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# The quality of life, neck and shoulder area dysfunction and upper body posture among people with and without moderate myopia

## Authors' Contribution:

**A** Study Design  
**B** Data Collection  
**C** Statistical Analysis  
**D** Data Interpretation  
**E** Manuscript Preparation  
**F** Literature Search  
**G** Funds Collection

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## abstract

**Background:** The current study aimed to examine the quality of life, dysfunction in the neck area and upper body posture among people with moderate myopia and to analyse the relationship between myopia and upper body posture.

**Material and methods:** Participants were 11 people with moderate myopia (MG) and 11 people without myopia (CG). The general quality of life was evaluated with the 36-Item Short Form Health Survey (SF-36), neck area pain with the Visual Analogue Scale (VAS) and discomfort with the Neck Bournemouth Questionnaire (NBQ). The National Eye Institute Visual Functioning Questionnaire (NEI-VFQ25) was used to measure vision-targeted health. Upper body was evaluated with the New York Posture Rating Chart. Correlation analysis examined the relationship between head position and vision.

**Results:** The general quality of life and upper body posture characteristics did not differ significantly in MG as compared to CG. A significant difference in NBQ ( $p < 0.05$ ), NEI-VFQ25 ( $p < 0.05$ ) and VAS ( $p < 0.01$ ) was established between MG and CG. A significant relationship ( $r = -.691$ ) between increasing severity of myopia and head position was found.

**Conclusions:** The study findings highlight the complaints of people with moderate myopia compared to people without myopia concerning both their quality of life and musculoskeletal problems.

**Key words:** head position, myopia, neck pain, postural disorders, quality of life.

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## INTRODUCTION

Myopia is one of the most wide-spread refractive disorders [1]. The incidence of myopia has doubled in the United States and Europe over the past 50 years. In the Chinese population, 90% of children and adolescents have myopia. However, 60 years ago the referred number was only 10-20% [2].

In the case of myopia, the optical axis of the eye is longer, so the optics of the eye focuses the objects in the distance in front of the retina, not on the retina. In the presence of more severe myopia, the deformity can lead to stretching and thinning of the inner layers and atrophy. These changes increase the risk of raptures of the retina, cataract, glaucoma which could lead to blindness [2].

The muscle activity pattern in the case of neck pain is altered. Activity of the superficial neck muscles increases and the activity lasts longer, whereas the activity of the deep neck muscles decreases [3]. Neck pain development is multifactorial. In addition to the incorrect posture (static position) and movements, patients have declared that their neck pain is also affected by their lifestyle, emotional well-being (stress, depression, anxiety), tiredness and sleep disorders [4].

In addition to the general vision problems and their negative impact on health, visual discomfort that develops among computer working people has also been found to lead to the development of neck and shoulder pain [5]. Neck and shoulder pain is also associated with 53% of cases of visual discomfort [6]. A strong connection between vision and musculoskeletal complaints has been reported [7].

In case of bad conditions while doing near work tasks disturbances can occur in accommodation which can result in a fuzzy or double image. The nervous system might try to compensate the current state, and the demand which is first directed to the oculomotor system might instead transfer to motor pathways. This can direct the visuo-skeletomuscular system in a synergistic way that results in fixation of the gaze [8] and tiring of the skeletal muscles. The tiring of the eyes can lead to secondary changes in the innervation of postural muscles leading to increased activity in the mentioned muscles, which in turn can lead to development of discomfort and pain. It has been demonstrated that ciliary muscle's tone increases simultaneously with trapezius muscle's tone activity [9].

Correct functioning of the proprioceptors of the extraocular muscles allows a correct visual analysis in the primary visual cortex that assures an accurate visuomotor behaviour [10]. Constant oculomotor overload affects posture and the muscle activity in the neck and shoulder area [8].

Head forward position is a malalignment of the head and the trunk that results in dysfunction of the musculoskeletal system, and neck pain might develop [11]. One of the reasons for neck pain is the incorrect position of the body, above all excessive neck flexion [12,13]. There exists a positive relationship between increased neck flexion and neck pain whereby neck flexion has to be a minimum of 20 degrees for at least 70% of the working hours [14]. Musculoskeletal and eye pain may result from the changes of the gaze angle and, therefore, the position of the body caused by tired eyes. Gaze angle can cause changes in the visual function that in turn causes visual stress [15].

The current study aimed to compare the quality of life, pain in the neck and shoulder area and posture of people with moderate myopia and people without refractive problems. Based on the above, we hypothesized that the quality of life of people with moderate myopia is lower; they suffer more often from neck pain and have a more dysfunctional upper body posture in comparison to people without vision problems.

## MATERIAL AND METHODS

### PARTICIPANTS

A total of 22 subjects participated in the current study: 11 people with moderate myopia and 11 without vision problems were recruited and assessed once. The subjects' anthropometric characteristics and spherical refraction strength are represented in Table 1.

Table 1. Anthropometric characteristics and spherical refraction strength of the subjects ( $\bar{x}\pm SE$ )

Group	Sex (M/W)	Age (years)	Height (cm)	Weight (kg)	BMI (kg/m <sup>2</sup> )	Right eye (dioptre)	Left eye (dioptre)
Myopia group	M=4 W=7	32.3±0.9	170.5±2.6*	70.8±4.8	24.2±1.2	-3.4±0.9	-3.5±0.8
Control group	M=10 W=1	34.0±1.0	179.8±2.0	81.4±3.7	24.7±0.9	N/A	N/A

\*p < 0.05 compared to control subjects

M - men; W - women; BMI - body mass index; N/A - emmetropic subjects

All participants had been examined by an ophthalmologist or an optometrist during the previous year. The inclusion criterion for MG was a diagnosis of myopia in the range of -2.5 to -5 dioptre. Exclusion criteria for MG were other additional eye diseases except for astigmatism  $\leq +1.0$  and neck and shoulder pathology (cervical radiculopathy, torticollis, periarthrititis, clavicular or humeral fractures). The inclusion criteria for CG were the absence of refractive error and neck and shoulder area pathology. Before participation in the study, all participants signed written informed consent. The Research Ethics Committee of the University of Tartu granted a permission to conduct the current study.

### PROCEDURE

Each participant was evaluated individually in the following order: SF-36, NEI-VFQ25, NBQ questionnaires and VAS scale were filled in; the assessments of body mass, height and posture were performed.

### INSTRUMENTS

SF-36 was used to measure the quality of life taking into account all the dimensions of health. The questionnaire consists of 36 questions that measure eight different dimensions (physical functioning, role limitation due to physical health, role limitation due to emotional problems, energy and fatigue, emotional well-being, social functioning, pain, general health). Every question has 2-6 different response options. A higher score demonstrates a better health condition [16].

NEI-VFQ25 was used to measure the dimensions of self-reported vision-targeted health status. The survey measures the influence of visual disability and visual symptoms on generic health domains such as emotional well-being and social functioning, in addition to task-oriented domains related to daily visual functioning. The survey consists of 25 questions; each question has either 5 or 6 response options. A higher score demonstrates better functioning and quality of life [17].

NBQ evaluates neck pain and its effect on everyday life. The questionnaire consists of seven questions, and the answers are given on a scale ranging from 0 to 10 (number 10 being the worst neck pain). The maximum score is 70 points [18].

VAS was used to evaluate pain and discomfort in the neck and shoulder area on a scale ranging from 0 to 10 points. VAS is used to evaluate modalities like pain which are difficult to measure directly and can widely vary [19].

To evaluate the upper body posture in standing, the New York Posture Rating Chart scale ranging from 0 to 10 points was used. The evaluation of the upper part of the body was viewed from the front, back and side. The subject stood without outerwear 2 meters apart from the evaluator. The head position, shoulder and chest area symmetry were evaluated. Every evaluated area received points based on the severity of the disorder: fewer points meaning poorer posture and more points referring to a correct posture. The minimal number of points was 0 and the maximal one was 10.

## STATISTICAL ANALYSIS

MS Excel 2016 programme was used to analyse the current study results. All data are presented as means and standard error of the mean ( $\pm$ SE) with probability values of  $< 0.05$  to indicate statistical significance. Independent samples t-test was used to compare the means of two groups. Pearson's correlation analysis was used to evaluate the relationship between myopia and posture.

## RESULTS

According to the SF-36 questionnaire, MG subjects evaluated their general quality of life higher ( $81.99 \pm 0.69$  points) than CG subjects ( $80.34 \pm 0.99$  points), but the difference was not statistically significant.

NBQ score of MG subjects was significantly higher ( $18.20 \pm 1.16$  points) when compared with CG ( $8.91 \pm 0.56$  points).

A statistically significant difference was found between MG ( $90.22 \pm 0.42$  points) and CG ( $95.16 \pm 0.26$  points) in the NEI-VFQ25 score (Table 2).

Table 2. Mean values of questionnaire scores ( $\bar{x} \pm SE$ )

Study group	SF-36 (points)	NBQ (points)	NEI-VFQ (points)
Myopia group	$81.99 \pm 0.69$	$18.20 \pm 1.16^*$	$90.2 \pm 0.42^*$
Control group	$80.34 \pm 0.99$	$8.91 \pm 0.51$	$95.16 \pm 0.26$

\* $p < 0.05$  compared to control subjects; SF-36 - Short Form Health Survey 36; NBQ - Neck Bournemouth Questionnaire; NEI-VFQ - National Eye Institute Visual Functioning Questionnaire

According to VAS, neck and shoulder area pain was significantly higher ( $p < 0.01$ ) in MG compared to CG, respectively  $3.3 \pm 0.6$  points and  $1.9 \pm 0.3$  points (Figure 1).

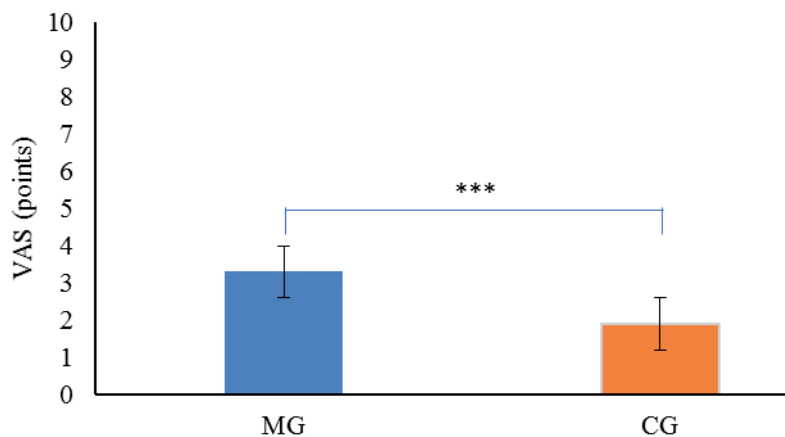


Fig. 1. Neck and shoulder area pain (VAS) in people with moderate myopia ( $n=11$ ) and people without refractive error ( $n=11$ )

Values are mean  $\pm$ SE. VAS - Visual Analogue Scale; MG - myopia group; CG - control group. \*\*\* $p \leq 0.01$

The upper body posture of MG was not statistically different from the CG group, although MG scored less on the New York Posture Rating Chart (Figure 2).

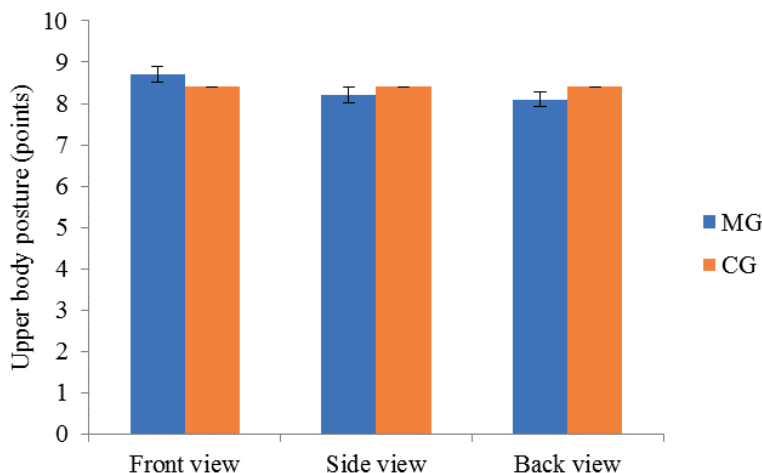


Fig. 2. Upper body posture in people with moderate myopia (n=11) and people without vision problems (n=11)

MG - myopia group; CG - control group

A negative correlation was found between myopia and the head position assessed from the front ( $r=-.691$ ) (Table 3). The more dioptres of myopia, the more incorrect upper body posture.

Table 3. Correlation between myopia and head position according to the New York Posture Rating Chart

Variables	Correlation
	Myopia
Head front	-.691*
Head back	-.290
Head side	.383

p\* < 0.05 compared to control subjects

## DISCUSSION

The present study aimed to evaluate the quality of life, dysfunction in the neck and shoulder area and the upper body posture of people with moderate myopia and people without vision problems. The relationship between myopia and the upper body posture was also examined.

Previous studies have focused on the aetiology and progression of myopia. The reasons for developing myopia are low physical activity and little time spent outdoors [1] as well as an incorrect head and body position [20]. The opposite relationships where myopia causes the changes in posture are less investigated. Relationships between myopia and changes in the musculoskeletal system are described by Richter [8] who emphasises the importance of vision in guiding the whole body. Except for the aforementioned research, no studies on the topic of people with myopia, their quality of life, posture, neck and shoulder area pain have been conducted. There are no studies before the current one where at the same time the upper body posture, neck and shoulder area pain symptoms and quality of life are evaluated, and which compared people with moderate myopia with people without vision problems.

Due to many components, it is difficult to define and evaluate the quality of life [21]. In the current study, the general quality of life is not lower in people with moderate myopia compared to people without vision problems. It has been found that the quality of life of people with higher myopia ( $\geq -8$ ) is lower compared to people with low myopia. High myopia is visually more demanding and economically more expensive [22]. Based on the results of the current study, the general quality of life in people with a moderate level of myopia does not differ from people without vision problems. However, the quality of life connected to visual functioning is significantly lower in people with moderate myopia. According to the results of NEI-VFQ25 questionnaire that evaluates the quality of life connected to visual functioning, MG scored significantly lower than CG. Therefore, it is very important to emphasise the importance of physical activity, neck and shoulder area good functionality and correct posture during everyday life. For comparison, NEI-VFQ score in people with cataract, diabetic retinopathy, macular degeneration and glaucoma has been  $67.4 \pm 15.0$  points [23]. The reason for not finding a statistically significant difference in the quality of life between the two study groups might be on the level of myopia - moderate myopia does not affect the general quality of life.

It has been found that the quality of life of people with myopia is lower compared to people without vision problems or people who have passed eye refractive surgery [24]. Ziaei et al. [24] found that after laser in situ keratomileuses (LASIK) operation the quality of life and visual acuity of those people significantly improved compared to people who use contact lenses or glasses. The change occurred due to the decrement of dependency on and unpleasantness of wearing contact lenses or glasses. In the current study, the difference in the results of SF-36 and NEI-VFQ25 may be related to the semantic difference between the two questionnaires. NEI-VFQ25 analyses vision-related quality of life, whereas SF-36 is more general and very wide concerning all the areas of life.

The results of the current study demonstrate that MG subjects have much more neck and shoulder area pain and discomfort. According to the results of the NBQ questionnaire, people with moderate myopia have much more neck pain compared to the control group. This might be because the accommodation of the eyes is connected to the muscles of the head and shoulder area. Changes in the muscle functioning due to tired eyes can lead to feeling discomfort and pain in the neck and shoulder area [9].

Mon-Williams et al. [15] found that tired eyes and the change in the gaze angle can cause pain and discomfort in the musculoskeletal system. Similarly, it has been found that the forward position of the head and incorrect posture can cause dysfunction in the musculoskeletal system, and neck pain can develop [11,12]. Also, Harrison et al. [13] and Ariens et al. [14] found that constant static position with the head forward for better vision can often cause neck pain. Constant overload to the eyes affects the body's alignment and the muscular activity of the muscles in the neck and shoulder area. Increased oculomotor muscle activity can lead to increased musculoskeletal activity [8] that results in changes in posture.

There have been several studies involving the head position of the people with myopia in near work tasks, but the head position as part of a static posture has not been analysed before. It has been found that in case of myopia the distance between the head and the viewed object is decreased compared to emmetropes [25]. Although statistically there was no connection between myopia and the upper body posture in the current study, a negative relation between myopia and malalignment of the head from frontal view was found. An increased neck lateral flexion and/or rotation from the frontal view was found. The higher myopia, the lower head position evaluation points. One of the reasons for detecting increased neck lateral flexion and/or rotation among subjects with moderate myopia might

be amblyopia (lazy eye) which causes neck flexion and/or rotation in a way which facilitates a clearer image. Other reasons for the upper body posture imbalance in front view were non ergonomic positions of a computer screen or other work-related equipment.

The research hypothesis was partly confirmed – the general quality of life of people with moderate myopia is not decreased, but their quality of life connected to vision is worse than people with normal eyesight. People with moderate myopia suffer more neck pain, but upper body posture does not differ from the people without vision problems.

The strength of the study is the novel aspect investigating people with moderate myopia, their quality of life, dysfunction in the neck and shoulder area and static head position in relation to vision. The findings of the study are important for all the specialists who work with patients having neck or shoulder area pain or discomfort which provides an insight into the quality of life of people with myopia. These findings lead to a better understanding of the possible underlying causes of postural problems and pain in the neck and shoulder area of people with myopia. One of the main limitations of the study was little sample size (n=22). In the case of a bigger sample size, the differences between the two groups would have been more representative, and it would be possible to generalise the findings of the relationship between the musculoskeletal system complaints and the quality of life of people with moderate myopia.

## CONCLUSIONS

Despite the fact that the general quality of life of people with moderate myopia does not differ from people without vision problems, their quality of life related to vision is worse. People with moderate myopia experience more pain and discomfort in the neck and shoulder area. The upper body posture of people with moderate myopia does not differ from that of the people without vision problems. There is a relationship between incorrect head position and myopia.

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