



Cross Sectional Study

PREVALENCE OF REFRACTIVE ERRORS AMONG PERFORMING ARTISTS AND ASSOCIATION OF *NETRASADHAKA* IN ITS PREVENTION – AN ANALYTICAL CROSS-SECTIONAL STUDY

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ABSTRACT :

Background: An estimated 2.2 billion people worldwide experience some form of visual impairment, including both near and distant vision impairments. Refractive errors are the leading cause of visual impairment and blindness. Approximately 88.4 million cases of refractive errors could have been prevented or remain unaddressed. In Ayurveda, these conditions are categorized as *vata-pradhana timira* (HG 1), a type of *drishtigata roga*. Treatment options of refractive errors like optical treatments don't treat the underlying causes and surgical treatment can cause complications. For correcting mild refractive errors, preventing the progression and reducing the asthenopia symptoms eye exercises are advised by ophthalmologists. *Netrasadhaka* is a type of eye exercise practiced regularly by some groups of performing artists. **Objectives:** To determine the prevalence of refractive errors among performing artists and to analyse the role of *netrasadhaka* in its prevention. **Methods:** The analytical cross-sectional study was conducted among 90 performing artists of both sexes between the age group 10-40 years of Kerala Kalamandalam, Thrissur through questionnaires and vision tests. Data were analysed statistically. **Results:** The analysis revealed a prevalence of refractive errors at 24.4%. A negative correlation was observed between the practice of *netrasadhaka* and the occurrence of refractive errors, eye pain, watering of eyes, and other symptoms. Statistical analysis confirmed that the preventive effect of *netrasadhaka* on refractive errors was significant. **Conclusion:** *Netrasadhaka* has a significant effect in preventing refractive errors. A case control study can be done to find the association of *netrasadhaka* with refractive errors for an accurate result.

KEYWORDS: *refractive errors, prevalence, netrasadhaka*

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1. INTRODUCTION

Among the five sensory organs, prime importance was given to eyes. Vision is crucial for the social & intellectual development of a person. Approximately 2.2 billion people worldwide experience visual impairment or blindness, with at least 1 billion cases being preventable or currently unaddressed. [1] Refractive errors contribute a major part to it. These are considered as a public health challenge as they affect all age groups.

Refractive errors include myopia, hypermetropia and astigmatism. In modern science the correction of refractive errors is through spectacles, contact lenses & refractive surgeries. Clinically the treatment of refractive errors often requires a holistic approach including dietary supplements, lifestyle modification and eye exercises.

In Ayurveda the symptoms of refractive errors are very much related to *vata* predominant *timira*. *Timira* is a *drishtigata roga* that can be attributed to various clinical conditions starting from mild blurring of vision. Management of *timira* includes *nidana parivarjana* (avoiding causative factors), *pathya ahara vihara seva* (wholesome diet and regimen), *snehapana* (internal oleation), *virechana* (purgation), *nasya* (nasal medication), *anjana* (collyrium), *murdhavasti* (making medicated oil to stand on the head), *vasti* (medicated enema), *tarpana* (holding medicated ghee over closed eyes), *lepa* (external application of medicines) and *seka* (pouring medicinal preparation over closed eyes), [2] eye exercises along with *agni vardhaka* (carminatives) and *chakshushya oushadhas* (medicines beneficial for eyes).

Eye exercises include movements of eyeballs, palming, blinking, shoulder and neck exercises etc. The movements of eyeballs are due to six extra ocular muscles; four recti and two oblique muscles.

Netrasadhaka is a kind of eye exercises that has been practiced by Indian classical performing artists especially by Kathakali and Koodiyattom artists. These exercises can be explained on the basis of movements of eye mentioned in *Natyashastra*, a treatise on performing arts written in Sanskrit.

Gestures of eyeballs or tara [3]

Eyeballs have gestures of nine kinds.

1. *Bhramana* - Turning round the eyeballs at random.
2. *Valana* – oblique movement of eyes.
3. *Patana/Pata* - Relaxation of the eyeballs while looking downwards.
4. *Chalana* - Tremor of the eyeballs.
5. *Sampraveshana/Pravasha* - Drawing the eyeballs in.
6. *Vivartana* - sidelong glance.
7. *Samudvritta* - Raising up of the eyeballs.
8. *Nishkramana* - Going out as it were of the eyeballs.
9. *Prakrita* - natural glance.

Eyelids or puta

These are of nine kinds.

1. *Unmesha* - opening of the lids
2. *Nimesha*- closing of the lids
3. *Prasrita* /expanding
4. *Kunchita* /contracted
5. *Sama* /level - natural position.
6. *Vivartita* /raising up
7. *Sphurita* /throbbing
8. *Pihita* /resting

9. *Vitadita* /driven

Technique of *netrasadhaka*

1. Make the eyes wide open using thumb and index finger.
2. Move the eyes horizontally from right to left and vice versa.
3. Next move the eyes from upwards to downwards and vice versa.
4. Then move the eyes obliquely from right upwards to left downwards and vice versa.
5. This should be followed by movement of eyes in a clockwise and anticlockwise half circle manner.
6. Move the eyes in a clockwise and anticlockwise manner completing a circle.
7. Move the eyes along a rectangular path, from the upper-left corner to the upper-right corner, then to the lower-right corner, and finally to the lower-left corner.
8. Draw a figure of eight.
9. Look at a far object for some time and then focus on a near object.
10. All the movements should be repeated in three speeds (slow, medium and fast)

Modern and Ayurveda ophthalmologists also suggest similar movements as eye exercises for correcting mild degrees of refractive errors and asthenopic symptoms.

Aim

To determine the prevalence of refractive errors among performing artists and to examine the role of *netrasadhaka* in preventing refractive errors.

Objective

Primary objective

To determine the prevalence of refractive errors in performing artists aged 10 to 40 years in central Kerala.

Secondary objective

To examine the role of *netrasadhaka* in preventing refractive errors.

Hypothesis

Null hypothesis

There is no role of *netrasadhaka* in preventing refractive errors.

Alternate hypothesis

There is a role of *netrasadhaka* in preventing refractive errors.

2. MATERIALS AND METHODS

Study design - Analytical cross-sectional study.

Study setting - Kerala Kalamandalam, deemed to be University of Art and Culture, Cheruthuruthy, Thrissur.

Study population - Performing artists of Kerala Kalamandalam, deemed to be University of Art and Culture, Cheruthuruthy, Thrissur, within the age group of 10-40 years of both sexes.

Study period -18 months (September 2021 to March 2023)

Sample size - $N = 4pq/d^2 = 88$ $p = 53.1\%$, $q = 46.9\%$, $d = 20\%$ of p So the sample size was taken as 90 [4]

Sampling technique - Purposive sampling

Selection of the patient - As per inclusion and exclusion criteria.

Collection of data - Using pre designed questionnaire and vision tests.

Bias – Kerala Kalamandalam follows strict rules including timely healthy vegetarian food for all from the

hostel, waking up at early morning, increased outdoor activities and reduced screen time for mobile phones and other gadgets. Sample obtained was between the age 13-21 years as the institution consists of 8th std to BA 3rd year students. So, the selection bias regarding age and lifestyle were limited. Recall bias can occur related to duration of watering of eyes, headache, eye pain and other symptoms. Refractive error was measured at a single point of time so there is a chance for measurement bias.

Inclusion and exclusion criteria

Inclusion criteria

Performing artists of any gender having age between 10- 40 years. Those who are willing to give consent for survey and vision test.

Exclusion criteria

Those who couldn't cooperate on providing details.

Those with other vision related ocular diseases.

Subject withdrawal criteria, replacement criteria & follow up of withdrawn subjects are not applicable here.

Diagnostic criteria

Myopia -0.5D to -3D

Astigmatism 0.75D to 2D

Hypermetropia +2D or less

Procedure

The study employed an analytical cross-sectional design, where data from a single examination of a population sample were analysed at a specific point in time. The study was conducted through the following steps.

1. A questionnaire was developed to collect data on participants' demographics, clinical features related to refractive errors, the duration and techniques of

netrasadhaka, and their typical dietary habits and lifestyle. The demographic section of the questionnaire recorded details including name, age, sex, religion, and occupation.

2. The study population consisted of performing artists from Kerala Kalamandalam, a deemed to be University of Art and Culture located in Cheruthuruthy, Thrissur. Participants were aged between 10 and 40 years, representing both sexes. Informed consent was obtained from the relevant authorities prior to conducting the study. Institutional ethical committee certificate was obtained.

3. Subjects were given all the information regarding the study and have assured the confidentiality of the data.

4. Then informed consent from the subjects were obtained and the questionnaires were given to them.

5. Total 90 subjects were surveyed meeting the inclusion and exclusion criteria.

6. Distant visual acuity was measured using the Snellen chart, while near visual acuity was assessed with the Jaeger chart.

7. All the data collected were tabulated and a master chart was prepared.

Statistical analysis

The data were analysed statistically using Chi square test for testing the significance and conclusions were made. Confidence interval was taken as 95%.

3. OBSERVATIONS AND RESULTS

A. Analysis of data

a. Data of surveyed population

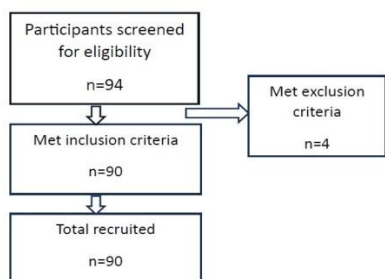


Figure 1: Participants Flow

Distribution according to age and gender

In the survey population 36.7% of subjects were < 16 years, 37.8% between 16 and 18 years, 25.6% were above 18 years. More number of subjects belong to the age group 16- 18 years and a smaller number of subjects were above 18 years. 55.6% were females and 44.4% were males.

Distribution according to artform

Among the art forms most of them were from Kathakali 17.8% and least from Mohiniyattom 2.2%.

Table 1 distribution according to art form

Art form	Frequency	Percentage
Carnatic music	11	12.2%
Chenda	5	5.6%
Kathakali	16	17.8%
Kathakali chutti	4	4.4%
Kathakali sangeetham	4	4.4%
Koodiyattom	15	16.7%
Madhalam	5	5.6%
Mizhavu	4	4.4%
Mohiniyattom	2	2.2%
Mridangam	4	4.4%
Nrittam	4	4.4%
Thullal	9	10%
Timila	7	7.8%
Total	90	100%

Distribution according to duration of *netrasadhaka*

Among the population 50% of them were not practicing *netrasadhaka*, 21.1% were practicing for <1 year,14.4% were practicing for 1-5 years and >5 years.

Table 2: Distribution according to duration of *netrasadhaka*

Duration of <i>netrasadhaka</i>	Frequency	Percentage
Nil	45	50.0%
<1 year	19	21.1%
1-5 years	13	14.4%
>5 years	13	14.4%
Total	90	100%

Distribution of symptoms

Among 90 subjects 21 (23.3%) of them had occasional headache, most of them were without headache (76.7%), 88.9% without eye pain 88.9% and only 11.1% had occasional eye pain. Only 17.8% of the population had watering of eyes occasionally, others didn't have the complaints of watering of eyes.

Distribution according to h/o spectacle use

Among the population only 8.9% had the history of spectacles, most of them (91.1%) weren't using spectacles.

Distribution according to family h/o refractive error

93.3% didn't have any family history of refractive error, only 6.7% of them had family history of refractive error.

b. Data of population with refractive error

Among 90 surveyed population,21 of them had refractive error. So, the prevalence of refractive error among performing artists were found to be 24.4%.

Distribution according to age and gender

47.6% of the subjects with refractive error belong to the age group 16-18 years and refractive error was least (14.3%) among those above 18 years of age, 14 were males (66.7%) and only 7 were females (33.3%).

Distribution according to art form

14.3% each were from Madhalam, Mizhavu, Kathakali sangeetham and Thullal; 9.5% each were from Chenda, Timila and Koodiyattom; 4.8% each were from Kathakali chutti, Carnatic music and Kathakali.

Table 3 Distribution according to art form with refractive error

SL No	Art form	Frequency	Percentage
1	Madhalam	3	14.3%
2	Mizhavu	3	14.3%
3	Chenda	2	9.5%
4	Kathakali chutti	1	4.8%
5	Carnatic music	1	4.8%
6	Kathakali sangeetham	3	14.3%
7	Timila	2	9.5%
8	Kathakali	1	4.8%
9	Thullal	3	14.3%
10	Koodiyattom	2	9.5%
	Total	21	100%

Distribution according to duration of *netrasadhaka*

According to the duration of *netrasadhaka*, 71.4% of the subjects with refractive error were from the group without *netrasadhaka*, 19% were practicing *netrasadhaka* for 1-5 years and 4.8% each were practicing for < 1 year and > 5 years.

Table 4 Distribution according to duration of *netrasadhaka* in subjects with refractive error

SL NO	Duration of <i>netrasadhaka</i>	Frequency	Percentage
1	0	15	71.4%
2	< 1 year	1	4.8%
3	1 – 5 years	4	19%
4	> 5 years	1	4.8%
	Total	21	100%

Distribution according to type of refractive error

Most of them with refractive error were simple myopic (61.9%), 33.3% were with myopic astigmatism and only 4.8% were with compound myopic astigmatism.

Distribution according to symptoms

7(33.3%) of them with refractive error had headache occasionally and 66.7% were without headache. Only 14.3% had occasional eye pain, 85.7% had no eye pain, 23.8% had watering of eyes and 76.2% had no watering of eyes.

Distribution according to h/o spectacle use

Among 21 subjects with refractive error, 8 of them had the history of spectacle use and 13 of them had no history of spectacle use.

Distribution according to family h/o refractive error

Only 9.5% of them with refractive error had family history of refractive error and 90.5% had no family history of refractive error.

No adjustment for confounding factors like age, screen time and family history were made.

B. Statistical analysis

Association of *netrasadhaka* with refractive error

Odds ratio obtained is 0.3076, indicates there is negative correlation which means *netrasadhaka* prevents the manifestation of refractive error. Chi square test value is less than 0.05, the association

between refractive error and *netrasadhaka* is considered to be statistically significant.

Table 5 Odds ratio between *netrasadhaka* and refractive error

<i>Netrasadhaka</i>	With refractive error	Without refractive error
Present	6	39
Absent	15	30
Total	21	69

Association of *netrasadhaka* with symptoms

Headache

Odds ratio obtained is 1.13, indicates there is association between *netrasadhaka* and headache. The chi square value obtained in 1.13 which indicates the association between *netrasadhaka* and headache is statistically insignificant.

Eye pain

The odds ratio obtained is 0.650 which indicates there is a negative association between *netrasadhaka* and eye pain. *Netrasadhaka* reduces eye pain. Chi square test value is greater than 0.05, so the association is statistically insignificant.

Watering of eyes

Odds ratio obtained is 0.534 which means there is negative association between *netrasadhaka* and watering of eye. *Netrasadhaka* reduces the manifestation of watering of eyes. Chi square value obtained is 0.098, which means the association is statistically insignificant.

4. DISCUSSION

Key results

After the survey study of 90 performing artists, the prevalence of refractive error was found as 24.4%.

71.4% of the artists with refractive error were from the group without *netrasadhaka*. 61.9% of the refractive error was simple myopia. 61.9% of the subjects with refractive error was unaware of their condition. A statistically significant inverse relationship was observed between *netrasadhaka* and refractive error. The association of *netrasadhaka* with head ache was not statistically significant. The association between *netrasadhaka* and eye pain was found as negative correlation but it was statistically insignificant. *Netrasadhaka* and watering was found negatively correlated but it wasn't statistically significant. By evaluating this, the null hypothesis is rejected and so alternate hypothesis is accepted. So, we reach to the conclusion that *netrasadhaka* has a significant effect in preventing refractive errors.

Limitations

The prevalence of refractive error was assessed only in performing artists of Kerala Kalamandalam which is actually a deemed university but follows nearly a gurukulams tradition. This study has to be conducted in a large population but only a few gurukulams are present in Kerala. The sample obtained contain subjects only up to 21 years of age, effect of *netrasadhaka* in initiation and progression presbyopia weren't assessed. Also effect in squint was also not assessed. The factors like prakriti, satva were not assessed as it was a self-answered questionnaire by the subjects which can act as a confounding factor. Information bias also can occur. Physical exercise also acts as a confounding factor that can affect the results.

Interpretation

Eye exercises are used as supportive methods to cure the errors of refraction by means of different relaxation techniques. They help to regain lost flexibility, strength, and coordination in the muscles of eyes. Eye exercises work on the principle of relaxation. But only lower degrees of refractive errors are curable through eye exercises while higher degrees could be improved. Currently, the demand for near and intermediate visual tasks has risen sharply due to extended use of computers and reading materials, placing continuous strain on the extraocular and ciliary muscles. This excessive workload may lead to functional impairments in these muscles, resulting in eye fatigue and various asthenopic symptoms.

During eye exercises, the extraocular muscles are consistently and fully engaged in multidirectional stretching, which heightens the metabolic requirements of the muscle tissues.[5] Extra ocular muscles contain slow twitch small fibres and fast twitch large fibres. The slow-twitch fibers have abundant mitochondria and myoglobin with great vascular supply which are resistant to fatigue. The fast-twitch fibers become fatigue rapidly. Exercise enhances the oxidative potential of all muscle fiber types, primarily by increasing mitochondrial density, boosting levels of aerobic enzymes, and promoting capillary growth in the active muscles, thereby improving fatigue resistance. [6] As the extraocular muscles strengthen, their performance becomes more efficient.

Blinking exercises enhance the function of the levator and orbicularis muscles, activating the blinking mechanism and making the blink reflex more automatic.

This reflex, in turn, stimulates the flow of aqueous humor, aiding in the nourishment and overall health of ocular tissues prolonged reading and close-up tasks can lead to muscle strain, which may be relieved through lateral viewing. Alternating between forward and sideways gazes enhances coordination between the medial and lateral eye muscles. Rotational viewing helps restore muscular balance around the eyes and improves the synchronized movement of both eyeballs. Vertical movements—looking up and down—aid in balancing the upper and lower ocular muscles. Nose tip gazing strengthens the eye muscles' ability to accommodate and focus effectively. [5]

The basic principles of eye exercise can be explained by some Ayurvedic principles. The role of mind in providing clear vision is elaborately described in Ayurveda. The sensory organ will perceive object only with the cooperation of mind. Also, Acharya Sushruta explains *krodha* (anger), *shoka* (grief) like *manasika bhavas* (psychological factors) in the causation of *netra rogas*. [7] In preventive ophthalmology Acharya Vagbhaṭa explains *manonivrtti* (withdrawing the mind from sensual actions) also [8]. The main activity or function of eye is visual perception, which depends on various factors. Refraction, accommodation, ocular movements, blinking etc. are some of the factors in which *vata* plays an important role. Every movement in the body is due to *vata*. Exercises provide physical and mental relaxation, which in turn alleviates *vata*. So, refractive error which are *vata* predominant and the asthenopic symptoms which are also mainly due to *vata*, gets relieved by eye exercises.

In Natyashastra the movements of eyelids are explained as *puta karma* in which *unmesha* is opening of the eyes, *nimesha* is closing or bringing together the eyelids, *prasrita* is separating the eyelids widely and *kunchita* is contracting the eyelids. These are also included in the eye exercises. The movements of eyeball are explained as *tara karma*, in which *bhramana* includes dextrocycloverision and levocycloverision, *Valana* includes dextroelevation, dextrodepression, levelevation and levodepression. *Patana/Pata* is infraversion, *samudvritta* is supraversion and *vivartana* includes dextroversion and levoversion. These movements are included in *netrasadhaka*.

Generalisability

While analysing the effects of *netrasadhaka*, a negative correlation between *netrasadhaka* and refractive error was found and it is statistically significant. Although *netrasadhaka* showed effectiveness in alleviating eye pain, excessive tearing, and other related symptoms, these effects were not statistically significant. From the survey conducted, dancers experienced the benefits of *netrasadhaka* as improvement in sharpness of vision, shine of eyes, easy and quick movements of eyes, more expressive eyes. These exercises may have helped in the proper nourishment of the eyes, increase in the metabolic activities of the extraocular muscles making them firm efficient to work and other benefits explained as in eye exercise. The awareness regarding importance of *netrasadhaka* and eye exercise in preventive refractive errors and reducing the asthenopic symptoms can be given to the performing artists and public.

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