

Prevalence of General Binocular Dysfunctions in a Population of University Students

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ABSTRACT: *Purpose.* Although some authors report that the prevalence of general binocular dysfunctions (nonstrabismic) for nonpresbyopes in the clinical population is greater than any condition except refractive error, limited research is available to support this statement. This clinical study determined the presence and clinical implications of these conditions in a population of university students with heavy near visual demands. *Methods.* From a group of second year students who were given a thorough eye examination, 65 students were selected. The criteria for selection were the absence of significant uncorrected refractive error, healthy eyes, and no strabismus or amblyopia. *Results.* 32.3% of the subjects showed general binocular dysfunctions. In 10.8% of the cases, accommodative excess was present. 7.7% had convergence insufficiency with accommodative excess. 6.2% showed accommodative insufficiency. 3.1% had basic exophoria. Convergence excess with accommodative insufficiency, basic esophoria, and fusional vergence dysfunction all showed the same prevalence of 1.5%. *Conclusions.* Accommodative and nonstrabismic binocular vision problems are prevalent in this population. Accommodative excess is the most common condition. Because these dysfunctions may have a negative effect on performance, appropriate vision evaluation for this population is important. (*Optom Vis Sci* 1997;74:111-113)

Key Words: general binocular dysfunctions, accommodative insufficiency, accommodative excess, basic exophoria, basic esophoria, fusional vergence dysfunction, convergence excess, convergence insufficiency

The presence of general binocular dysfunctions (nonstrabismic) in nonpresbyopes is commonly reported, but there are few studies on their prevalence.¹⁻³ Purcell et al.² provided an indirect comparison figure for symptomatic binocular dysfunctions. They reviewed the records of 120 patients at an optometry college clinic. The patients were between 25 and 35 years of age without strabismus, amblyopia, eye pathology, or current contact lens wear. They found that in addition to refraction, 30.8% of patients needed treatment, e.g., vision training, prism, bifocals, or nearpoint lenses, for symptoms associated with their vision, namely headache, eye strain or "pulling," watering, tearing, redness, photophobia, and double vision.

In a sample of 119 patients (39.5% were students), Hokoda³ found that 21% (25 patients) had general binocular dysfunctions with asthenopia. The most commonly encountered conditions were accommodative dysfunctions, which was seen in 16.8% of all patients, 80% of those with dysfunctions. In a study by Hoffman et al.⁴ of 129 individuals diagnosed with binocular vision disorders,

62% had accommodative dysfunctions. In Hokoda's study³ the prevalence of the different types of accommodative dysfunctions was 55% (11 patients) with accommodative insufficiency, 30% (6 patients) with accommodative infacility, and 15% with accommodative spasm (3 patients). Other studies also report that the most common accommodative dysfunction is insufficiency. Daum,⁵ for example, reported 84% with accommodative insufficiency and 2.6% with accommodative excess of 114 patients with accommodative dysfunctions.

Nonstrabismic binocular vision problems have also been found to be prevalent. Morgan's normative data⁶ predict that approximately 12% of nonpresbyopes will have significant near esophoria (greater than 2 Δ), but the prevalence of symptomatic near esophoria was not reported. In his study, Hokoda³ found 5.9% (7 patients) with near esophoria greater than 2 Δ, and 5 of these patients showed an accommodative dysfunction. In the same study, convergence insufficiency occurred in 4.2% (5 patients) and 2 of these patients had associated accommodative dysfunctions.

Other authors⁷⁻⁹ report an incidence of convergence insufficiency in 3 to 5% of the population. Daum¹⁰ found that of 177 patients with exo deviation 62.1% had convergence insufficiency and 27.6% showed basic exophoria.

This study was designed to fill a void in the literature by investigating prevalence of nonstrabismic general binocular dysfunctions among university students.

METHODS

A group of 2nd year university students aged 22 years (± 3 years) were given a thorough eye examination over a period of 3 months. From these, 65 students were selected. The criteria for selection were the absence of significant uncorrected refractive error, healthy eyes, and no strabismus or amblyopia.

The examination consisted of the following:

1. History: a questionnaire about symptoms while studying, e.g., appearance, severity, and duration.
2. Preliminary tests: distance and near visual acuity, distance and near cover test in the nine positions of gaze, nearpoint of convergence, ocular motility, pupils, fusion (Worth Four-Dot Test) and stereopsis (Randot Stereotest).
3. Distance refraction: retinoscopy and distance subjective.
4. Binocularity and accommodation tests: distance and near lateral and vertical phorias (von Graefe's technique), distance and near lateral and vertical fusional vergence (smooth and step vergence testing), AC/A measured by the gradient method, jump vergence testing (8Δ base-out and 8Δ base-in), fixation disparity (with the Mallet unit), monocular estimation method (MEM) retinoscopy, fused cross-cylinder, NRA and PRA (negative and positive relative accommodations), monocular and binocular accommodative facility with ± 2.00 D flipper lenses (the target for binocular testing is the Bernell no. 9 Vectogram), and accommodative amplitude using both the push-up method and the minus lens procedure.
5. Evaluation of ocular health: direct ophthalmoscopy, biomicroscopy, visual fields, and color vision test.

The results of each of the tests were compared first with the population norms,¹¹ derived from Morgan's data⁶ and new data from other tests such as accommodative facility, fusional facility, step vergence, ocular motor test, MEM retinoscopy, and fixation disparity. The results were then grouped according to their deviation from the normal values. The syndrome or anomaly was then identified. Table 1 lists the classification criteria for general binocular dysfunctions used in this study.

RESULTS

Subjects with both abnormal signs and symptoms were considered to have general binocular dysfunctions. Asymptomatic subjects with abnormal clinical findings were excluded and counted as normals, as were those subjects with symptoms but whose accommodative-convergence findings were normal.

The most prevalent symptoms among the students (see Table 2) were 21.5% with asthenopia or eyestrain, followed by 18.5% with headaches, 12.3% had intermittent blurred vision at distance and difficulty in focusing when looking from near to far, 9.2% showed sensitivity to light, 4.6% had intermittent blurred near vision or

TABLE 1.

Classification criteria for general binocular dysfunctions.

Binocular Vision Disorders	
Convergence Insufficiency	
1.	Symptoms associated with reading
2.	Signs: Moderate to high exophoria at near $>6 \Delta$ Low AC/A ratio (less than 3/1) Reduced positive fusional vergence at near Receded nearpoint of convergence
Basic Exophoria	
1.	Symptoms associated with distance and near tasks
2.	Signs: Exophoria of approximately equal magnitude at near and at distance Normal AC/A ratio (4/1 with a SD of ± 2) Reduced positive fusional vergence at distance and near
Basic Esophoria	
1.	Symptoms associated with distance and near tasks
2.	Signs: Esophoria of approximately equal magnitude at near and at distance Normal AC/A ratio (4/1 with a SD of ± 2) Reduced negative fusional vergence at distance and near
Fusional Vergence Dysfunction	
1.	Symptoms associated with reading
2.	Signs: Orthophoria at distance and near, or a low degree of exophoria or esophoria at distance and near Normal AC/A ratio (4/1 with a SD of ± 2) Reduced negative and positive fusional vergence at distance and near
Convergence Excess	
1.	Symptoms associated with reading
2.	Signs: Significant esophoria at near $>2 \Delta$ High AC/A ratio (greater than 7/1) Reduced negative fusional vergence at near
Accommodative Anomalies	
Accommodative Insufficiency	
1.	Symptoms associated with reading
2.	Signs: Push-up accommodative amplitude at least 2 D below Hofstetter's calculation for minimum age-appropriate amplitude: $15 - 0.25 \times \text{age in years}$ ¹² Decreased positive relative accommodation, ≤ 1.25 D Difficulty clearing -2.00 D with monocular and binocular accommodative facility (monocular ≤ 6 cpm, binocular ≤ 3 cpm) High MEM, ≥ 0.75 D High fused cross-cylinder, ≥ 1.00 D
Accommodative Infacility	
1.	Symptoms associated with reading
2.	Signs: Difficulty clearing -2.00 D and $+2.00$ D with monocular and binocular accommodative facility (monocular ≤ 6 cpm, binocular ≤ 3 cpm) Low positive and negative relative accommodation. PRA ≤ 1.25 D and NRA ≤ 1.50 D
Accommodative Excess	
1.	Symptoms associated with reading
2.	Signs: Variable static and subjective Possibly low degree of against-the-rule cylinder Variable visual acuity findings Difficulty clearing $+2.00$ D with monocular and binocular accommodative facility (monocular ≤ 6 cpm, binocular ≤ 3 cpm) Low MEM, ≤ 0.25 D Low fused cross-cylinder, ≤ 0.00 D

TABLE 2.
Prevalence of students' symptoms.

Symptom	Frequency of Occurrence (%)	No. Subjects
Asthenopia after 1 or 2 h	7.7	5
Asthenopia toward the end of the day	13.8	9
Headaches after 1 or 2 h	10.8	7
Headaches toward the end of the day	7.7	5
Intermittent blurred vision at distance and difficulty in focusing when looking from near to far	12.3	8
Sensitivity to light	9.2	6
Intermittent blurred near vision or words appearing to move	4.6	3
Intermittent diplopia	3.1	2
Poor concentration	3.1	2

words appearing to move, and 3.1% presented intermittent diplopia, with a similar percentage reporting loss of concentration.

The prevalence of general binocular dysfunctions detected in the students (see Table 3) was 32.3% (21 subjects); 10.8% had accommodative excess; 7.7% convergence insufficiency with accommodative excess; 6.2% accommodative insufficiency; and 3.1% basic exophoria. Convergence excess with accommodative insufficiency, basic esophoria, and fusional vergence dysfunction all showed the same prevalence of 1.5%.

DISCUSSION

Accommodative and nonstrabismic binocular vision problems were prevalent (32.3%) in a population of university students. Accommodative excess was the most common dysfunction detected.

The term accommodative excess is used in the literature to refer to several conditions such as accommodative spasm, spasm of the near reflex, ciliary spasm, and pseudomyopia. Scheiman and Wick,¹³ suggested a definition of accommodative spasm, spasm of the near reflex, and ciliary spasm. These conditions are a very severe form of the more mild condition they described as accommodative excess. With accommodative excess there is no dramatic overaccommodation, miosis, or limitation of abduction. It should be noted that, as Scheiman and Wick¹² suggested, accommodative

TABLE 3.
Prevalence of general binocular dysfunctions.

Classification	Prevalence (%)	No. Subjects
Accommodative excess	10.8	7
Convergence insufficiency with accommodative excess	7.7	5
Accommodative insufficiency	6.2	4
Basic exophoria	3.1	2
Convergence excess with accommodative insufficiency	1.5	1
Basic esophoria	1.5	1
Fusional vergence dysfunction	1.5	1

excess is not as rare as accommodative spasm. It is in fact very common among university students as is the case in this study. The impact of near visual demands may be responsible for this type of primary accommodative disorder, which was found in 10.8% of the subjects and as a secondary problem in 7.7% of the subjects with convergence insufficiency.

These findings suggest that in university students it is important to give a thorough eye examination to detect these general binocular dysfunctions (particularly accommodative excess) and to consider applying the appropriate treatment in the form of lenses, prisms, and/or visual therapy to help improve performance and visual efficiency.

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