6.00cpm	3.126cpm	5.50cpm	2.915cpm

SD- Standard deviation AOA- Amplitude of accommodation MEM- Monocular estimation method NRA-Negative relative accommodation PRA-Positive relative accommodation MAF-Monocular accommodative facility BAF- Binocular accommodative facility

Table 4
Distribution of ametropia among accommodative anomalies

Accommodative Anomaly	Type of Ametropia	Frequency (%)
Accommodative Insufficiency	Myopia	3 (1.5)
	Hyperopia	0 (0)
	Astigmatism	4(2.0)
	Emmetropia	38 (18.8)
	Total	**45 (22.3)**
Accommodative infacility	Myopia	1(0.5)
	Hyperopia	1(0.5)
	Astigmatism	4 (2.0)
	Emmetropia	16 (7.9)
	Total	**22 (10.9)**
Accommodative excess	Myopia	0 (0)
	Hyperopia	1 (0.5)
	Astigmatism	2 (1.0)
	Emmetropia	24 (11.9)
	Total	**27 (13.4)**
Accommodative fatigue	Myopia	2 (1)
	Hyperopia	0 (0)
	Astigmatism	1 (0.5)
	Emmetropia	7 (3.5)
	Total	**10 (5)**