The Impact of Eye Exercises on High Myopia and Visual Acuity in Patients Aged (15-30) Years

Hassnaa shareef 1, Munther sameen 2, Shaimaa Jafaar3
1Faculty of Engineering, Biomedical engineering Department, Al-nahreen university, Iraq
2, 3College of Health and Medical Technology – Iraq, Baghdad.
hassnaa.shareef@eng.nahrainuniv.edu.iq
drnihadkhalawe@gmail.com

Abstract. High myopia is a state in which the spherical equivalent objective refractive error is ≤ -5.00 Diopters (D) in either eye. Currently, there are several treatment options to correct high myopia including laser eye surgery, refractive lens exchange, pharmaceutical treatment, and others. This study focuses on physiotherapy treatment and aims to evaluate the potential advantage of applying new physical exercises for the eyes of patients aged between 15-30 years, was applied on 50 patients with a known case of high myopia who were recruited through criteria based purposive sampling, they visit the optical clinic routinely at the Medical Technical University. The optometrist assessed the refractive errors and visual acuity of subjects using a Snellen’s chart and an auto refractometer, then the eye exercises treatment was done by the specialist physician. The effect of physical exercises on the eyes was determined by comparing the visual acuity of patients before and after the treatment through the SPSS program, and the result was found to be significant with a P-value = 0.0281 <0.05. Therefore, eye exercises provide an enhancement in visual acuity, ocular health, and correct the refractive error of high myopia resulting in better vision.

Keywords: High Myopia, Eye exercises, Muscles Eye rehabilitation, Visual acuity, physiotherapy.

1. INTRODUCTION
Myopia is one of the most common refractive errors of the eye in which the beam of light that derives from infinity does not straightly focus on the retina but in front of it, causing a blurry image. Myopia comes from the Greek word μυοπία which means "trying to see like a blot", and is also named as shortsightedness[1]. Shiny et al. [2] described the eye with myopia as "one for which the punctum farther is a short distance off, often only a little inch from the eye".

Myopia is classified into three groups based on clinical findings and prognosis; physiological, intermediate, and pathological myopia. This study focuses on the third and most devastating type which is pathological myopia. In this type, a highly myopic refractive error is often present from early childhood and is usually progressive [3], with increased axial length and fundus changes that are evident at the earliest examination. Prognosis is poor with legal blindness resulting from maculopathy or retinal detachment in almost 50% of patients [4].

High myopia is a term that generally refers to myopia greater than -5 diopters[5]. Clinically, the eyes may fit into either the intermediate or pathological category because the cause is usually at least partly axial or can result if one of the eye's external muscles is weaker than the other which is the main problem in high myopia. Factors associated with increased risk for progression to high degrees of myopia include fundus changes, intraocular pressure greater than 16 mm Hg, and myopia greater than -3.00 diopters by 11 years of age [6].

According to the World Health Organization WHO, myopia and high myopia were found to affect 27% (1893 million) and 2.8% (170 million) of the world populace, respectively, in 2010. In agreement with other distributed studies, myopia is mostly prevalent in east Asia; where China, Japan, the Republic of Korea, and Singapore have a predominance of around 50%, and a lower prevalence in Australia, Europe, and north and south America [7]. Initial estimations based on this prevalence information and taking into consideration the impact of age and time, show that myopia and high myopia will influence 52% (4949 million) and 10.0% (925 million), respectively, of the world’s population by 2050 [7] (Figure 1).
Figure 1. Numbers of people worldwide with high myopia (blue) and prevalence (red) between 2000 and 2050 [5].

There are several techniques to treat high myopia such as surgical LASIK, but this technique is very expensive and causes side effects such as dry eyes. In this paper, we have proposed a new method that uses physiotherapy. It is performed on the extra-ocular muscles (EOMs), the eye is suspended by six EOMs (four rectus muscles and two oblique muscles), these muscles are activated together to move the eyes vertically, horizontally, and torsional. The EOMs that control eye movement are connected to the outer part of the and can be controlled through moving the eyes in all directions manually. These muscles may be infected weakness causes troubles in vision and refractive errors [8].

In our study, treatment using eye physical exercises is chosen to avoid the risk of surgical correction which must be done on patients older than 18 years and causes side effects such as dry eyes. These eye exercises not only focus on external ocular muscles but also on internal weak muscles, consequently retarding the progression of myopia and reducing the optical power of high myopia.

2. Method. The study was conducted on a group of 50 patients (20 males and 30 females), diagnosed with high myopia by counting fingers test, and was examined in the optical clinic at the Medical Technical University in Baghdad. This study has taken up to 8 months (2019/2020). After getting informed consent from each patient, the first step was to collect patient history data; their initial refractive values based on the patients’ current spectacle prescription, and their power was checked by the autorefractometer model (NADIK AR-310A), patients were also examined for their visual acuity using a Snellen’s chart for distant vision. Then, patients were asked to fill up a questionnaire regarding their different habits, age, family history, symptoms, specific risk factors such as using smart devices and excess reading, or diseases like (diabetes, cataracts), and each was interviewed individually as well. The second step of the procedure included the physiotherapy examination focusing on the treatment of EOMs. Every patient had approximately six sessions that took place 2-3 times a week at the clinic. The patients were instructed to adhere to the exercises intermittently during the day and advised to sleep early at night.

3. The Intervention of Physical Exercise. Experimentally, we have given our patients a variety of exercises, the first one was eye muscle relaxation exercise which aims to warm up and stretch out the EOMs by asking the patients to close their eyes for 10 minutes and then focus on a certain point in front. The second exercise aimed at EOMs strengthening, patients were asked to focus their eyes on the tip of the therapist’s finger while opening the eyes as wide as possible. Then, patients were allowed to rest their eyes for a few minutes. The third exercise aimed at correcting the shape of the cornea by asking the patients to
open their eyes widely and to track the therapist’s finger by moving their eyes only with a fixed head position for 20 seconds and then return to the primary position of vision, this exercise was repeated 10 times.

4. Data analysis. The statistical package for social science (SPSS) version 16 was used to analyze the collected data with a 95% confidence interval. Descriptive statistics were used for the subject’s demographic characteristics. The level of significance was set at 0.05. Within-group variable chi-square matched paired test was used to compare pre and post values of visual acuity of patients. One sample T-test was used to make a report of the mean and standard deviation of risk factors such as using smart devices, reading, and disease.

5. Result. This study evaluates the effect of risk factors for high myopia such as age, gender, visual acuity before treatment, reading, smart devices excess use, diseases that can cause high myopia such as (diabetes, glaucoma), and the efficiency of physiotherapy in treating high myopia and improving vision. It was applied to a group of 50 patients of which 30 were females and 20 were males. This is shown in (table-1) which divides the 50 subjects according to their age to three groups with a variable of n=5. This table shows the relationship between age (years) and gender in patients diagnosed with high myopia, the result was P value =0.001 < 0.05 which was statistically significant, indicating that high myopia is related to age.

| Items  | Gender | Total |
|--------|--------|-------|
| Age 15-20 | Count | Male | Female | Total |
|        | Count | 4    | 5      | 9     |
| % within Gender | 8.0% | 10.0% | 18.0% |
| 21-25   | Count | 6    | 8      | 14    |
| % within Gender | 12.0% | 16.0% | 28.0% |
| 26-30   | Count | 10   | 17     | 27    |
| % within Gender | 20.0% | 34.0% | 54.0% |
| Total   | Count | 20   | 30     | 50    |
| % within Gender | 40.0% | 60.0% | 100.0% |

Table 1. Baseline characteristics of sample size, gender, age, in Exp. Group.
VA of both eyes: VA of eyes in group 1 was statistically lower than that in other groups. In our regression study, we defined high myopia as a dependent variable with age; we compared the parameter of right and left eyes VA and found no statistical difference, so they can't enter regression analysis. The visual acuity of high myopia patients is significantly declined with advanced age, so high myopia was positively correlated to the age of patients. The result is the same as the study of Keiko et al. [9], Ya Mo et al. [10].

Table 2. Relation between age and types of acquisition.

| Items   | Acquisition |         |         |     |        |
|---------|-------------|---------|---------|-----|--------|
|         | Smart device| Reading | Other   | Total |        |
| Age     |             |         |         |      |        |
| 15-20   | Count       | 9       | 0       | 0   | 9      |
|         | % within Age| 18.0%   | .0%     | .0% | 18.0%  |
| 21-25   | Count       | 12      | 1       | 1   | 14     |
|         | % within Age| 24.0%   | 2.0%    | 2.0%| 28.0%  |
| 26-30   | Count       | 24      | 2       | 1   | 27     |
|         | % within Age| 48.0%   | 4.0%    | 2.0%| 54.0%  |
| Total   | Count       | 45      | 3       | 2   | 50     |
|         | % within Age| 90.0%   | 6.0%    | 4.0%| 100.0% |

From the table above, we conclude that the number of patients with high myopia is more for older ages between (21-30) years, with P values = 0.0012 <0.05 sig. This is illustrated in figure 2.

![Figure 2. The Ratio of Gender Distribution with Age](image-url)
Through these results with P-value = 0.0311 p<0.05 significant, it was concluded that the use of smart devices has the highest percentage of 90% of the results, in agreement with sadagopan et al. [11], while reading and others factors such as diseases (cataract, diabetic, glaucoma, sequent) have a percentage of 10 % of the results. The results showed that smart devices are the most influential factor, since it is a moderately new technological tool, versatile and easily accessible for young people, and whose use includes a risk of abuse and addictive behavior. In recent years there has been increasing interest in this problem, especially because it involves a younger population [12]. Spending so much time on smaller screens can accelerate a pattern of ophthalmic problems such as headaches, blurred vision, sore eyes, dry eye, and muscle strain [13]. (As shown in figure 3)

![Figure 3. Distribution of patients depending on acquisition types.](image)

**Table 3. Report of smart devices use in hours per day.**

| use smart devices (hours/day) | Number of patients | Percent | Mean | Std. Deviation |
|------------------------------|--------------------|---------|------|---------------|
| 3-6 h/day                    | 14                 | 28%     | 2.1429 | .86444 |
| 7-10 h/day                   | 21                 | 42%     | 2.3333 | .79582 |
| more than 11h/day            | 15                 | 30%     | 2.6000 | .63246 |
| Total                        | 50                 | 100%    | 2.3600 | .77618 |

In this table, information was collected from the patients by answering a questionnaire;

1- How many hours do you spend on smart devices per day?

- All responses were “used it more than 2 hours”.

2-Have you experienced symptoms such as headache, tiredness, or inattention after continued use of smart devices? (Long use is defined as more than two continuous hours spent on smart devices).
• All responses were “yes”.

3- Have you experienced any eye tension or wakefulness after using a smart device for longer than 2 hours?

• All respondents felt eye tension after continued smart device usage. 30% of them experienced wakefulness after using it longer than two hours.

Table 4. Represent Patients with High Myopia, Before and After Treatment by Physical Exercises.

| VA Before   | Number of patients | Percent | VA After   | Number of patients | Percent |
|-------------|--------------------|---------|------------|--------------------|---------|
| C.F1-3m     | 15                 | 30%     | 6/36       | 12                 | 24%     |
| C.F4-6m     | 19                 | 38%     | 6/24       | 23                 | 46%     |
| 6/60        | 11                 | 22%     | 6/18       | 13                 | 26%     |
| 6/36        | 5                  | 10%     | 6/12       | 2                  | 4%      |
| Total       | 50                 | 100%    | Total      | 50                 | 100%    |
| Mean        | 2.12000            |         | Mean       | 2.10000            |         |
| Std. Deviation | 0.96129         |         | Std. Deviation | 0.81441         |         |

These results with P value=0.0281<0.05 significant, represent 50 patients with high myopia, the first column describes the VA of patients examined by Optometrist, the second column represents the number and percentage of patients classified depending on their VA, the third column represents VA of patients after treatment. All patients had a positive response to treatment and recorded an improvement in their VA. However, there are different degrees of improvement. For example, patients in CF (1-6m) transform to the best degree of vision, as 24% of subjects improved their vision to 6/36, and 46% improved their vision to 6/24. Finally, the best post-treatment result has been reached at 6/12 with a percentage of 4%. The degree of improvement in vision depends on the patient's age; younger patients had a faster and better degree of improvement in VA, however, they must keep practicing eye exercises and adhere to instructions such as early sleep and reducing the use of smart devices.
6. Conclusion. This study has found that specific eye exercises are beneficial in treating high myopia and improving vision in patients with different refractive errors.

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