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Original Article

Body mass index and binocular vision skills

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Abstract

Introduction: Body Mass Index (BMI) is of increasing interest to eye care practitioners. Associations have recently been proven between high BMI and several diseases affecting the eyes, including AMD, intracranial hypertension, optic disc cupping, and glaucoma. The symptoms of dizziness and vertigo have also been associated with high BMI. However, to these authors' knowledge, there has been no study performed comparing BMI to binocular function.
Methods: In this analytical-descriptive study, 119 randomly selected young subjects had their BMI measured, along with refractive error, dissociated phoria, near point of convergence, vergence ranges and facility, and stereopsis.
Results: In most situations, the subjects classified as normal and overweight, based on their BMI had better performance than those classified as underweight or obese. The worst binocular performance was found in underweight subjects. The one-way ANOVA showed only statistically significant differences between mean of near point of convergence and vergence facility, in different states of BMI.
Conclusion: Unlike most ocular diseases that are adversely affected by higher BMI values, most binocular vision skills are adversely affected by lower BMI values. The possible reasons for this are discussed.

Keywords: Body Mass Index (BMI), Binocular vision, Stereopsis

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Introduction

As a single value to measure overall health, Body Mass Index (BMI) has generated growing interest worldwide. In its usefulness as both a measure of patient symptoms as well as overall health, BMI might be to systemic health as visual acuity is to ocular health. In fact, increasingly elevated BMI has been associated with ocular disease as well.

BMI reduces weight and height to a single number. As such, it does not take into account body fat percentage, waist circumference, or other important factors. Although details like these are lost when BMI is used, it remains a straightforward, if simplified way to compare large numbers of research participants – much like spherical equivalent refractive error does.

Recall that the formula for BMI is = weight (kg)/height^2(m^2) $\frac{\text{Mass (kg)}}{(\text{height(m)})^2}$.

Definition of different states of BMI is presented in Table 1.

The original AREDS study found that subjects classified as obese (>30), compared to non-obese, based on BMI had a 1.93 higher odds ratio of having AMD.[1] Patients with idiopathic intracranial hypertension (IIH) and a normal-range BMI, while uncommon, have better outcomes than the more commonly obese IIH participants who were at high risk for pseudotumor cerebri.[2] A 2010 study found that ''persons

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Table 1. Definitions based on BMI.

Definition	BMI
Underweight	Under 18.5
Normal	18.5–24.9
Overweight	25–29.9
Obese	>30

Table 2. Mean and SD of age (years), height (centimeters) and weight (kilograms) in all subjects and separately in two sexes.

Variables	Sex			*P*-value
	Males, Mean ± SD	Females, Mean ± SD	All subjects, Mean ± SD	
Age	20.9 ± 1.0	21.2 ± 1.5	21.1 ± 1.3	0.2
Height	172.0 ± 9.4	163.2 ± 8.0	166.7 ± 9.5	<0.001
Weight	69.1 ± 8.8	60.0 ± 7.0	63.6 ± 8.9	<0.001

Table 3. The frequency of different conditions of BMI in all subjects and separately in two sexes.

BMI	Sex		
	Females, *N* (%)	Males, *N* (%)	All subjects, *N* (%)
<18.5	4 (3.4)	4 (3.3)	8 (6.7)
18.5–24.9	30 (25.2)	49 (41.2)	79 (66.4)
25–29.9	12 (10.1)	15 (12.6)	27 (22.7)
>30.0	1 (0.8)	4 (3.4)	5 (4.2)
Total	47 (39.5)	72 (60.5)	119 (100.0)

Table 4. Mean and SD of sphere, cylinder, axis of astigmatism and spherical equivalent (SE) in two eyes of subjects.

Eye	Refraction			
	Sphere, Mean ± SD	Cylinder, Mean ± SD	Axis, Mean ± SD	SE, Mean ± SD
Right	−0.69 ± 1.6	−0.11 ± 0.2	39.1 ± 69.0	−0.63 ± 1.5
Left	−0.72 ± 1.6	−0.10 ± 0.2	37.0 ± 69.4	−0.67 ± 1.5

who are taller have lower BMI, have a smaller neuroretinal rim area and a larger optic cup-to-disc area ratio''.[3]

What has not been investigated to authors' knowledge is the effect of BMI on binocular function. That is the aim of this study.

Materials and methods

In this analytical-descriptive study, students at Zahedan University of Medical Sciences were randomly selected from a list of students. One hundred and nineteen students, who met the inclusion criteria and consented, were entered into the study. We assured all subjects that their information was kept confidential in accordance with the tenets of the Declaration of Helsinki. Inclusion criteria included best-corrected visual acuity of 20/25 or better in each eye at 6 m and 40 cm, absence of manifest deviation at 6 m and 40 cm with cover test, no history of eye and/or head trauma and normal eye health. The Horizontal Lang Two-Pencil Test was used to screen for stereopsis and binocularity.[4] Refractive errors were determined by retinoscopy (Heine β-200 retinoscope) and the results of retinoscopy were refined by subjective refraction and finally dissociated red–green balance test was performed.

Near dissociated heterophoria was determined with alternate cover test method with best correction, and with subjects fixating on an accommodative target which was a small isolated letter ''E'' of approximately 20/30 (6/9) size on the fixation bar. Measurement of the deviation was carried out with prism neutralization. The lowest power of prism that neutralizes the recovery movement was taken as a measure of the deviation in prism diopters. For confirmation of the end point, the subjects were asked to observe an apparent jump of the fixation target when the cover test was repeated (subjective cover test or Phi test).[5]

For determination of near point of convergence (NPC), a push-up test was carried out. A small isolated letter ''E'' of approximately 20/30 (6/9) size from a reduced Snellen chart target was slowly brought from 40 cm toward the subject along the subject's midline at a rate of approximately 3–5 cm/s. The subjects were instructed to keep the target single during the test and report when it appeared double (break point). The distance between break point to the plane of the lateral canthus was measured with a millimeter ruler. In cases in which subjects did not report diplopia, the examiner measured the distance at which one eye lost its fixation on the target.[6]

For assessment of the jump convergence, the subjects were asked to alternate their fixation between two pencils placed at two different distances along the subject's midline, one at 50 cm and another at 15 cm. Subject's eyes were observed during the change of fixation from the more distant

Table 5. Mean and SD of some of the binocular vision tests according to different states of BMI.

Variables	BMI					*P*-value
	<18.5, Mean ± SD	18.5–24.9, Mean ± SD	25–29.9, Mean ± SD	>30.0, Mean ± SD	Total, Mean ± SD	
NPC	12.0 ± 2.5	6.0 ± 1.4	6.5 ± 0.7	6.5 ± 1.1	6.6 ± 1.3	<0.001
Vergence facility	5.0 ± 2.4	15.0 ± 2.0	12.7 ± 1.7	12.3 ± 2.0	12.3 ± 2.2	0.003
Stereopsis	120.9 ± 106.1	95.97 ± 54.4	60.0 ± 30.5	107.5 ± 86.0	100.9 ± 65.0	0.1
BO blur	10.0 ± 3.4	11.4 ± 5.9	12.0 ± 3.5	10.3 ± 3.3	11.1 ± 5.3	0.09
BO break	20.3 ± 8.4	35.0 ± 6.2	40.0 ± 5.0	22.2 ± 8.7	22.4 ± 9.0	0.2
BO recovery	15.6 ± 5.8	25.0 ± 4.2	25.0 ± 6.0	16.6 ± 6.5	16.7 ± 6.4	0.3
BI blur	10.0 ± 3.3	12.0 ± 2.0	8.3 ± 2.6	12.0 ± 4.3	9.6 ± 3.2	0.3
BI break	14.0 ± 2.3	17.7 ± 5.3	18.0 ± 3.2	17.2 ± 5.3	17.3 ± 2.7	0.9
BI recovery	6.0 ± 2.1	14.0 ± 4.3	14.3 ± 3.3	12.9 ± 4.1	13.1 ± 4.0	0.2
Dissociated phoria at near (negative = exophoria)	−12.0 ± 2.7	−5.0 ± 5.6	−3.8 ± 3.2	−8.0 ± 1.9	−4.9 ± 5.1	0.4