Measurement of the eye accommodation range in young people with different daily habits

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Abstract

Objective: To evaluate and measure the dioptric eye accommodation range in young people with different daily habits and especially into two groups, those who use computers for about 8 hours per day and those who do not use computers at all or use them for less than 2 hours per day. The purpose of this study was to see if there is a difference in eye accommodation range between these two populations.

Method and materials: The eye accommodation range was measured in the right eye of 200 young people whose ages were from 20 to 23 years. The average age of individuals was 21.5 years. Basic requirement was that the first 100 were daily users of computers (students from the Department of Informatics, T.E.I. of Athens with at least 8 hours daily use of computers) while the remaining 100 have little or no use of computers (students from Department of Optics & Optometry, T.E.I. of Athens).

The two clinical techniques used for measuring subjectively eye accommodation range were a) The push-up method b) the minus lenses method.

Results: The data showed, that the differences in eye accommodation range between the two populations, was around 0,25 Ds approximately maximum 0,33 Ds corresponding to 2-4% of the total eye accommodation range which is probably within the limits of statistical error. What should also be noted is that in both group populations there was a reduction in the range of eye accommodation about 2.00 Ds from the Donder's results that may be due to the subjective type of measurements used or other environmental factors.

Key words: eye accommodation, push-up method, minus lenses method.

Introduction

Accommodation[1,2,10,12] , as we all know is the ability of the eye to change its power by changing the shape of the crystalline lens[6,8,9,10,14,15] (changing the curvature of the lens), and allow objects to be seen clearly at varying distances from it.

The crystalline lens of the eye is held in place by Zinn ligaments (Zinn's membrane, the ciliary zonule), a ring of fibrous strands connecting the ciliary body with the crystalline lens of the eye and attached in the region of the equator of the lens. The ciliary body is the circumferential tissue inside the eye composed of the ciliary muscle and the ciliary processes. The ciliary body receives parasympathetic innervations from the oculomotor nerve.

The parasympathetic system increases the curvature of the lens and facilitate accommodation in order that nearby objects to be focused. The sympathetic system reduces the curvature of the lens, facilitating the vision of distance vision objects distant. Contraction of the ciliary muscle causes relaxation of the Zinn ligaments[3,4,5,7] and reduction of tension that they carry in the lens periphery. Under the influence of elastic forces[13] of the lens capsule, the lens takes a more spherical shape and

increases its refractive power. By this mechanism the eye can focus and display clearly on the retina not only distant objects but also nearby.
The unit used to measure eye accommodation is the dioptre (D). The accommodation of one dioptre is the amount of accommodation needed for an emmetropic person to see a clear and sharp object away from its eyes at 1m distance.

The following **Table 1.** is given by Donders[11,12]. The first column shows the age and the second the near point for an emmetropic eye in millimetres, the third the diopters of adaptive (accommodative) power.

Table 1. Correspondence of dioptres, age and the near point in the normal eye

Age	Near vision point in mm	Corresponding Diopters
10	7	14
20	9	11
30	12	8
40	22	4,5
45	28	3,5
50	40	2,5
55	55	1,75
60	100	1
65	133	0,75
70	400	0,25
75	infinity	0

Method and materials

The amplitude of accommodation of the right eye was recorded. Ametropic cases were given full correction before recording the near point of accommodation. In this study the known clinical techniques for measuring subjectively eye accommodation range[16] were adopted and below analyzed:

The PUSH-UP Method[11,12]

For a young healthy person, a card (Snellen's optotype for near) appears at 40 cm distance with 40 W lighting and the patient is instructed to find the smallest letter in the card that can be seen clearly, usually 10/10 newsletter. As the card approaches the patient, the examiner asks the patient when these letters start to blur. This test can be conducted either binocular or by one eye at a time. The point where these letters start to blur is measured in centimetres and record for example 10 cm. The dioptre of eye accommodation is that number divided by 100 cm (e.g.100/10 = 10.0 dioptres).

The MINUS LENS TEST Method[17]

The method is using negative lenses of increasing power in front of the examined eyes and is still a subjective measure technique for the range of eye accommodation. Under specified conditions the test is performed monocularly, while the testing card (Snellen's optotype for near) is held at 33 cm in front of the tested eye. Then negative lenses of increasing power are added in 0.25 dioptre increments. The purpose is to add negative lenses up until the subject examined starts to defocus the letters of the Snellen's optotype. The sum of the negative lenses added in front of the eye is the

measured eye accommodation. While the push-up method may overestimate the final eye accommodation due to the relative magnification of the target letters, the method of the negative lenses may underestimate the eye accommodation because of the reduced relative magnification produced by the negative lenses. In an effort to address this problem, a proposal was made to place the test within 33cm instead of the 40 cm distance used by the push-up method. An expected difference between the two tests of about >2.0 diopters is reported in other research projects. In our study the difference between the two techniques was 3.07 Ds.

Clinical techniques

The survey was carried out using these two techniques for measuring subjectively eye accommodation range in two populations with different daily behavior. The reference was in working hours of computer use. The eye accommodation range was measured in the right eye of 200 young people whose ages were from 20 to 23 year. The average age of individuals was 21.5 years. Basic requirement was that the first 100 were daily users of computers (students from the Department of Informatics, T.E.I. of Athens with at least 8 hours daily use of computers) while the remaining 100 have little or no use of computers (students from Department of Optics & Optometry, T.E.I. of Athens). The purpose of this study was to determine whether the use of computers for about 8 hours per day affects the eye accommodation range and thus to differentiate the results between these two groups of people, those who use computers for more than 8 hours daily and those who use them less than 2 hours.

Results

Comparison of the two groups
Statistical study of results

Table 2.

Group 1 (Non users of computers < 2 hours per day)		**Group 2 (Users of computers > 8 hours per day)**	
Method : PUSH - UP		Method : PUSH - UP	
Sample	100	Sample	100
Arithmetic mean of eye accommodation	**9,0000**	**Arithmetic mean of eye accommodation**	**8,8850**
95% CI for the mean	8,7541 έως 9,2459	95% CI for the mean	8,6453 έως 9,1247
Standard deviation	1,2391	Standard deviation	1,2078
Paired samples t-test			
Mean difference	**-0,1150**		
Standard deviation	1,6664		
95% CI	0,4457 έως 0,2157		

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Lower limit	=	-3,1512
95% CI	=	-3,7182 έως -2,5843
Upper limit	=	3,3812
95% CI	=	2,8143 έως 3,9482

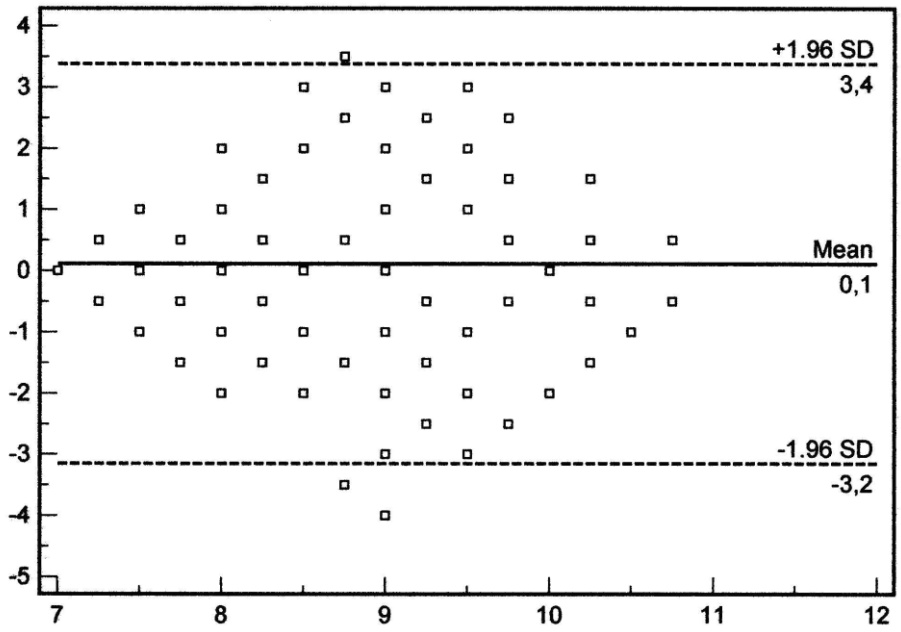

Figure 1. *Bland & Altman plot, showing the average difference between these two groups, Group1 & 2 in dioptres for eye accommodation range, measured with the PUSH-UP method. The average difference between these two populations in eye accommodation range corresponds to 0.11 Ds*

Group 1 (Non users of computers < 2 hours per day)		**Group 2 (Users of computers > 8 hours per day)**	
Method : MINUS LENS TEST		Method : MINUS LENS TEST	
Sample	100	Sample	100
Arithmetic mean of eye accommodation	**6.0400**	**Arithmetic mean of eye accommodation**	**5.7100**
95% CI for the mean	5.8883 έως 6.1917	95% CI for the mean	5.5293 έως 5.8907
Standard deviation	0.7644	Standard deviation	0.9106

Paired samples t-test	
Mean difference	**0.33000**
Standard deviation	1,2252
95% CI	0,0869 έως 0,5731

BLAND AND ALTMAN PLOT

Lower limit	=	-2,0714
95% CI	=	-2,4882 έως -1,6545
Upper limit	=	2,7314
95% CI	=	2,3145 έως 3,1482

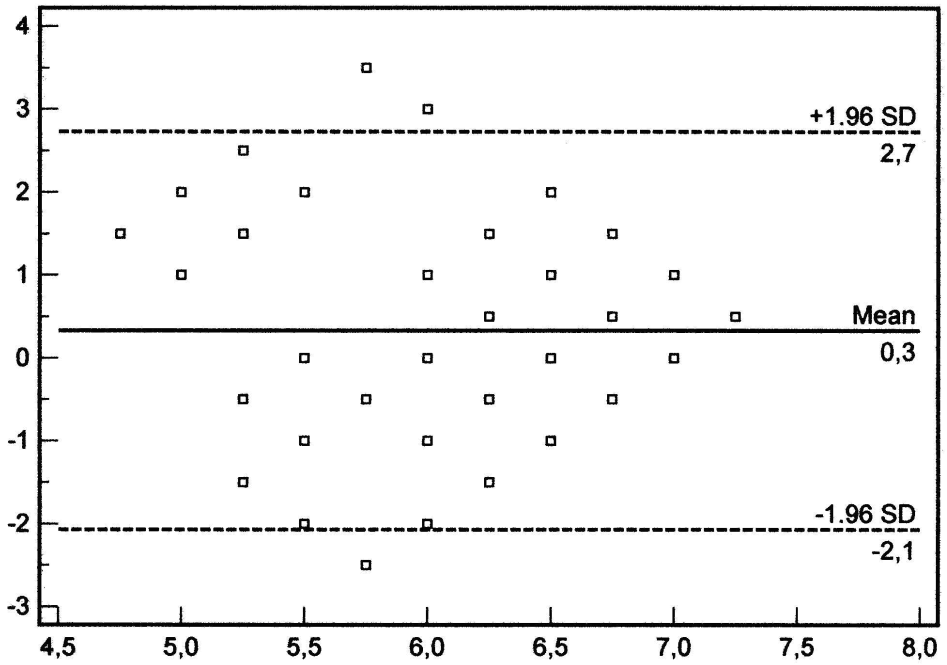

Figure 1. *Bland & Altman plot, showing the average difference between these two groups, Group1 & 2 in dioptres for eye accommodation range, measured with the MINUS LENS TEST method. The average difference between these two populations in eye accommodation range corresponds to 0.33 Ds*

Conclusions

As it is evident from the results of the clinical research for at least the age group between 20 to 23 years the population who does close reading work and especially usage of computers for > 8 hours daily does not seem to be affect in their eye accommodation range compared with those who do close work less than 2 hours per day. The differences in eye accommodation range between the two populations was around 0,25 Ds approximately (maximum 0,33 Ds – minimum 0.11 Ds) corresponding to 2-4% of the total eye accommodation range, which is probably within the limits statistical error. What should also be noted is that for both groups populations there was a reduction in the eye accommodation range of about 2.00 Ds from Donder's results, which might be due to measurement procedure errors or other environmental factors. It should be therefore a necessity to re-evaluate earlier studies for the measurement of eye accommodation in all age groups by using both subjective and objective techniques, cross-checked.

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