Status of Eye Health of the Workers of Visually Demanding Occupations in Bangladesh: Assessing the Prevalence of the Symptoms of Asthenopia and Computer Vision Syndrome

A Project Report to be submitted in the Department of Pharmacy for the Partial Fulfillment of the Degree of Bachelor of Pharmacy.

Submitted By

Md.Wasiful Gofur

ID: 2012-1-70-044

Department of Pharmacy

East West University

DECLARATION BY THE RESEARCH CANDIDATE

I, Md.Wasiful Gofur, ID: 2012-1-70-044, hereby declare that the dissertation entitled **"Status of Eye Health of the Workers of Visually Demanding Occupations in Bangladesh: Assessing the Prevalence of the Symptoms of Asthenopia and Computer Vision Syndrome''** submitted to the Department of Pharmacy, East West University, in the partial fulfillment of the requirement for the degree of Bachelor of Pharmacy (Honors) is a genuine & authentic research work carried out by me. The contents of this dissertation, in full or in parts, have not been submitted to any other institute or University for the award of any degree or Diploma of Fellowship.

_____

Md.Wasiful Gofur
ID: 2012-1-70-044
Department of Pharmacy,
East West University
Dhaka, Bangladesh.

CERTIFICATION BY THE SUPERVISOR

This is to certify that the dissertation, entitled **"Status of Eye Health of the Workers of Visually Demanding Occupations in Bangladesh: Assessing the Prevalence of the Symptoms of Asthenopia and Computer Vision Syndrome'"** is a bona fide research work done by Md.Wasiful Gofur (ID: 2012-1-70-044) in partial fulfillment of the requirement for the degree of Bachelor of Pharmacy under my supervision.

_____

Nishat Nasrin
Senior Lecturer
Department of Pharmacy
East West University
Dhaka, Bangladesh

ENDORSEMENT BY THE CHAIRPERSON

This is to certify that the dissertation, entitled **"Status of Eye Health of the Workers of Visually Demanding Occupations in Bangladesh: Assessing the Prevalence of the Symptoms of Asthenopia and Computer Vision Syndrome'"** is a bona fide research work done by Md.Wasiful Gofur (ID: 2012-1-70-044) in partial fulfillment of the requirement for the degree of Bachelor of Pharmacy under the guidance of **Nishat Nasrin**, Senior Lecturer, in partial fulfillment of the requirement for the degree of Bachelor of Pharmacy.

_____

Dr. Shamsun Nahar Khan
Associate Professor & Chairperson
Department of Pharmacy
East West University
Dhaka, Bangladesh

ACKNOWLEDGEMENTS

Above all, I express my gratitude to Almighty Allah for all the bounties granted to me and only with HIS guidance and help this achievement has become possible.

It is my pleasure and proud privilege to express my heartiest regards and gratitude to my respected teacher and supervisor **Nishat Nasrin**, Senior Lecturer, Department of Pharmacy, East West University, for her expert supervision, constructive criticism, valuable advice, optimistic counseling, constant support & continuous backup and encouragement throughout every phase of the project as well as to prepare this dissertation.

I would also like to put forward my most sincere regards and profound gratitude to **Dr. Shamsun Nahar Khan**, Associate Professor & Chairperson, Department of Pharmacy, East West University, for giving me the opportunity to conduct such an interesting project and for facilitating a smooth conduction of my study.

I would also like to thank my dear friends **Mohsin Ibna Amin**, **Md Faysal**, **Kazi Tanvir Islam**, **Fariha Kabir**, my dear younger brother **Md. Waliul Gofur** and last but not least each and every member of my batch **2012-1**, who helped me instantaneously when I needed the most while working on this research paper.

And at the end, I would like to thank my family for their endless inspiration, support and care during my research work.

DEDICATION

This research paper is dedicated to my beloved parents for their unconditional support.

Table of contents

List of Tables

List of Figures

Abstract

Visually demanding occupations are professions which involve extensive function of eyes. So workers of such professions are prone to conditions called asthenopia which is the medical term for eye fatigue. In addition, individuals who work on computer are vulnerable to a condition named computer vision syndrome which consists of asthenopic symptoms and extraocular symptoms, such as, pain in the limbs. The study was aimed to assess the overall condition of eye health of workers of such professions emphasizing on the prevalence of asthenopia and computer vision syndrome. Correlation of various factors with asthenopia and computer vision syndrome was evaluated. The survey was conducted on 287 workers of varied visually demanding professions: 32 computer operators, 18 weavers, 201 garment workers and 36 general tailors. 32.40% of the subjects were found to be asthenopic. Among the symptoms eye pain (5.38% severe, 1.08% moderate, 22.58% mild), headache (26.88% severe, 9.68% moderate, 20.43% mild) and blurry vision (6.45% severe, 4.30% moderate, 20.43% mild) was found to be prominent. This study provides the picture of a small fragment of the visually demanding workers of Bangladesh. In order to obtain a more comprehensive picture, a study on larger population and on more sorts of professions should be conducted.

Keywords: *Asthenopia, Computer vision syndrome, Visually demanding occupation, Bangladesh, Eye health.*

Chapter 1

Introduction

1.1 Overview

Eye is a very complicated and delicate organ. It is a spheroid divided in different layers and cavities. There are different delicate parts involved in obtaining optical signals, interpreting it into sensory information and convey it to the central nervous system. The most important parts involved in viewing are cornea, lens, ciliary body, retina etc. (Lang, Amann and Grossman, 2000).

There are also some structures around the eye which are very useful such as, conjunctiva and eyelids, lacrimal apparatus (Martini and Nath, 2009).

Viewing involves some complex mechanisms such as, refraction, accommodation, image reversal, convergence etc. (Bye, Modi and Stanford, 2013).

There are a wide range of diseases of eye and many of them are common. The diseases of the eye are originated from anomalies either of the structures of the eye or of the processes involved in seeing (Basak, 2013).

Asthenopia is a condition originated from excessive use of the eyes. It consists of symptoms associated with strain or weakness felt on the eyes (Abdi and Rydberg, 2005). Computer vision syndrome is a condition caused by working excessively on computer. The condition is manifested by asthenopic symptoms along with pain in various parts of the body (Akinbinu and Mashalla, 2013).

People who are involved in visually demanding professions are prone to asthenopia (Rajabi-Vardanjani *et al*., 2014). Some visually demanding professions are weaving, tailor works, operating computer, garments labor etc.

1.2 Anatomy of the Eye

The eye is the visual instrument of human body. It is an irregular spheroid like organ with an average diameter of 24mm and weight of about 8g (Lang, Amann and Grossman, 2000).

The anatomy of the eye is described below:

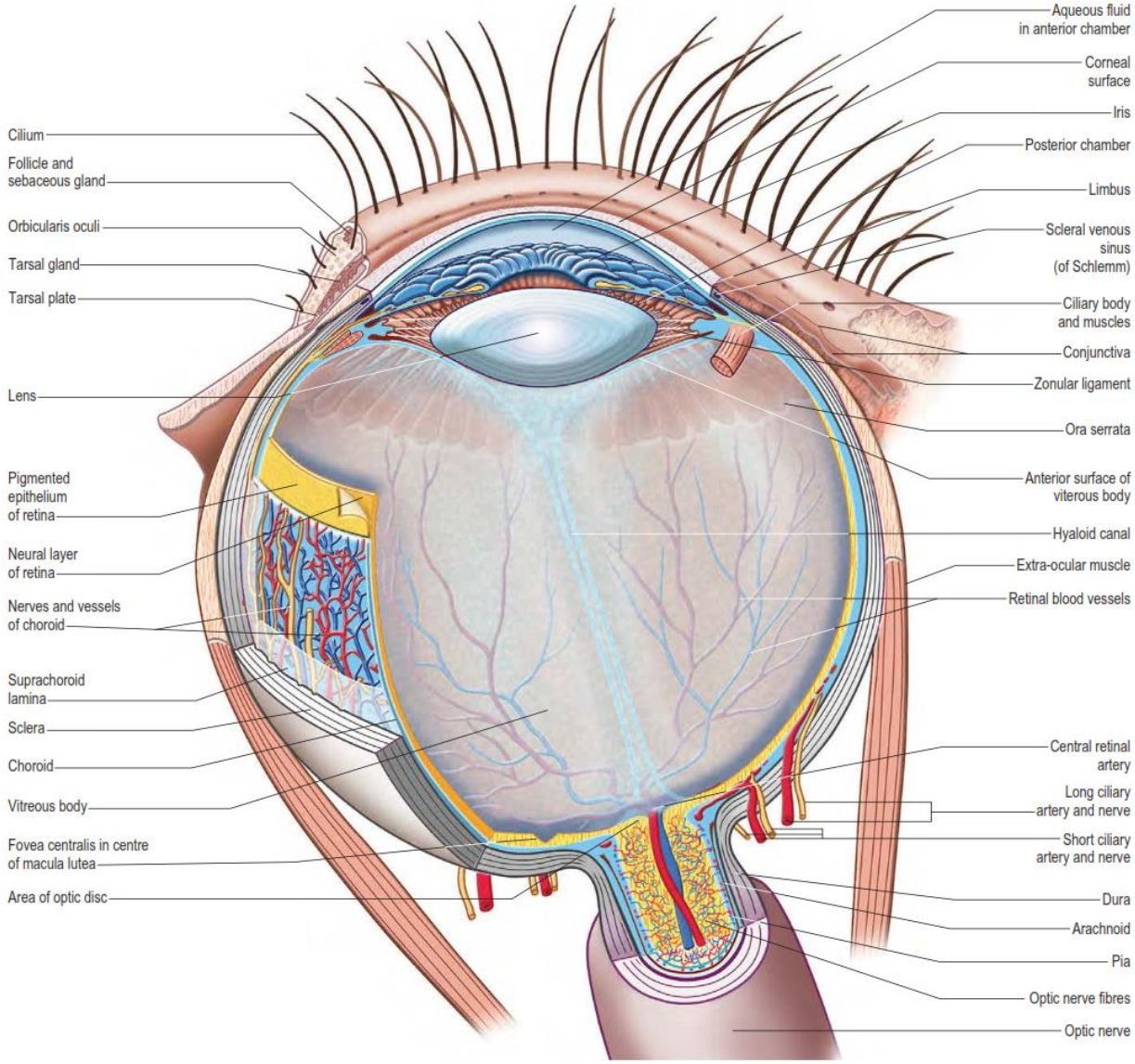

Figure 1.1: Anatomy of Eye (Gray, Williams and Bannister, 2008)

1.2.1 Tunics of the Eye

The wall of eye consists of three different tunics or layers. They are:

- Fibrous tunic
- Vascular tunic
- Neural tunic (Martini and Nath, 2009)

1.2.1.1 The Fibrous Tunic

It is the outermost layer of the eye. It provides mechanical support and protection to the eye and assists in the focusing process. Extrinsic eye muscles attach on this tunic. It consists of sclera and cornea (Basak, 2013).

1.2.1.1a Sclera

It covers most of the ocular surface and is visible as the white portion of the eye. It consists of dense fibrous connective tissues containing collagen and elastic fibers, small blood vessels and nerves. The collagen fibers of sclera blends with those of the extrinsic eye muscles (Lang, Amann and Grossman, 2000).

1.2.1.1b Cornea

Cornea is located above the iris, the portion of vascular tunic visible as the colored portion. It is transparent. It is continuous with the sclera. The border between these two is called corneal limbus. Cornea consists of an epithelial layer, a dense matrix beneath the layer that contains multiple layers of collagen fibers. There are numerous free nerve endings but no blood vessel in cornea. Hence the supply of oxygen and nutrition for the corneal cells is dependent on the tear (Martini and Nath, 2009).

1.2.1.2 The Vascular Tunic

It is the intermediate layer of eye wall which is composed of blood vessels, lymphatic vessels and intrinsic muscles. It provides a route for lymphatic and blood vessels, controls eye sight by regulating amount of light entering the eye and controlling the shape of the lens and secretes and reabsorbs aqueous humor. The layer consists of iris, ciliary body and choroid (Gray, Williams and Bannister, 2008).

1.2.1.2a Iris

The iris is visible through the corneal surface. It consists of blood vessels, pigment cells and two layers of muscles called pupillary muscles involved in the diameter change of pupil, the central opening of iris.

Pupillary muscles are of two types: pupillary constrictor muscles and pupillary dilator muscles. Pupillary constrictor muscles forms a series of concentric circles around the pupil whose contraction leads to the decrease in pupil diameter. Pupillary dilator muscles extends radially away from the pupil whose contraction leads to the increase in pupil diameter (Martini and Nath, 2009).

1.2.1.2b Ciliary Body

Ciliary body is attached to iris at the periphery of iris. It begins deep from the corneal limbus and extends posteriorly to the orraserata, which is the anterior edge of the inner portion of the neural tunic. It mainly consists of ciliary muscle and ciliary processes, the epithelium with folds covering the ciliary muscle. Ciliary processes hold the lens in place with suspensory ligaments (Lang, Amann and Grossman, 2000).

1.2.1.2c Choroid

It is a vascular layer which separates the fibrous and neural tunic posterior to the orraserata. It is covered by the sclera and attached to the outermost layer of retina. It is involved in oxygen and nutrient supply to retina (Bye, Modi and Stanford, 2013).

1.2.1.3 The Neural Tunic

It is also called retina. It is the innermost layer of eye. It consists of two layers: the pigmented part and the neural part.

The pigmented part is the outer layer. It is thin and consists of pigment cells. It absorbs light and prevents the light from bouncing back from the neural part. The pigments also have biochemical interaction with light receptors.

The neural part is the inner layer which is thick and consists of light receptors, supporting cells and neurons. Preliminary processing and integration of visual information is done here (Gray, Williams and Bannister, 2008).

1.2.2 Cavities and Fluids of the Eye

The ciliary body and lens divide the interior of the eye into two cavities: large posterior cavity and smaller anterior cavity.

The anterior cavity is subdivided into anterior chamber and posterior chamber. The anterior chamber extends from the cornea to the iris. The posterior chamber is between iris and the ciliary body and the lens.

The cavities are filled with fluid. The anterior cavity is filled with aqueous humor. The posterior cavity is filled with smaller amount of aqueous humor and larger amount of vitreous humor (Basak, 2013).

1.2.2.1 Aqueous humor

It circulates through the pupil and diffuses through the vitreous humor and across the retina surface. The ciliary process epithelium secretes it and regulates its composition.

It maintains the intraocular pressure, thus the shape of the eye. It also stabilizes the position of the retina (Lang, Amann and Grossman, 2000).

1.2.2.2 Vitreous humor

It is a gelatinous mass. It also helps stabilize the eye shape. There are cells embedded in it responsible for the production of collagen fibers and proteoglycans (Martini and Nath, 2009).

1.2.3 The Lens

The lens is a transparent portion of eye that is involved in focusing by shape changing. It is located posterior to the cornea. It consists of concentric layers of anucleate cells called lens fibers which are covered by a dense fibrous capsule. The clarity and focusing ability of lens depend on transparent proteins called crystallins, which are produced by lens fibers (Bye, Modi and Stanford, 2013).

1.3 Accessory Structures of Eye

Accessory structures of the eye include eyelids, superficial epithelium of the eye and lacrimal apparatus.

1.3.1 Eyelids

The eyelids are continuation of the skin. They are involved in lubrication of eye through blinking, removal of dust and debris and protection of the eye. Blinking of eyelids is done with the help of

skeletal muscles. The eyelids have robust hair at its margin which are called eyelashes which protect eye surface from foreign surface.

There are glands associated with eyelids such as, tarsal glands and lacrimal caruncle. Tarsal glands are involved in secretion of lipid rich product that keeps the eyelids from sticking together. Lacrimal caruncle produces thick secretions that is responsible for gritty deposition that is seen after long sleep (Bye, Modi and Stanford, 2013).

1.3.2 Superficial Epithelium of the Eye

There is an epithelium covering the inner surface of eyelid and outer surface of eye which is called conjunctiva. It is a mucous membrane and it is covered with specialized stratified squamous epithelium.

The inner surface of eyelid is covered by palpebral conjunctiva and outer surface of eye is covered by ocular conjunctiva. Only cornea is not covered by ocular conjunctiva (Martini and Nath, 2009).

1.3.3 Lacrimal Apparatus

The lacrimal apparatus is responsible for production, distribution and removal of tear. Tear keeps conjunctival surface moist and clean, reduces friction, removes debris, prevent bacterial infection and provides nutrients and oxygen to portions of the epithelium of conjunctiva.

Lacrimal apparatus consists of a lacrimal gland with associated ducts, paired lacrimal canaliculi, lacrimal sac and nasolacrimal duct. The lacrimal gland is involved in supplying key ingredients and most of the volume of tear and supplying nutrient and oxygen to corneal cells through diffusion. The tear produced by the gland is swept across the ocular surface. Then through two small pores named lacrimal puncta tear empties into lacrimal canaliculi, which is a small canal. Lacrimal canaliculi leads tear to lacrimal sac, from where tear enters nasal cavity through nasolacrimal duct and nasolacrimal canal (Gray, Williams and Bannister, 2008).

1.4 Visual Acuity

Visual acuity is the measurement of the clarity of vision. It is rated with fraction whose numerator is 20. Level of detail seen by a person at a distance of 20 feet is designated by 20/20. The lower is the denominator, the better is the visual acuity, e.g., 20/15 indicates that at 20 feet the person will

be able to see as clear as a person with 20/20 will see at a distance of 15 feet. The higher is the denominator, the worse is the visual acuity (Tsai *et al*., 2011).

1.5 Processes Involved In Seeing

From acquiring optical signals to interpreting it into sensory information, there are various processes involved. The principle processes are described below:

1.5.1 Refraction

For obtaining sensory information from the light entering into the eyes, the incoming rays have to strike a specific site on retina which is the focal point. For this to be done, the light rays have to be bent or refracted.

Refraction occurs when light enters into an optical media whose optical density is different from air. Corneal tissue and lens serves as such optical media. Corneal tissue is responsible for the greatest amount of refraction. It has a density close to that of water.

Additional refraction occurs with the lens which is denser. The distance between the center of the lens and focal point is called the focal distance. It is determined by two factors:

- Distance from the object to the lens: The closer is the object, the greater is the focal distance.
- Shape of the lens: the rounder is the lens, the more is the refraction than that of a flatter one (Martini and Nath, 2009).

1.5.2 Accommodation

The lens can change its shape in order to adjust the focal distance to a constant value, thus focusing light rays on the focal point. This process is called accommodation. For seeing a nearby object the lens becomes rounder and it flattens in the case of a distant object.

The smooth muscle fibers of ciliary body is involved in accommodation. Contraction of the ciliary muscle makes the lens rounder, allowing to focus on nearby objects. Relaxation of ciliary muscle makes the lens flatter and distant objects can be focused on (Basak, 2013).

1.5.3 Image Reversal

A miniature image of the object being viewed is created on the retina. But in the image the object appears upside down. This happens because a complex light source is a large number of individual points, among whom image of the topmost point is created on the bottom of the retina and for the bottommost point the image is created on the top of the retina.

The brain compensates for this image reversal, rendering us unaware of the disparity between the image created and the original light source (Martini and Nath, 2009).

1.5.4 Convergence

Vergence or convergence is the movement of eyes to place the two retinal images on corresponding retinal points and thus minimal retinal disparity. It is required for normal binocular vision.

Initial convergence is the movement of the eyes from the resting physiological position to the position of single binocular fixation of a distant object.

Near point of convergence is the point where the lines of sight intersect when the eyes converge to the maximum extent with preserved binocular single vision. It is located about 6 to 10 cm in front of the eyes and independent of age (Basak, 2013).

1.5.5 Near Vision Complex

It is the coordination of accommodation, convergence and constriction of pupil. During fixation on an object located at near distance accommodation creates a clear image on retina, convergence system changes the relative position of visual axes and pupillary sphincter muscle reduces pupil size by constriction.

Parts of nervous system involved are:

- Cerebral cortex: generates signals of three components of near vision response.
- Pretectum and tectum of midbrain: control, integrate and synthesize impulses.

Oculomotor nuclear complex including the Edinger-Westpal nucleus: acts as the final common pathway and transmit impulses to the effector organs: ciliary body, medial rectus and iris sphincter (Abdi and Rydberg, 2005).

1.6 Disorders of Eye

Disorders of the eye can be originated from anomaly of any anatomical structure or any process involved in viewing. The disorders are described below:

1.6.1 Refractive Errors

The common disorders originated from errors in refraction are: hypermetropia, myopia, astigmatism, anisometropia etc. They are discussed below:

1.6.1.1 Hypermetropia

It is a condition in which upon relaxation, distant objects are focused behind retina. This condition can be removed temporarily by accommodation and for permanent treatment by wearing convex lenses. Hypermetropia can be classified by the degree of the refractive error:

- Low hypermetropia (less than or equal to 2.00 D)
- Moderate hypermetropia (2.25-5.00 D)
- High hypermetropia (greater than or equal to 5.00 D)

Young hypermetropic patients can accommodate to overcome part or all of their error, and have good distant view. So they do not need correction usually.

Most children cannot overcome hypermetropia without lenses, because their amplitude of accommodation is low comparing to their degree of hypermetropia. So these children need correction, so that they have to accommodate less in order to stabilize binocular vision and eliminate hypermetropia.

When the level of hypermetropia exceeds 1.00 D, patient should be prescribed plus lenses (Martini and Nath, 2009).

1.6.1.2 Myopia

Myopia is a condition in which the image of distant object is formed in front of the retina, rather than on it, upon the relaxation of accommodation. But if the object is located at the dioptric distance equivalent to the degree of myopia, then the image will be formed on the retina. Wearing a concave lens will eliminate this condition.

Myopia can also increase the size of near eso-deviation (a condition in which two eyes are not directed towards the same object and the direction of the deviating eye is inwards in relation to the fixating eye) or accommodative fluctuations at near distance. Coexistence of abnormal accommodative response and myopia can cause uncomfortable vision and eyestrain.

If myopia of schoolchildren is more than 1.00D, then it should be corrected. If there is high or intermittent exophoria (a condition in which the visual axes are directed outward and patient cannot fuse images together), refractive correction should be worn fulltime. In case of esophoria (a condition in which the visual axes are directed inward and patient cannot fuse images together) of near vision or accommodative insufficiency, a plus lens for near vision can also be used (Lang, Amann and Grossman, 2000).

1.6.1.3 Astigmatism

In this condition the image of the object is not formed on a single point but as two focal lines at different distances from retina. It can be present in combination with hypermetropia or myopia. Based on the location of focusing of the focal lines astigmatism can be classified into four classes:

1. Compound hypermetropic astigmatism: behind the retina
2. Compound hypermetropic astigmatism: in front of the retina
3. Mixed astigmatism: behind and in front of retina
4. Simple astigmatism: one focal line is on retina and other one is in front or behind.

A cylindrical correction is needed for astigmatism. Astigmatism larger than 0.25 D should be corrected if asthenopic symptoms are seen (Lang, Amann and Grossman, 2000).

1.6.1.4 Anisometropia

It is a condition in which refraction is unequal in two eyes. It occurs due to the difference in size or refractive components of eyes. For anisometropic patients difference in spherical refraction is more than 1.00 D and they also have astigmatism of more than 0.50 D.

In the presence of large uncorrected anisometropia a central retinal suppression area can develop in the eye with more blurred vision. This may lead to abnormal visual development and amblyopia of the eye.

Correction with glasses may lead to two problems:

1. Prismatic effect of the glasses.
2. Aniseikonia (difference in retinal image size between two eyes) caused by differences in magnification of two lenses. This may make binocular vision difficult or impossible.

But these do not apply for preschool children as they can adapt to these effects (Bye, Modi and Stanford, 2013).

1.6.2 Accommodation Disturbances

Disturbance is accommodation can lead to various disorders:

1. Insufficiency of accommodation: In this condition the amplitude of accommodation in relation to age is lower than expected. It is the most frequently diagnosed near vision anomaly.
2. Infacility of accommodation: In this condition patient cannot use accommodation properly to adjust focus when the image is unclear. This can be diagnosed by measuring the length of time taken for altering focus from one distance to another. In case of infacility of accommodation, it will be 1 second or more.
3. Fatigue of accommodation: In this condition a reduction in acoomodation amplitude is seen with repeated measurements.
4. Spasm of accommodation: In this condition accommodation occurs excessively than required. It is originated from the overaction of ciliary muscle or excessive flexibility of the lens. The patient cannot relax accommodation properly.
5. Paresis of accommodation: It is the deficiency in accommodation caused by an organic lesion.
6. Unequal accommodation: In this condition the accommodative ability is unequal for two eyes, either in amplitude or facility or in spasm (Lang, Amann and Grossman, 2000).

1.6.3 Convergence Insufficiency

It is a condition of convergence anomaly in which the patient is incapable to maintain convergence to meet the visual near point demand giving rise to asthenopia. It can be originated from two conditions:

- From exophoria: Exophoria is a condition in which the visual axes are directed outward and patient cannot fuse images together. Exophoria puts large demand on the vergence system.
- From muscular deficiency: The muscular system is incapable of meeting the vergence demand.

Regardless of its origin, this condition exhibits manifestation of high exophoria or exotrophia (a condition in which two eyes are not directed towards the same object and the direction of the deviating eye is outward in relation to the fixating eye) at near vision (Basak, 2013).

1.6.4 Heterotrophia and Heterophoria

Heterotrophia is a condition in which the visual axes of two eyes are not directed towards the same fixation point when fixation is actively done on an object.

Heterophoria is a condition in which the visual axes of two eyes are not directed towards the same fixation point when the patient is prevented from being able to fuse the images of two eyes.

The classification of heterotrophia or heterotrophia can be done based on direction of the deviating eye in relation to the fixating eye (also used as the description of the direction of heterotrophia or heterotrophia). They are:

- Esotropia or esophoria: inward.
- Exotropia or exophoria: outward.
- Hyper- or hypotropia or phoria: vertical.
- Cyclotropia or cyclophoria: the eye has rotated around the visual axes.

Depending on the angle of deviation heterophoria and heterotrophia can be divided into two major forms:

- Comitant deviation: the angle of deviation remains the same with either eye fixating and in all the directions of gaze. It usually appears congenitally or from an early age.
- Incomitant deviation: the angle of deviation differs according to which eye is fixating and in which direction of gaze. It is usually acquired (Abdi and Rydberg, 2005).

1.6.5 Diseases of the Eyelid

Common diseases of the eyelid are various congenital anomalies of shape and position, involuntary and spasmodic blinking, inflammation and tumors of eyelids etc.

Congenital anomalies of shape and position include adhesion between upper and lowereyelid margins (ankyloblepharon), outward (ectropion) and inward (entropion) turning of lid margin,extra fold in the skin on medial side of lower lid (epicanthus)etc. The condition of involuntary and spasmodic blinking is called blepharospasm. Inflammation is manifested by eczematous lesion, itching and swelling of lids (Lang, Amann and Grossman, 2000).

1.6.6 Diseases of the Conjunctiva

The diseases of conjunctiva are hyperaemia, conjunctivitis, tumors and cysts in conjunctiva etc.

Hyperaemia is the dilation of the conjunctival blood vessels. The inflammation of conjunctiva is conjunctivitis, which can be infective or allergic. It is manifested by stickiness of the lids during sleep, itching, redness etc. (Bye, Modi and Stanford, 2013).

1.6.7 Diseases of the Cornea and Sclera

The diseases of cornea and sclera are congenital anomalies, corneal edema,keratitis, corneal degenerations and dystrophies etc.

Congenital anomalies of cornea are microcornea (decreased diameter and radius of curvature of cornea), megalocornea (increased corneal diameter), corneal opacities etc. Corneal edema can occur from the fluid of aqueous humor or tears. Keratitis is the inflammation of cornea. Both corneal degenerationsand dystrophies are the pathological changes in the corneal cells. Degenerations are caused by abnormal circumstances, whereas dystrophies are caused by inborn defects (Basak, 2013).

1.6.8 Diseases of the Uvea

Iris, ciliary body and choroid are collectively called uvea. Diseases of uvea are various congenital anomalies of pupil and iris, uveitis (inflammation of uvea), degenerations of uveal tract etc. (Basak, 2013).

1.6.9 Diseases of the Lens

Diseases of the lens are congenital anomalies, cataract, subluxation and dislocation of lens etc.

Cataract is the opacification of the lens. It can be congenital, originated from other ocular diseases, traumatic, secondary to other diseases (diabetes, hypocalcemia etc.), due to exposure to toxic substances etc. Subluxation of lens is a condition in which the lens stays in the pupillary are but is displaced or tilted. In dislocation the lens is completely displaced from the pupillary area (Bye, Modi and Stanford, 2013).

1.6.10 Glaucoma

Glaucoma is a condition in which intraocular pressure is increased. This disturbs the functional integrity of eye and results in irreversible loss of visual field. Glaucoma can be congenital or developmental, or acquired later. Acquired glaucoma can occur secondary to other ocular or systemic disease (Lang, Amann and Grossman, 2000).

1.6.11 Diseases of the Vitreous

Diseases of vitreous are degenerations, vitreous opacities, vitreous hemorrhage etc.

In degenerations vitreous humor becomes partially or completely fluid or vitreous detaches. Vitreous opacities can be caused by foreign substances being suspended such as, parasites or foreign bodies, different cells, pigments, crystals etc. (Basak, 2013).

1.6.12 Diseases of the Retina

Various diseases of the retina are congenital and developmental anomalies, vascular disorders (occlusion), macular degeneration, retinitis pigmentosa (night blindness and constricted visual fields.), retinal detachment, hypertensive and diabetic retinopathy (retinal edema, hemorrhage, occlusion, hypoxia etc.).

Congenital and developmental anomalies are myelinated nerve fibers, phakomatosis (tumors in blood vessels and neural tissues) etc. Macular degeneration is the leading cause of blindness in western world (Basak, 2013).

1.6.13 Diseases of the Optic Nerve

Diseases of the optic nerve include developmental anomalies (anomalies of the disc and arteries), optic neuritis (inflammation or demyelination), papilloedema (swelling of optic disc), optic atrophy (degeneration of optic nerve fibers) etc. (Lang, Amann and Grossman, 2000).

1.6.14 Diseases of the Orbit

The various diseases of the orbit are developmental anomalies (involves bones of skull or face), proptosis (forward protrusion of eyeball), inflammation, thyroid ophthalmopathy (can be present in hyper or hypothyroidism), tumors etc. (Bye, Modi and Stanford, 2013).

1.6.15 Diseases of the Lacrimal Apparatus

Diseases of the lacrimal apparatus include dry eye, watery eye, dacryocystitis (inflammation of lacrimal sac) etc. (Lang, Amann and Grossman, 2000).

1.6.16 Diseases of Ocular Motility

They are diplopia (double vision), amblyopia (reduction in vision), squint (visual axes are not parallel), nystagmus (involuntary rhythmic, to-and-fro oscillation of eyeballs) etc. (Basak, 2013).

1.7 Asthenopia

1.7.1 Definition of Asthenopia

Asthenopia is a condition in which strain, weakness or fatigue is felt on the eye due to excessive use of eyes. If we break down the word, we can see,

‘a’ means ‘not’,

‘sthenos’ means ‘strength’,

‘ops’ means ‘vision’ (Abdi and Rydberg, 2005).

1.7.2 Symptoms

The symptoms of asthenopia are:

- Headaches
- Focusing problems
- Diplopia
- Distant or near blurred vision
- Teary eyes
- Redness of eyes
- Eyestrain etc. (Rajabi-Vardanjani *et al*., 2014)

1.7.3 Epidemiology

- Asthenopia is less frequent at distant vision than near vision, because distant vision puts less strain on the accommodation and vergence systems.
- Working with computers requires fixed posture, at the same near visual distance and sometimes even for hours. This factors puts strain on near vision system. So among computer users asthanopia is frequent.
- Asthenopia is prevalent in 15.2% in 6 year children and 34.7% in schoolchildren who are 6-10 years old (Abdi and Rydberg, 2005; Dehghani *et al*., 2008).

1.7.4 Causes and Classification

Asthenopia is classified based on the causes of its origin. The classes are:

1. Refractive asthenopia
2. Muscular asthenopia

Refractive asthenopia is caused by refractive errors. The causes are:

- Hypermetropia
- Myopia
- Astigmatism
- Anisometropia

Muscular asthenopia is caused by neuromuscular anomalies. The causes are:

- Heterotrophia and heterophoria
- Convergence insufficiency
- Accomodative insufficiency
- Disturbance in the balance of near vision complex (Abdi and Rydberg, 2005)

1.7.5 Measurement of Asthenopic Symptoms

Various questionnaires, classification schemes and scales were used by many researchers to assess the asthenopic symptoms. They are discussed below:

1.7.5.1 Questionnaires and Classification Schemes

Cooper *et al*. (1983): It contains 8 questions, most of whom have five alternatives and a scale for estimating symptoms due to convergence insufficiency and other binocular vision disorder.

Convergence Insufficiency and Reading Study Group (CIRS): A classification scheme has been developed based on measurements of the asthenopic problems in relation to accommodative insufficiency and convergence insufficiency.

There are other questionnaires and classification schemes such as COVD-QOL (College of Optometrist in Vision Development Quality for Life Checklist) and questionnaire of Borsting *et al*. (1999). But they are complicated, time consuming and difficult.

1.7.5.2 Scales for Assessment of Disease Symptoms

1.7.5.2a Pain Scales

Pain Face Scales (PFS):There are several of them such as face scales of Kuttner and LePage (1989) and Bieri *et al*. (1990). They are mostly used for children, but are also used for adults too for whom visual anologue scales are difficult. In these scales there are pictures of facial expressions among which the subject has to indicate the one best represent their pain.

Word graphic rating scales: These are used for assess pain, measure, monitor and evaluate the effect of treatment. Subjects are asked to indicate the degree of pain by five verbal anchors. They are useful in communicating the level of symptoms and identifying individual perception of pain.

1.7.5.2b Visual Analogue Scale (VAS)

There are two types of these:

- The original one is a vertical line with word anchors indicating ‘no pain’ to ‘the worst possible pain’, among which the subject has to choose one.
- The other one uses numbers for the intensity of pain rather than word anchors. Rating 2.5 or lower indicates tolerable pain and above 4 indicates agitation.

It is easy to use, reliable as it produces reproducible results and produces data which are sensitive to treatment and statistically analyzable (Abdi and Rydberg, 2005; Rajabi-Vardanjani *et al*., 2014).

1.7.6 Treatment of Asthenopia

Treatment of asthenopia is done by treating the underlying causes. In case of refractive asthenopia refractive error is corrected. Muscular asthenopia is treated by orthoptic treatment as well as glasses if needed. A table of diagnosis and treatment is given below:

Table 1.1: Diagnosis and Treatment of Asthenopia

Causes	Investigation	Treatment
Hypermetropia	Refraction/cyclopegia	Refractive correction
Myopia	Refraction/cyclopegia	Refractive correction
Astigmatism	Refraction/cyclopegia	Refractive correction
Anisometropia	Refraction/cyclopegia	Refractive correction
Reduced accommodation	Near point of accommodation	Refractive correction: plus glasses
Convergence insufficiency	Near point of convergence/ degree of deviation/prism cover test	Convergence exercises/prism/surgery
Heterophoria	Degree of deviation/prism cover test	Prism glasses/surgery
Heterotrophia	Degree of deviation/prism cover test	Prism glasses/surgery

1.7.6.1 Treatment of Reduced Accommodation: It involves reading addition or orthoptic exercises. These are aimed for creating a clear and focused image on retina and training the visual sensory system to recognize a clear image and reinforce accommodative response to a defocused image.

One of such exercises is 'flip lens' or 'spherical flipper' in which a plus and a minus lenses of the same diopter are put on different eyes. The patient has to alternately an object placed at a distance of 40 cm normally, through either sides of the flipper, and to obtain a clear image before flipping to the other side.

1.7.6.2 Treatment of Convergence Insufficiency:

Prism glasses: They reduce deviation to provide a comfortable view. Power of the prism is based on the measurement of distance and near deviation. In some cases, deviation may get increased by itself. In such cases, power of the prism should also be increased.

Surgery: It is required for deviation is too large for prism to handle.

Botulinum toxin type A: It is needed in case of deviations less than 15 prism diopters. It is not applicable for children.

Home-based exercises: Home-based exercises are 'pencil push-up', flipper spherical lenses and flipper prisms (it is similar to a spherical flipper except for prismatic lenses, base-in and base-out on different sides) (Abdi and Rydberg, 2005).

1.8 Computer Vision Syndrome

Computer is one of the greatest inventions in modern age. Day by day, new fields for the use of computer is emerging. But this gift of modern science has some grave shortcomings too, among which CVS is one of the most prevalent one.

1.8.1 Increase in the Use of Computer

The use of computer is increasing day by day, not only in number of users, but also in the length of time for use. Approximately 90million adults use computers in regular basis worldwide (Chiemeke, Akhahowa and Ajayi, 2007). An image of the increase in computer use in modern days is depicted below:

Evolution of computer into various devices: Computer has evolved from desktops into notebooks, tablets, smartphones and e-book readers, thus increasing the use. The use of these digital display devices extends from work to web surfing, social networking and playing video games.

It is found that, professional video game players in South Korea spend 18 hours per day in front of their screens at a stretch (Barthakur, 2013).

Use in school and children: Computers are used in schools for educational programs and computer-generated games. Basic skills of computing are introduced at a high percentage of elementary schools in the developed countries. Also number of schools introducing computer-based curriculum as a component of the general education of the elementary aged students is increasing (Chiemeke, Akhahowa and Ajayi, 2007).

Almost 90% of children in the USA work on a computer at home or in school every day (Akinbinu and Mashalla, 2013).

Children as young as two years are allowed to use touch screen devices like iPads to play and learn with (Barthakur, 2013).

At job sectors: Since 2000, about 75% of daily activities of all jobs involve computer use (Dehghani *et al*., 2008).

1.8.2 Definition of CVS

According to the American Optometric Association, computer vision syndrome is a group of eye and vision-related problems which results from prolonged computer usage (Barthakur, 2013).

1.8.3 Cause

The causes which contribute to CVS are described below:

Difference between characters on screen and characters printed on paper: Eye and brain reacts differently to characters on the screen than to printed characters. Because:

- The computer screen constantly refreshes at a certain rate whereas paper is steady.
- Unlike printed characters, the characters on a computer screen lack the contrast or well defined edges. For this reason, the color intensity of digital characters diminishes around the edges. Thus it gets difficult for eyes to remain focused. Having to

continuously refocusing on digital text fatigues the eyes and can lead to burning or tired eyes (Akinbinu and Mashalla, 2013).

Dry eye: It is found that dry eye is closely related to CVS as either cause or effect (Barthakur, 2013).

Others: The possible other causes are:

- Different visual problems
- Glare on the screen
- Incorrect sitting posture
- A combination of all these factors (Barthakur, 2013).

1.8.4 Risk Factors

The risk factors related to CVS can be divided into three categories:

- Extrinsic factors
- Factors related to the visual system of each person
- Demographic factors

They are described below:

Extrinsic factors:

- Ergonomics of the computer monitor, such as screen resolution and contrast, image refresh rates, screen flicker and glare, and working distances and angles
- The desk and chair with which it is used
- Sources of glare such as windows or lighting
- Poor lighting
- Job related pressures and other psychologic factors
- Environmental factors (air conditioners, heating, low humidity)
- Workstation design

Factors related to the visual system of each person:

- Accommodation: Accommodation is the dynamic refraction which involves change in refractive power of the lens so that a clear image of various objects is formed on the retina.
- Discomfort related to vergion: Vergion means binocular, conjugate movements of the eyes allowing the lines of sight to move in a parallel direction.
- Uncorrected refractive error: It is probably the most common cause of eye strain of CVS.
- Anisometropia: Anisometropia is a condition in which there is a difference in the refractive error of the two eyes).
- Refractive miscorrection
- Reduced rate of blinking
- Corneal exposure due to higher gaze angle in desktop monitor viewing
- Reduction of the stability of the precorneal tear

Demographic factors:

- Increasing age
- Female gender (Barthakur, 2013; Nakaishi and Yamada, 1999; Akinbinu and Mashalla, 2013; Vertinsky and Forster, 2005)

1.8.5 Symptoms

If computers are used even for three hours per day, it may lead to a range of injury or health risk. The symptoms of CVS can be divided into several groups, such as:

Asthenopia:

- Eye fatigue
- Pain on eye
- Pressure on eye

Eye surface disorders:

- Dry eye sensation
- Tearing

- Irritation
- Redness
- Burning sensation
- Gritty sensation

Vision disturbances:

- Blurred vision
- Diplopia (double vision)

Extra ocular complaints:

- Musculoskeletal pain in neck, shoulder and back
- Tension headache
- Occupational Overuse Syndrome (an umbrella term for a range of conditions such as swelling, numbness, restricted movement and weakness in or around muscles and tendons of the back, neck, shoulders, elbows, wrists, hands, or fingers usually caused or aggravated by poor work processes and unsuitable working conditions pain) (Subratty and Korumtollee, 2005).

Psychological disturbances:

- Psychosocial stress
- Alienation from work (Dehghani *et al*., 2008; Akinbinu and Mashalla, 2013; Rajabi-Vardanjani *et al*., 2014; Sen and Richardson, 2010).

1.8.5.1 Prevalence and Duration of Symptoms

Up to 90% of computer users may experience visual symptoms like blurred vision, eyestrain, headaches, ocular discomfort, dry eye and diplopia.

The ocular discomfort increases with the increase in the amount of computer usage (Barthakur, 2013).

According to the reports from VDU (Video Display Unit) operators Eye discomfort is the second frequent problem after musculoskeletal discomfort. About 10% of them have asthenopic complaints to a severe extent.

Approximately 30% of VDU users made frequent reports about asthenopic complaints like blurred vision, ocular soreness,blinking, heaviness of the eyes, itching of the eyes or double vision (Stüdeli and Menozzi, 2003).

For most cases, vision problems are only temporary and will decline after stopping computer work at the end of the day.

But in some cases, it is seen that workers may experience continued impaired or reduced visual abilities such as blurred distance vision even after work (Chiemeke, Akhahowa and Ajayi, 2007).

Many studies have been performed to assess eye strain in office workers using computers with current estimates of prevalence of approximately 40% (Vertinsky and Forster, 2005).

1.8.6 Diagnosis

The diagnosis of CVS involves:

- Comprehensive workup with a proper history
- Thorough eye examination including visual acuity measurement, refraction, assessment of convergence and accommodation and evaluation for dry eye (Barthakur, 2013).

1.8.7 Measurement of Symptoms

There are a number of diverse one or multi-dimensional instruments to assess the amount of the intensity and fatigue level of CVS. They are:

Visual fatigue meter (VFM): It is a device based on the flicker changes. This device is used to evaluate the visual fatigue changes in ergonomics science.

Subjective visual fatigue questionnaire: Questionnaires converts mental parameters into objective parameters. Various questionnaires previously used by researchers are:

- Kuze and Ukai: In 2007, they produced a 28-item questionnaire including a list of visual fatigue symptoms in a scale of 7 and in 5 major areas.
- Lin YT *et al*.: In 2008, they simultaneously assessed visual fatigue with the Heuer's questionnaire and critical fusion frequency (CFF) index.
- Ogata *et al*.: They presented a series of visual fatigue symptoms in their questionnaire.

- Yano *et al*.: They assessed the Visual fatigue by a question in a scale of 5. Such one item questionnaires along with other objective methods to assess visual Fatigue simultaneously.
- Rajabi-Vardanjani *et al.*: They have attempted to design a comprehensive questionnaire to cover all those aspects of visual fatigue of the VDT operators using a physiologic parameter (CFF change) as a criterion to determine the cut-off points of visual fatigue (Rajabi-Vardanjani *et al*., 2014).

1.8.8 Treatment

The strategies treatment or management for CVS are given below:

- Correction of any refractive errors and use of occupational glasses as needed.
- Treatment of dry eyes.
- Ensuring proper lighting at the workplace. Reflected glare from windows and lighting should beavoided. Anti-glare screens can be used.
- Ensuring proper positioning of the monitor: It should not be too high. The ideal posture is to have the center of the screen about 6 inches below the straight ahead gaze.
- Maintaining monitor display quality: High resolution LCD monitors with matte finish reduce eye strain. In case of older CRT monitors, highest refresh rates should be set to minimize flicker.
- Blinking frequently: This re-wets the cornea preventing dryness and irritation.
- Maintaining rest breaks: 20/20/20 rule - after every 20 minutes of computer viewing, one should look into the distance 20 feet away for 20 seconds to allow the eyes to refocus. It is suggested by the American Optometric Association to take a break of 15 minutes after 2 hours of continuous computer use (Barthakur, 2013).

1.8.9 Epidemiology

An epidemiologic depiction of CVS is shown below:

- CVS is called as the number one occupational epidemic of the 21st century by some eye care professionals (Akinbinu and Mashalla, 2013).
- Nearly 60 million people suffer from CVS worldwide.
- A million new cases occur each year (Sen and Richardson, 2010).

- 75% of computer users has been found to suffer from visual problems in several studies (Rajabi-Vardanjani *et al*., 2014).
- About 70% of computer workers worldwide report having vision problems and the number of people affected is increasing alarmingly.
- In the USA more than 143 million Americans work on a computer each day and an estimated 90% of them suffer from computer eyestrain (Akinbinu and Mashalla, 2013).
- In a national survey by doctors of optometry in Nigeria, it was found that more than 14% of their patients were present with eye or vision-related symptoms resulting from computer work (Chiemeke, Akhahowa and Ajayi, 2007).

1.8.10 Effect on Life and Work

Lowering of life standard: CVS puts strain on the physical well-being of the users and thus reducing the quality of life.

Decrease productivity: There are many evidences showing that CVS can significantly harm workplace productivity. Previous studies have shown that there is a direct correlation between proper vision correction and the time required for a computer worker to complete a task; and that productivity is reduced even more among computer users who were unaware that they had vision problems.

For these reasons, CVS is a significant public health problem affecting computer users from all walks of life (Akinbinu and Mashalla, 2013).

1.8.11 Prevention

Reduce stress and discomfort: Therefore, steps should be taken to reduce the potential for development of stress and related ocular and physical discomfort in the workplace (Chiemeke, Akhahowa and Ajayi, 2007).

Educational programs: Educational programs should be held for the workforce and schoolchildren. So that such problems can be minimized by inspiring good habits in computer usage (Barthakur, 2013).

The contributions of computers extend from local to national and global affairs. A large population cannot do a day without computers. Almost every citizen is directly or indirectly dependent on

computers. So, the health-related shortcomings of computers puts public health at high stake. Proper cautions should be practiced and inspired in the use of computers.

1.9 Description of Visually Demanding Occupations

Short discussions of some visually demanding occupations and the reasons for being chosen for the study are shown below:

1.9.1 Weavers

Weaving is an occupation which involves production of textiles. In the context of Bangladesh weavers produce chiefly Banarasi sarees. Weaving machine is operated by using both hands and legs. There is a set of threads aligned longitudinally. A weaver has to press lateral threads one by one with a wooden bar to interlace at right angle with the longitudinal ones and thus the fabric is made. There is complex mechanism in the machine which changes the height of the longitudinal threads which creates various designs on the fabric.

1.9.2 Tailors

Tailors produce garment items. This mainly involves cutting of fabric to desired size, stitching, sewing and sometimes attaching accessories to the garment items. Stitching is done by sewing machine which is operated by legs. A needle containing a thread climbs up and down to sew the thread on the fabric. During this time a tailor has to hold the fabric properly to achieve the desired stitch. There are two types of tailor jobs where making of shirts is concerned: body making (making of the whole item except the collar) and collar making.

1.9.3 Computer Operators

Almost all desk-job holders are having their fair share of working on computers more or less now-a-days. For computer operators the whole job involves working on computers. Computer operators are employed in almost all sophisticated organizations for various tasks such as data management, maintaining accounts, designing of various sorts etc. In Bangladesh computer operators chiefly work on composing and designing banners, business cards and various other cards, illustrations etc.

1.9.4 Garments Workers

Garments workers are involved in various stages of production of apparels. Their job descriptions are given below:

1.9.4.1 Sewing Operators

They are involved in sewing operations. They operate sewing machine to perform it.

1.9.4.2 Bartake Operators

They are involved in attaching buttons to apparels using a bartake machine.

1.9.4.3 Quality Checkers

They are involved in evaluation of quality of apparels. They have to check whether there is any default, such as, missing of stitches, inappropriate stitches etc.

1.9.4.4 Helpers

Their job is to help sewing operators by fixing thread into sewing machines, checking label-numbers of apparels which are visually demanding works.

1.9.4.5 Finishing Operators

They are involved in finishing of apparel products, such as, sewing the portions where stiches are missed etc.

1.9.4.6 Finishing Quality Checkers

They evaluate the quality of the finished products.

1.9.4.7 Finishing Helpers

They help the finishing operators by finding out missed stitches, missing labels etc.

1.9.4.8 Cutter Man

They are involved in marking the fabrics according to the desired cut and cutting the fabrics following the marks drawn.

Chapter 2

Literature Review

There has been numerous studies on various aspects of asthenopia and computer vision syndrome in different countries. A number of them are introduced below in order of years:

2.1 Abnormal Tear Dynamics and Symptoms of Eyestrain in Operators of Visual Display Terminals

This study was conducted by Nakaishi and Yamada in 1999. It was aimed to clarify the relation between the prevalence of dry eye syndrome and subjective symptoms of asthenopia in visual display terminal (VDT) operators. It involved an ophthalmological examination consisting of refractometry and a tear function (phenol red thread) test on two groups of subjects: 242 with symptoms of asthenopia and 480 controls without such symptoms. Subjects from both groups did not have any obvious organic ocular diseases.

The study found that more than 30% of the first group have dry eye. The odds ratio compared with the controls was 4.61 ($p<0.001$) which was significantly greater than that obtained for refractive errors (2.31). Despite failure in proving dry eyes as the cause of asthenopia, an association of dry eyes with asthenopia was confirmed (Nakaishi and Yamada, 1999).

2.2 Psychological Factors and Visual Fatigue in Working with Video Display Terminals

Mocci conducted this study in 2001 with an objective to investigate the role of psychological factors in the occurrence of visual health complaints among banking officers involved in working at video display terminals (VDTs). It was carried out on 212 subjects without organic visual disturbances using three questionnaires: (a) the NIOSH job stress questionnaire; (b) a questionnaire investigating subjective discomfort related to environmental and lighting conditions of the workplace; (c) a questionnaire on the existence of oculovisual disturbances. The obtained data was processed with correlation and multiple regression analyses for examination of the presence of predictors of asthenopia.

The study found out some predictors of visual complaints, such as, social support, group conflict, self-esteem, work satisfaction, and underuse of skills. Stress and strain model accounted for 30% of the variance and social support played a role in it. Subjective environmental factors were not identified as strong predictors of the symptoms despite having correlation with asthenopia in some cases. The study suggests likelihood of some part of the visual health complaints as indirect expressions of psychological discomfort related to working conditions (Mocci, 2001).

2.3 Effect of Subjective and Objective Workload on Asthenopia at VDU Workplaces

Stüdeli and Menozzi conducted this study in 2003 to investigate effects of subjective and objective workload on work related visual complaints (asthenopia). It involved field studies on different VDU work places using an ergophthalmological tool.

The study identified objective and subjective work load, work intensity and work breaks (5-9 minutes/hour) to have effect on asthenopia. Asthenopic complaints were found to follow the effective workload during the first hour. The effect of a general and visual fatigue overlap other reported visual complaints with increasing working time in the majority of cases (Stüdeli and Menozzi, 2003).

2.4 Asthenopia in Schoolchildren, Orthoptic and Ophthalmological Findings and Treatment

Abdi and Rydberg conducted this study in 2005 with the aim to perform an orthoptic and ophthalmological assessment in schoolchildren with asthenopia, to correlate them with asthenopic symptoms and to evaluate the effect of treatment. It was conducted on 120 schoolchildren between the ages of 6–16 years who were referred to have asthenopic symptoms. Accommodative insufficiency, convergence insufficiency, refractive errors and latent strabismus were mainly diagnosed.

Treatments were provided to the subjects. 93% of the subjects were relieved of symptoms 3–6 month after treatment had started. The treatments include: reading glasses for subjects with reduced accommodation, spherical, cylindrical and prism correction for subjects with refractive errors and heterophorias and convergence exercise for convergence insufficiency. The treatments were proved to be effective for most subjects: reading glasses and correction were helpful for 98% and 94% respectively. The study identifies a relation between abnormalities in the subjects with visual problems (Abdi and Rydberg, 2005).

2.5 Evaluation of Vision-Related Problems amongst Computer Users: A Case Study of University of Benin, Nigeria

This study was conducted by Chiemeke, Akhahowa and Ajayi in 2007 in the University of Benin, Benin City, Nigeria. The aim was to assess the visual symptoms complaints among computer users,

especially Cathode-Ray Tube (CRT)-based Visual Display Units (VDUs) users. The study was conducted on 103 subjects between the ages of 10 and 35 years with the exclusion criteria of presbyopia and magnitude +1 hyperopia.

The aspects which were investigated are: visual symptoms such as eyestrain, blurred distance vision and headache, number of hours of use, level of computer room illumination, screen contrast and viewing in determining visual symptoms occurrences. There were three indicators for assessing the level of the symptoms: moderate, severe and mild, among which only moderate and severe were considered. The study found various factors for the prevention of visual symptoms such as, proper computer workplace illumination, screen contrast, work interval before break, viewing distances and viewing angles during computer (Chiemeke, Akhahowa and Ajayi, 2007).

2.6 Prevalence of Ocular Symptoms and Signs among Professional Computer Users in Isfahan, Iran

This study was conducted by Dehghani *et al*. in 2008 in Isfahan in order to detect the prevalence of ocular symptoms and signs in professional video display users (VDUs) and non-users. It involved a cross-sectional descriptive case-control investigation on two groups: the VDUs group which consisted of 57 employees working with computer (34 male & 23 female with mean age of 30.7 ± 6.8) and the control group which consisted of 56 employees not working with computer (25 male & 31 female, mean age of 27.6 ± 7.2).

The study found that there were 45 cases (79%) of burning eyes and tearing, 38 cases (66%) of dry eye, 37 cases (65%) of asthenopia, and 47 cases (82.5%) of musculoskeletal pain among VDUs, whereas these values for the control group were 24 (42.8%), 18 (32.2%), 22 (39.3%) and 15 (26.8%) respectively. So a statistically significant difference ($p = 0.037$, $p = 0.023$, $p = 0.044$, $p = 0.013$) was observed. Also 22 (38.5%) and 19 (33.3%) VDUs were found to be respectively positive for Schirmer's test and heterophoria versus 6 (10.7%, $p = 0.012$) and 3 (5.4%, $p = 0.032$) control subjects respectively (Dehghani *et al*., 2008).

2.7 A Study of Computer-Related Upper Limb Discomfort and Computer Vision Syndrome

Sen and Richardson conducted this research in 2010. It involved a cross-sectional study on 136 university students and office staff who were computer users. In this study a questionnaire was used with 'Modified Rapid Upper Limb Assessment (RULA) for office work' technique for the

evaluation of OOS (Occupational Overuse Syndrome) and a 10-point scoring system for each CVS (Computer Vision Syndrome) symptom. Computer usage and awareness of ergonomic modifications of computer furniture and peripherals were also investigated.

The major findings of the study are: the use of standard keyboard and mouse without any ergonomic modifications by many subjects, low back pain in around 50% subjects lacking adjustable backrest, higher RULA scores of the wrist and neck in many subjects suggesting increased risk of developing OOS and high scores of CVS among 64% despite using refractive corrections. Eye fatigue, headache and burning sensation were found to be common among CVS symptoms. Also a correlation between the increase of CVS scores with the increase in computer usage spells was found (Sen and Richardson, 2010).

2.8 Knowledge of Computer Vision Syndrome among Computer users in the workplace in Abuja, Nigeria

Akinbinu and Mashalla conducted this research in 2013 in Abuja, Nigeria with the aim to determine the level of knowledge and extent of computer vision syndrome (CVS) among computer users. It involved a quantitative, descriptive, cross-sectional study using a structured questionnaire on 100 computer users aged between 18 and 40 years who worked at the Securities and Exchange Commission (SEC).

The study found that 40% of the subjects were aware of CVS; among which 27% had knowledge of the disorder and 74% of the respondents experienced at least one symptom of CVS. Headache and eyestrain were found to be the most common CVS symptoms. The study suggests that there is lack of awareness among general people about CVS (Akinbinu and Mashalla, 2013).

2.9 Prevalence of asthenopia and Its Risk factors in Chinese College Students

Han *et al*. conducted this study in the same year in Xi'an, China with the aim to determine the prevalence of asthenopia and identify any associated risk factors. It involved administration of a validated questionnaire to 1500 students from five universities who were selected according to a multi-stage stratified cluster sampling method. The questionnaire investigated demographic features, lifestyle or dietary habits, health status, living environment conditions, sleep and mental status, and asthenopia symptoms. The data obtained from the questionnaire were processed with

univariate logistic regression and multivariate logistic regression analysis modified by the factor analysis in order to evaluate risk factors for asthenopia.

The study found complain of asthenopia among 57% of the subjects. A significant relationship between the use of computer and asthenopia was observed. Also good sleep and mental status, good living environment conditions and high intake of green leafy vegetables were identified as strong predictors of decreasing the occurrence of asthenopia complaints (Han *et al*., 2013).

2.10 Designing and Validation a Visual Fatigue Questionnaire for Video Display Terminals Operators

This research was conducted by Rajabi-Vardanjani *et al*. in 2014 in order to design a tool to assess the visual fatigue of the video display terminal operators in different professions. A questionnaire containing 15 questions was designed which the authors claim to be valid and reliable. The questionnaire consists of four areas: Eye strain, visual impairment, surface impairment of the eye and out of eye problems.

The questionnaire was prepared with the help of books, papers and other questionnaires. Then its validity and reliability was appraised and confirmed by content validity index (CVI), Cronbach's Coefficient Alpha, a cross-sectional study on 248 VDT users, software such as $AMOS_{16}$ and SPSS 11.5 and observing receiver operating characteristic curves. The study also involved using visual fatigue meter (VFM) device to measure visual fatigue level (Rajabi-Vardanjani *et al*., 2014).

Significance of the Study

The visually demanding job holders make significant contribution to economy. So their well-being is required for economic welfare. Most of the visually demanding jobs are related to small and cottage industries. A data chart showing the size and growth rate of small and cottage industries in Bangladesh:

Table 1.2: Economic Significance

Year	Size (in crore Taka)	Growth rate (%)
2006-07	16112.9	9.48
2008-09	18525.3	7.15
2009-10	20039.5	7.30
2010-11	21176.0	8.17
2011-12	22569.1	5.67
2012-13	24557.9	6.58
2013-14	26113.1	6.33
2014-15	28907.1	10.70

(Ministry of Finance, Government of the People's Republic of Bangladesh, 2015)

In addition, many of the visually demanding job holders are in cottage industry and handicrafts. Their products bear cultural significance and are important elements of culture. So, in order to nurture their skills, proper care of their eye health should be emphasized.

Eye diseases decrease job performance, increase error rates and thus decrease productivity quantitatively and qualitatively. At severe stage of diseases, one may have to discontinue their job. So caution should be exercised against eye diseases. Thus obtaining data about their eye health bears importance.

Professions chosen for the study were weaver, tailor, garments worker and computer operator. These professions involve works that are visually demanding.

A weaver has to fix gaze upon the fabric consistently to ensure that the designs are made properly. He also has to focus on very fine threads. A tailor has to fix his gaze on the proceeding stitch to make sure it is done properly. He handles fine threads and sometimes he has to put thread into a

needle. A computer operator has to fix his gaze on the glaring computer screen consistently. Moreover, he has to focus on the characters on the screen. All of these works put strain on the eyes. A garments worker also has to do various visually demanding works depending on his/her post, such as, matching labels, sewing, looking for missing of stitches and faults etc. Consistent involvement in visually demanding jobs may render an individual prone to asthenopia.

To our knowledge, there has been no study either on asthenopia or on computer vision syndrome in Bangladesh before this. So, considering the need to address these conditions, the study was conducted.

Aims of the Study

The aims of the study were:

- Assessing the condition of overall optical health by collecting data regarding existing eye conditions and treatment.
- Evaluation of the prevalence of various symptoms of asthenopia and computer vision syndrome.
- Investigation of the relation of lifestyle, work pattern and environment and psychology related factors with the prevalence.

Chapter 3

Methodology

3.1 Type of Study

This is a survey based study.

3.2 Study Population

The study population consisted of the workers of visually demanding occupations. The selected occupations and respective numbers of subjects are given below:

Weavers: 18

General tailors: 36

Computer operators: 32

Garments workers: 201

3.3 Study Area

The study was conducted in three different areas in Dhaka city. They are:

- Bihari Camp, Mirpur: Survey on the weavers was conducted here. This area mainly comprises of mainly potions of sector 11 and 12. The inhabitants mostly belong to the Bihari race and many of them have carried the occupation of weaving across generations.
- Nilkhet: This area contains a huge market of books, printing and publications. For various jobs related to printing and publication a large number of computer operators work here.
- Urdu Road: Survey on general tailors was conducted here. Many tailor shops scattered there where the tailors work.
- KB Apparels Ltd.: It is a garments factory situated in Postogola industrial area. The survey on garments workers was conducted here.

3.4 Inclusion Criteria

The only inclusion criteria for the subjects was to be a weaver, general tailor, computer operator or garments worker.

3.5 Exclusion Criteria

The exclusion criteria for the subjects was not being a weaver, general tailor or computer operator.

3.6 Data Collection Tools

The tools used for the survey were a questionnaire, weighing scale, measuring tape, Snellen chart for measuring far vision and near vision acuity.

3.6.1 Questionnaire

The questionnaire comprised of questions regarding demographic information, existing medical conditions, treatment, asthenopic symptoms, lifestyle, work pattern and environment, psychology related factors which could be affecting asthenopia and information related to computer vision syndrome for computer operators.

3.6.2 BMI (Body Mass Index) Measurement

The height and weight was measured with a measuring tape in inches and with a weighing machine in kilograms respectively. The BMI (Body Mass Index) was measured using the following formula:

BMI = (weight in kilograms) / (height in meters)^2 (WHO, 2015)

3.6.3 Visual Acuity Measurement

Visual acuity is the measurement of a subject's ability to see clearly. Visual acuity was measured for far vision and near vision. The methods are described below:

3.6.3.1 Measuring Far Vision

Snellen chart was used for this purpose. In that chart there were various letters of English alphabet arranged in rows. Each row was denoted by a fraction, whose numerator was the distance from which the chart was viewed, and the denominator was the furthest distance at which the subject could see clearly. The numerator was fixed for all the rows. The topmost row had the highest denominator, which gradually lowered with the descending rows.

The subject was asked which rows s/he can read clearly, among which the fraction of the one with the lowest denominator indicated his/her visual acuity. The lower was the denominator of the visual acuity fraction, the further the subject could see clearly (Tsai *et al*., 2011).

Usually the test is done at a distance of 20 feet or less. For this study, a chart was used for which the test distance to be used was 5 feet, but the chart provided fractions with a numerator of 20. As many of the subjects were supposedly illiterate, the chart had the English letter 'E' tumbled in different positions instead of other letters.

3.6.3.2 Measuring Near Vision

The near vision chart used the same principle as the far vision chart, except the test distance being 16 inches.

3.7 Data Analysis

After collecting, the data were checked and analyzed with the help of Microsoft Excel 2013. The result was shown in bar, pie and column chart and different variables were calculated in percentages.

Chapter 4

Result

4.1 Demographic Distribution of Subjects

4.1.1 Distribution of Professions with Asthenopic Symptoms (N=287)

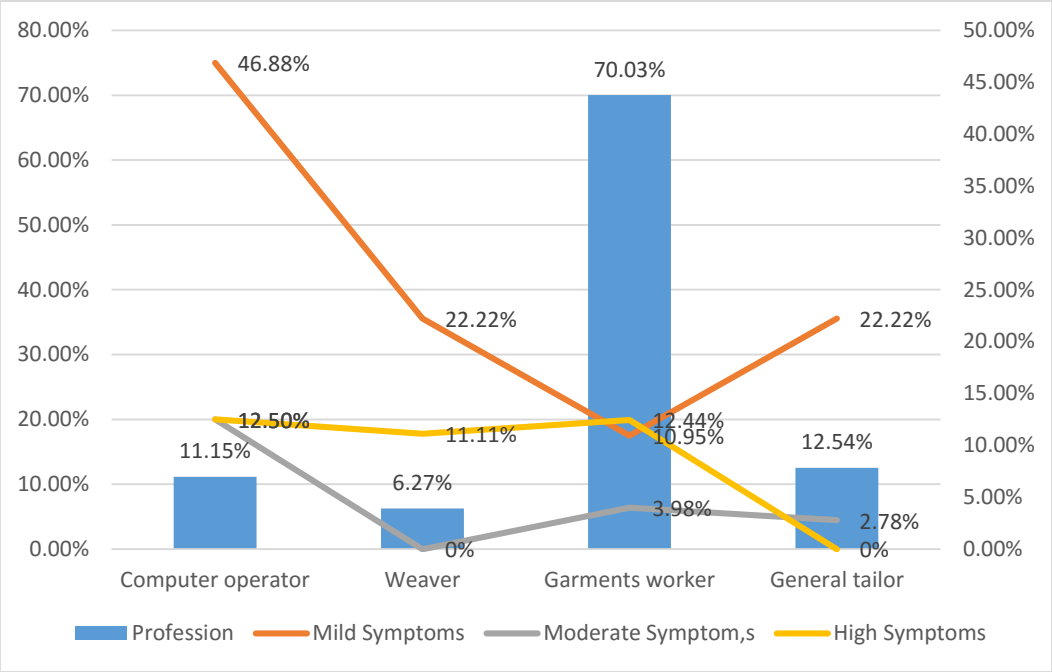

Fig 4.1.1: Distribution of Professions with Asthenopic Symptoms (N=287)

The study was conducted on 287 subjects, among whom garments workers accounted for 70.03%, general tailors accounted for 12.54%, computer operators accounted for 11.15% and weavers accounted for 6.27%. Mild asthenopic symptoms were present in 10.95% of the garments workers, 22.22% of the general tailors, 46.88% of the computer operators and 22.22% of the weavers. Moderate asthenopic symptoms were present in 3.98% of the garments workers, 2.78% of the general tailors, 11.15% of the computer operators and 0% of the weavers. Severe asthenopic symptoms were present in 12.44% of the garments workers, 0% of the general tailors, 11.15% of the computer operators and 11.11% of the weavers.

4.1.2 Distribuition of Gender and Relation with Asthenopic Symptoms (N=287)

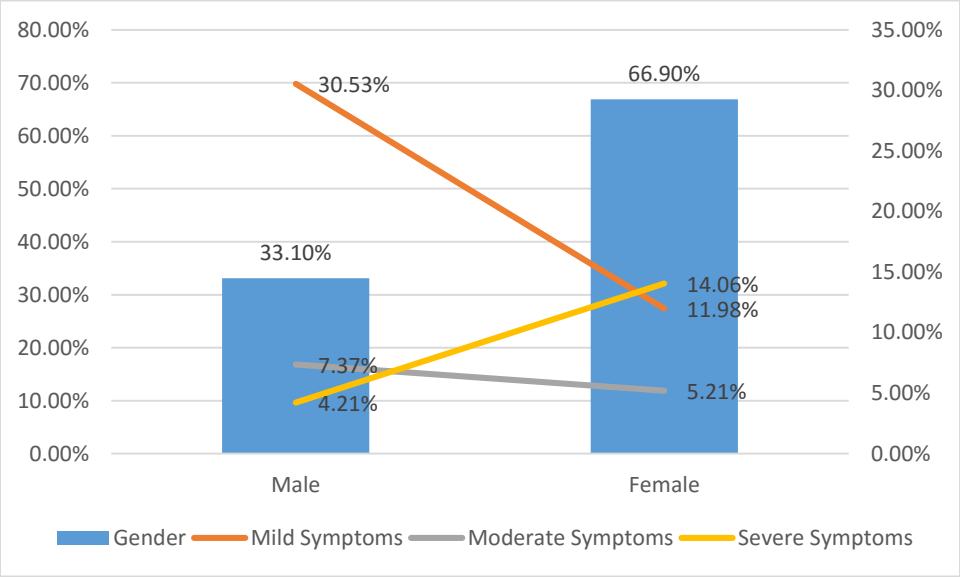

Fig 4.1.2: Relationship of Gender and Asthenopic Symptoms (N=287)

Among the subjects 33.10% was male and 66.90% was female. Mild asthenopic symptoms were present in 30.53% of male and 11.98% of female. Moderate asthenopic symptoms were present in 7.37% of male and 5.21% of female. Severe asthenopic symptoms were present in 4.21% of male and 14.06% of female.

4.1.3 Distribution of BMI and Relation with Asthenopic Symptoms (N=287)

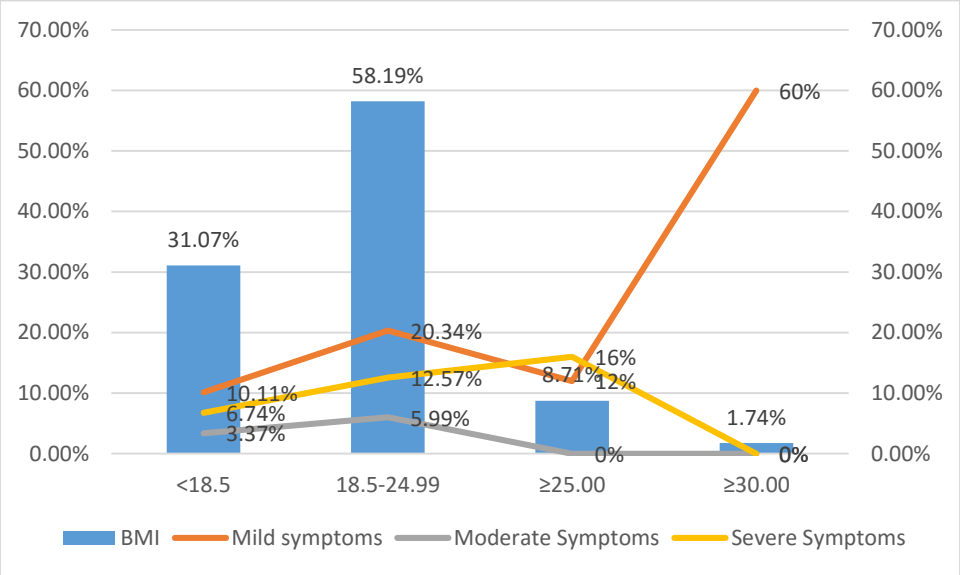

Fig 4.1.3: Distribution of BMI and Relation with Asthenopic Symptoms (N=287)

Subjects with BMI <18.5 accounted for 31.07% of the total population. Rest of the subjects with BMI's 18.5-24.99, ≥25.00 and ≥30.00 accounted for 58.19%, 8.71% and 1.74% of the total population respectively. Mild asthenopic symptoms were present in 10.11%, 20.43%, 12% and 60% of population with BMI <18.5, 18.5-24.99, ≥25.00 and ≥30.00 respectively. Moderate asthenopic symptoms were present in 3.37%, 5.99%, 0% and 0% of population with BMI <18.5, 18.5-24.99, ≥25.00 and ≥30.00 respectively. Severe asthenopic symptoms were present in 6.74%, 12.57%, 16% and 1.74% of population with BMI <18.5, 18.5-24.99, ≥25.00 and ≥30.00 respectively.

4.1.4 Distribution of Age and Realtion with Asthenopic Symptoms (N=287)

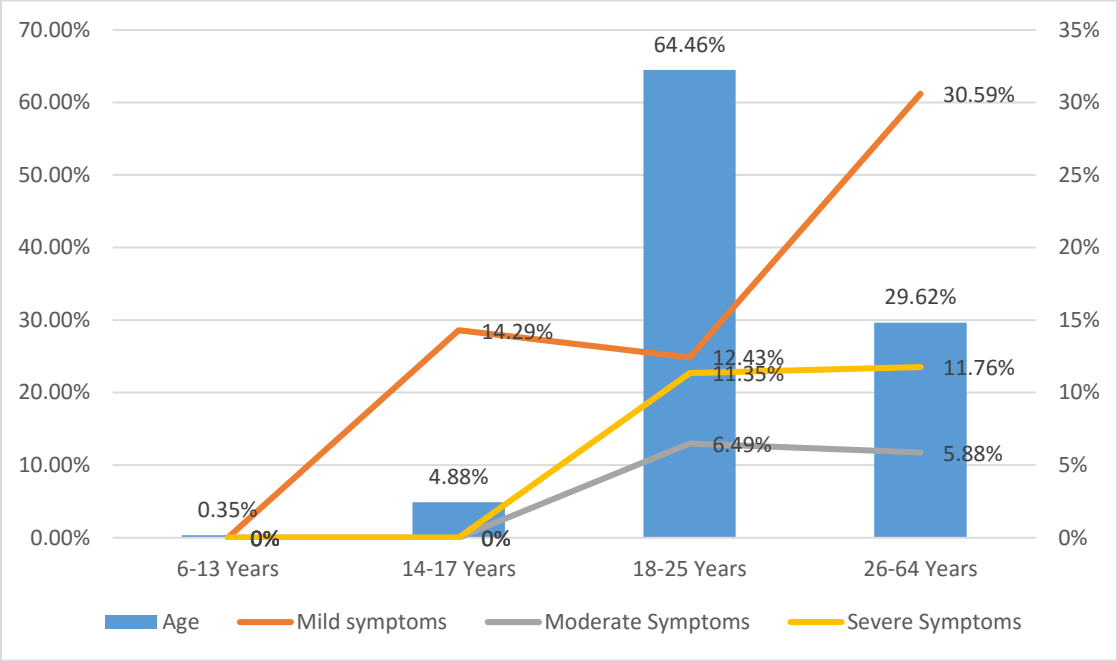

Fig 4.1.4: Distribution of Age and Realtion with Asthenopic Symptoms (N=287)

Subjects with age 6-13 years, 14-17 years, 18-25 years and 26-64 years accounted for 0.35%, 4.88%, 64.46% and 29.62% respectively. Subjects with mild symptoms accounted for 0% of population with age range 6-13 years, 14.29% of population with age range 14-17 years, 12.43% of population with age range 18-25 years and 30.59% of population with age range 26-64 years respectively. Subjects with moderate symptoms accounted for 0% of population with age range 6-13 years, 0% of population with age range 14-17 years, 6.49% of population with age range 18-25 years and 5.88% of population with age range 26-64 years respectively. Subjects with mild symptoms accounted for 0% of population with age range 6-13 years, 0% of population with age range 14-17 years, 11.35% of population with age range 18-25 years and 11.76% of population with age range 26-64 years respectively.

4.1.5 Distribution of the Types of Work

4.1.5.1 Distribution of Work among Computer Operators (N=32)

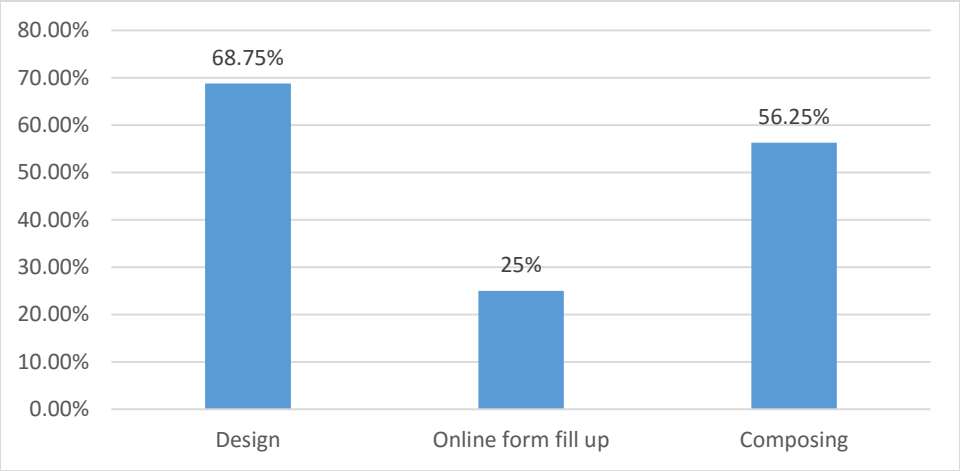

Fig 4.1.5.1: Distribution of Work among Computer Operators (N=32)

Among the 32 computer operators 68.75% was involved in design works, 25% was involved in online form fill up and 56.25% was involved in composing. There were computer operators who were involved in more than one type of work.

4.1.5.2 Distribution of Work among Tailors (N=36)

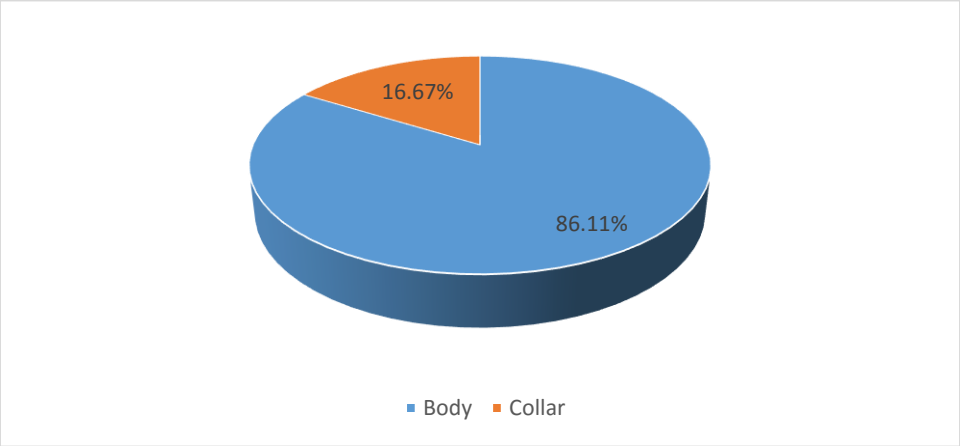

Fig 4.1.5.2: Distribution of Work among Tailors (N=36)

Among the 36 tailors interviewed, 16.67% was involved in collar making and the rest (86.11%) was involved in body making.

4.1.5.3 Distribution of Work among Garments Workers (N=201)

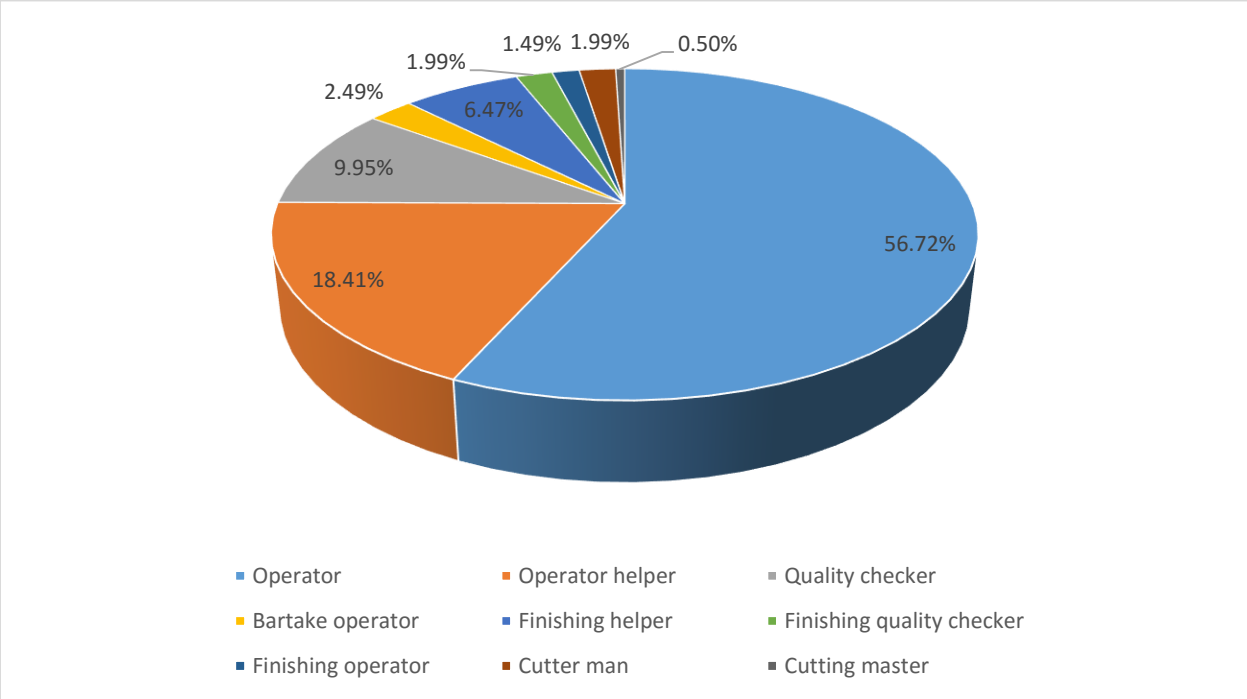

Fig 4.1.5.3: Distribution of Work among Garments Workers (N=201)

Total 201 garments workers were interviewed. Among them sewing operators were the majority who accounted for 56.72%. Among the others, bartake operators, finishing operators, operator helpers, finishing helpers, Cutter men, quality checkers, finishing quality checkers and cutting master comprised 2.49%, 1.49%, 18.41%, 6.47%, 1.99%, 9.95%, 1.99% and 0.50% respectively.

4.2 Distribution of Visual Acuity

4.2.1 Distribution of Visual Acuity of Far Vision and Relation with Asthenopic Symptoms (N=287)

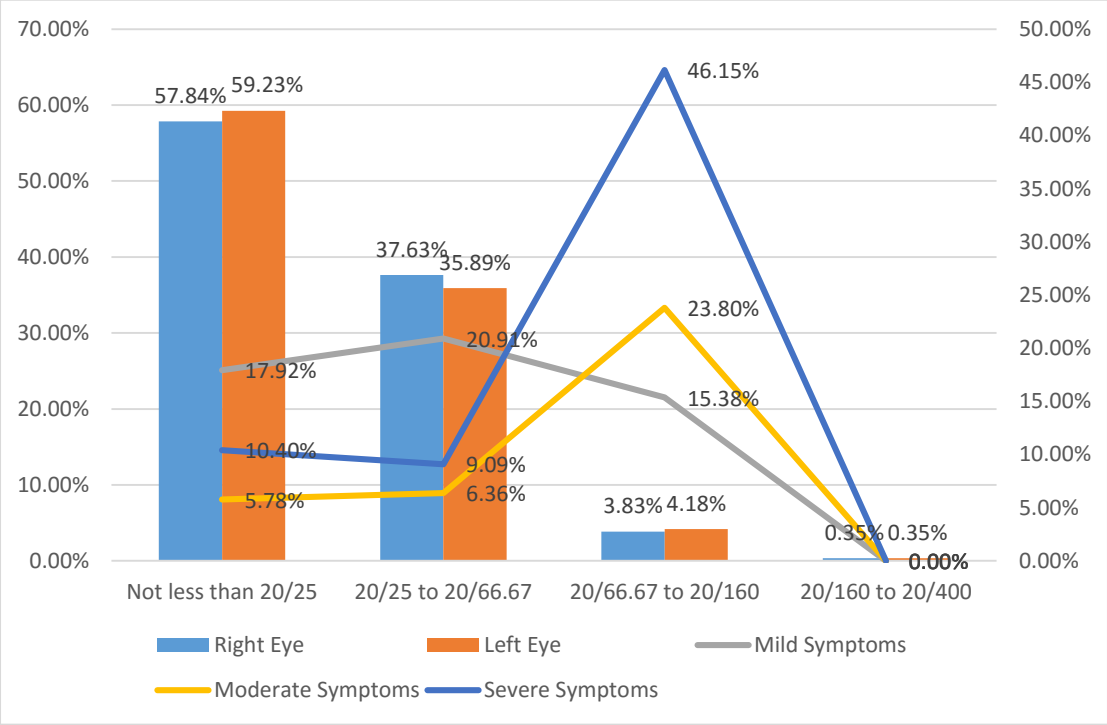

Fig 4.2.1: Distribution of Visual Acuity of Far Vision and Relation with Asthenopic Symptoms (N=287)

Subjects with Far vision visual acuity not less than 20/25 accounted for 57.84% for right eye and 59.23% for left eye. Accordingly, subjects with far vision visual acuity 20/25 to 20/66.67, 20/66.67 to 20/160 and 20/160 to 20/400 accounted for 37.63% for right eye and 35.89% for left eye, 3.83% for right eye and 4.18% for left eye and 0.35% for right eye and 0.35% for left eye respectively. Subjects with mild symptoms accounted for 17.92%, 20.91%, 15.38% and 0.00% for visual acuity ranges not less than 20/25, 20/25 to 20/66.67, 20/66.67 to 20/160 and 20/160 to 20/400 respectively. Subjects with moderate symptoms accounted for 5.78%, 6.36%, 23.80% and 0.00% for visual acuity ranges not less than 20/25, 20/25 to 20/66.67, 20/66.67 to 20/160 and 20/160 to 20/400 respectively. Subjects with severe symptoms accounted for 10.40%, 9.09%, 46.15% and

0.00% for visual acuity ranges not less than 20/25, 20/25 to 20/66.67, 20/66.67 to 20/160 and 20/160 to 20/400 respectively.

4.2.2 Distribution of Visual Acuity of Near Vision and Relation with Asthenopic Symptoms (N=287)

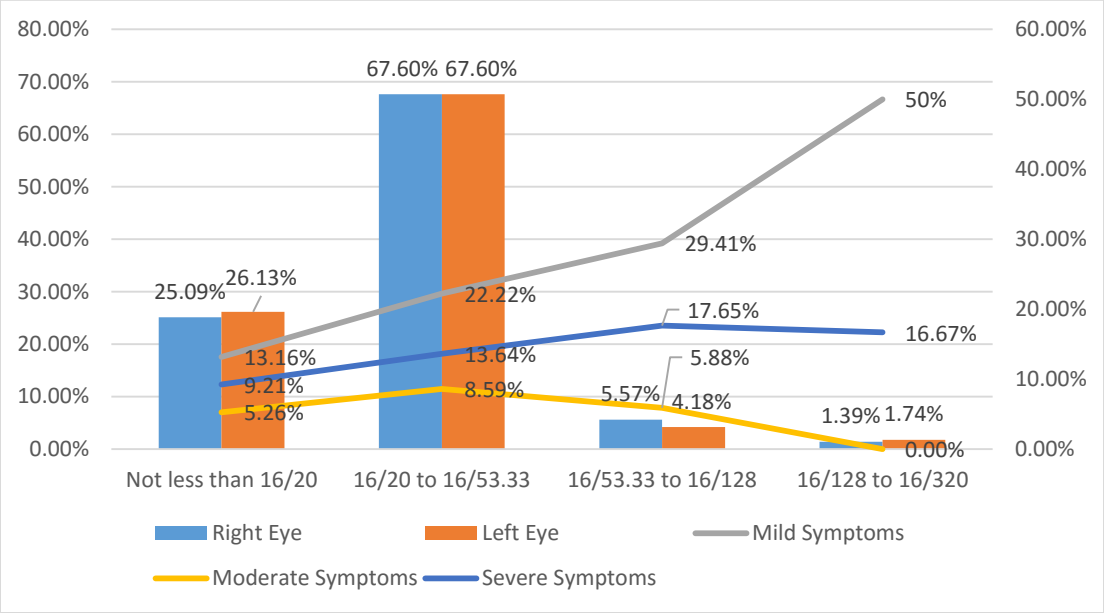

Fig 4.2.2: Distribution of Visual Acuity of Near Vision and Relation with Asthenopic Symptoms (N=287)

Subjects with near vision visual acuity not less than 16/20 accounted for 25.09% for right eye and 26.13% for left eye. Accordingly, subjects with near vision visual acuity 16/20 to 16/53.33, 16/53.33 to 16/128 and 16/128 to 16/320 accounted for 67.60% for right eye and 67.60% for left eye, 5.57% for right eye and 4.18% for left eye and 1.39% for right eye and 1.74% for left eye respectively. Subjects with mild symptoms accounted for 13.16%, 22.22%, 29.41% and 50.00% for visual acuity ranges not less than 16/20, 16/20 to 16/53.33, 16/53.33 to 16/128 and 16/128 to 16/320 respectively. Subjects with moderate symptoms accounted for 5.26%, 8.59%, 4.18% and 0.00% for visual acuity ranges not less than 16/20, 16/20 to 16/53.33, 16/53.33 to 16/128 and 16/128 to 16/320 respectively. Subjects with severe symptoms accounted for 9.21%, 13.64%, 17.65% and 16.67% for visual acuity ranges not less than 16/20, 16/20 to 16/53.33, 16/53.33 to 16/128 and 16/128 to 16/320 respectively.

4.3 Medical History

4.3.1 Ocular History (N=287)

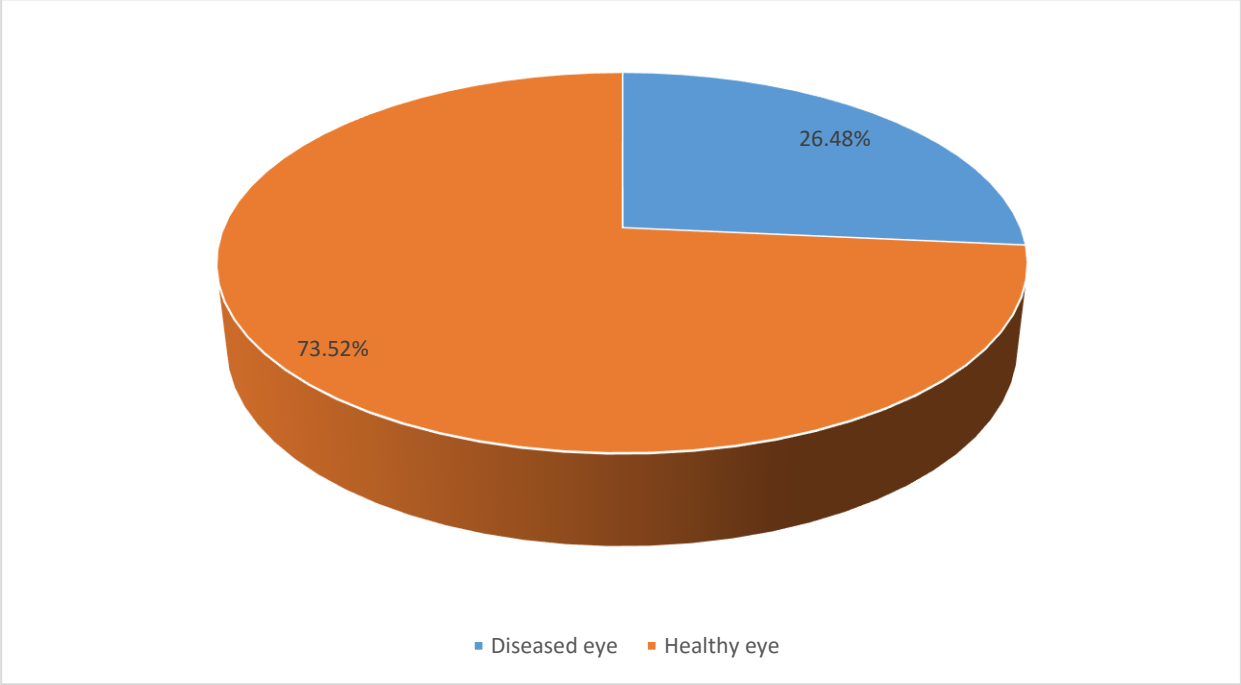

Fig 4.3.1a: Distribution between Subjects with Healthy Eyes and Diseased Eyes (N=287)

Approximately 26.48% of the subjects had eye diseases (during the study or previously). The rest of them (73.52%) had healthy eye.

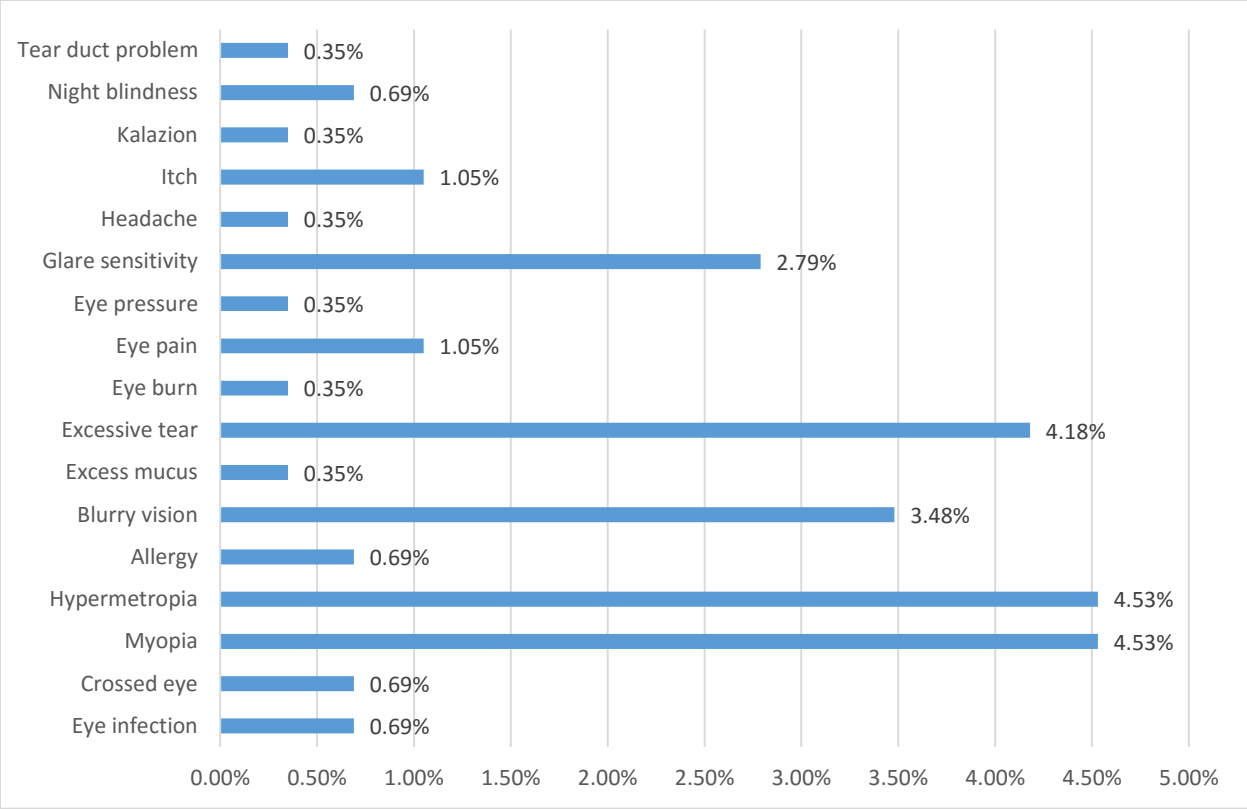

Fig 4.3.1b: Distribution of Eye Diseases (N=287)

Subjects with tear duct problem, night blindness, kalazion, itch, headache, glare sensitivity, eye pressure, eye pain, eye burn, excessive tear, excess mucus, blurry vision, eye allergy, hypermetropia, myopia, crossed eye and eye infection accounted for 0.35%, 0.69%, 0.35%, 1.05%, 0.35%, 2.79%, 0.35%, 1.05%, 0.35%, 4.18%, 0.35%, 3.48%, 0.69%, 4.53%, 4.53%, 0.69% and 0.69% of the total population respectively.

4.3.2 Ocular History of Family Members (N=287)

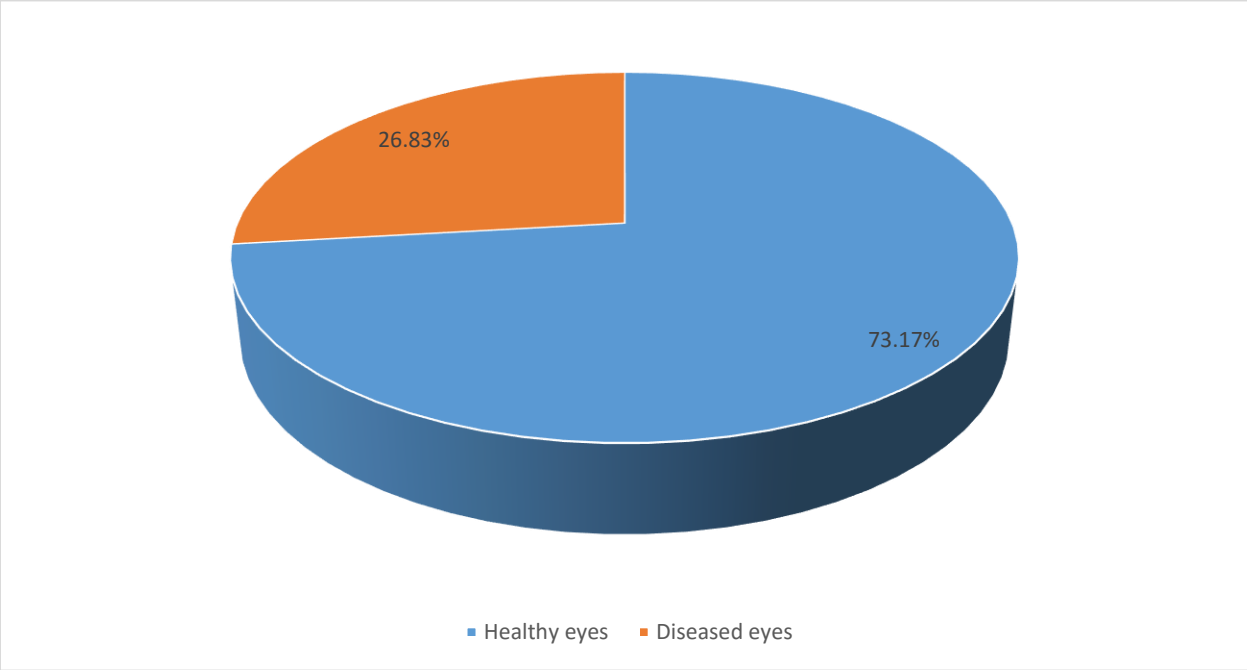

Fig 4.3.2a: Distribution between Subjects with Relatives Having Healthy Eyes and Diseased Eyes (N=287)

Approximately 26.83% of the subjects had relatives with eye diseases or damage. The rest of them (73.17%) had relatives with healthy eye.

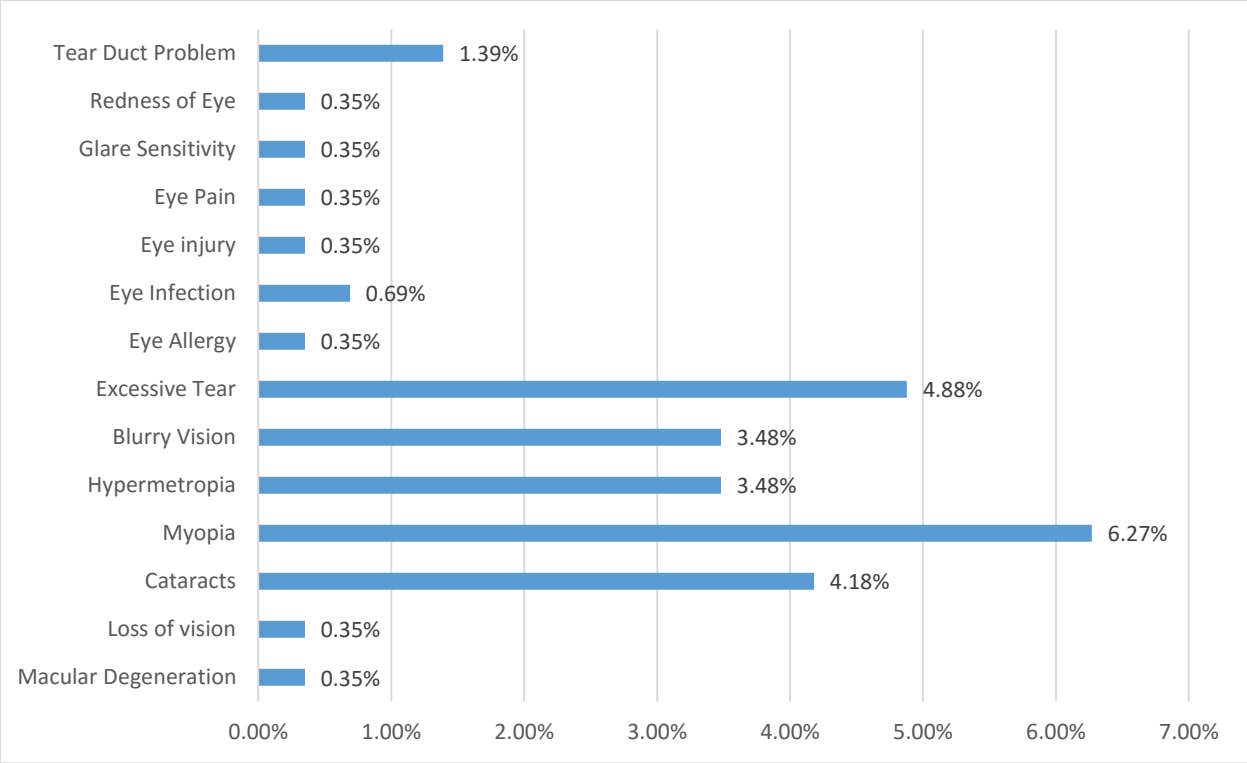

Fig 4.3.2b: Distribution of Eye Diseases of Family Members (N=287)

Subjects having family members with tear duct problem, redness of eye, glare sensitivity, eye pain, eye injury, eye infection, eye allergy, excessive tear, blurry vision, hypermetropia, myopia, cataracts, loss of vision and macular degeneration accounted for 1.39%, 0.35%, 0.35%, 0.35%, 0.35%, 0.69%, 0.35%, 4.88%, 3.48%, 3.48%, 6.27%, 4.18%, 0.35% and 0.35% of the total population respectively.

4.3.3 General History

Among the 287 subjects, asthma, renal disorder, headache and diabetes was reported by 1 subject for each disease. Hypertension was reported by 3 subjects.

4.3.4 General History of Family Members (N=287)

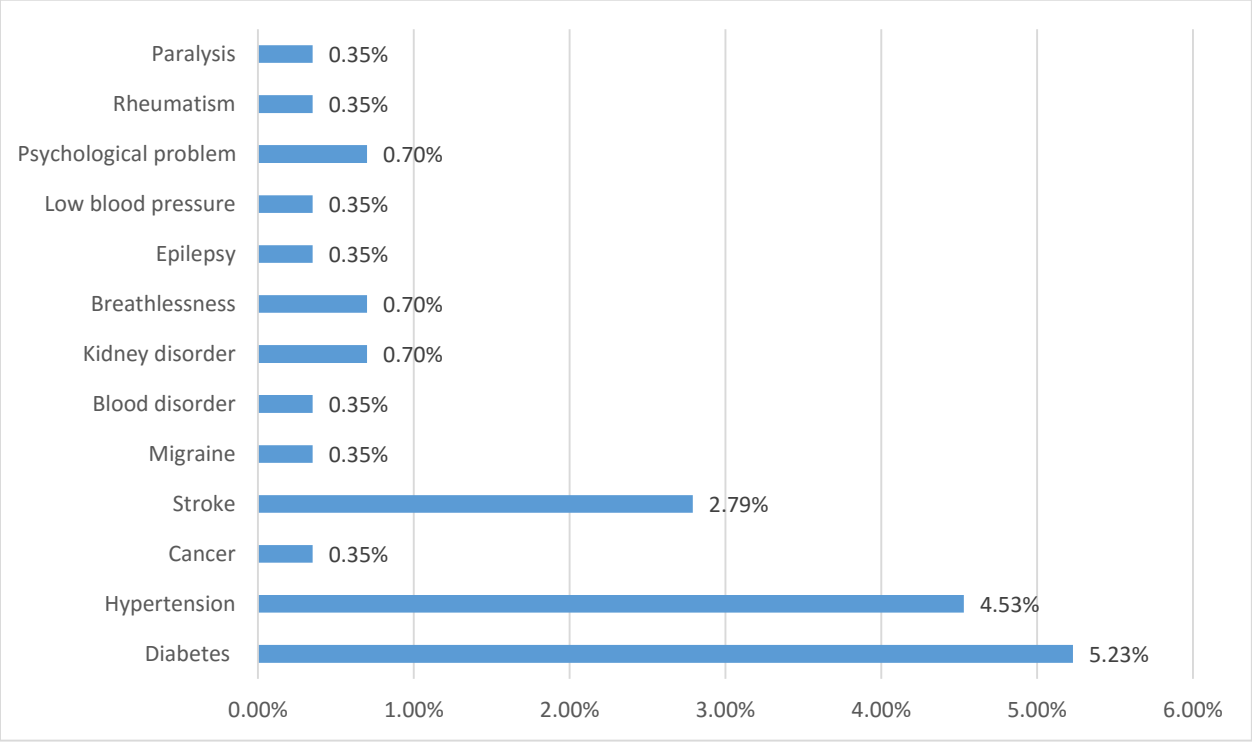

Fig 4.3.4: Distribution of General Diseases of Family Members (N=287)

Subjects having family members with paralysis, rheumatism, psychological problem, low blood pressure, epilepsy, breathlessness, kidney disorder, blood disorder, migraine, stroke, cancer, hypertension and diabetes accounted for 0.35%, 0.35%, 0.70%, 0.35%, 0.35%, 0.70%, 0.70%, 0.35%, 0.35%, 2.79%, 0.35%, 4.53% and 5.23% of the total population respectively.

4.4 Treatment

4.4.1 Distribution between Treated and Untreated Subjects (N=76)

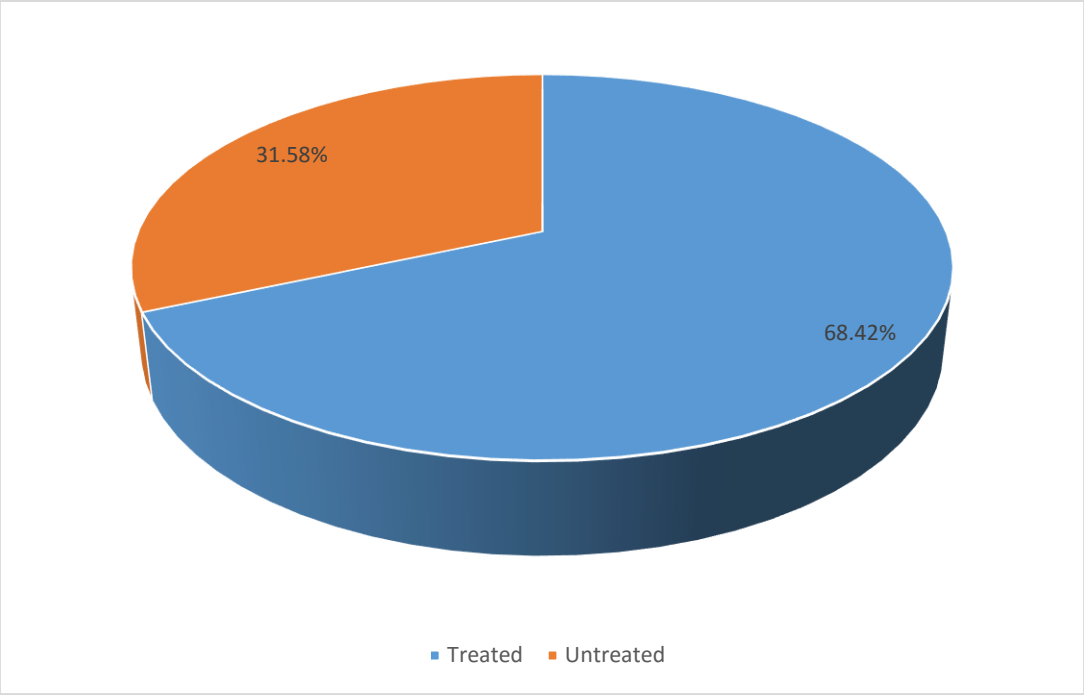

Fig 4.4.1a: Distribution of Treated and Untreated Patients (N=76)

Among the 76 subjects with ailing eye, 68.42% comprised of subjects who have received treatment. The rest (31.58%) were still untreated.

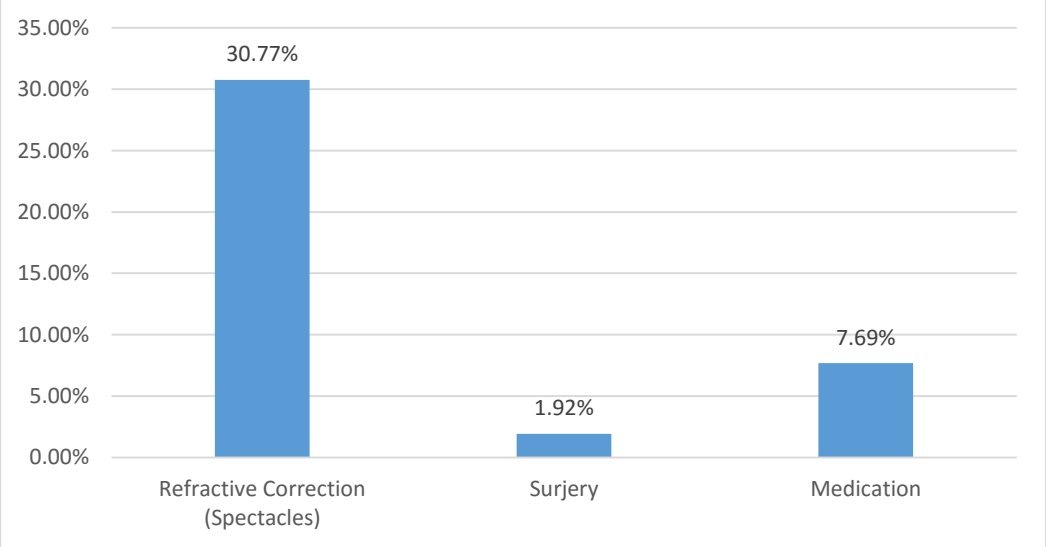

Fig 4.4.1b: Distribution of Modes of treatment (N=52)

Among the 52 subjects who had received treatment, 30.77% had received refractive correction. The power of the spectacles were: -0.5 (R) and -0.75 (L), -0.5 (R) and -0.5 (L), 1.5 (R) and 1.5 (L), 0.75 (R) and 0.75 (L), -1.75 (R) and -1.5 (L), 1.5 (R) and 1.5 (L), -1.5 (R) and -1.5 (L) and -2.25 (R) and -2.25 (L). Here, R and L indicates right eye and left eye respectively.

Approximately 1.92% had received surgery. Only one person comprised 1.92% of the 52 subjects who had received tear duct surjery.

Approximately 7.69% had received medication for eye disease. The medications were Gatifloxacin, Tramadol, Xylometazoline, Olopatadine, Levofloxacin, Potassium chloride, Clonidine and Chlorthalidone combination, Acetazolamide and Loratadine. No medication was taken by more than one subject.

The medications taken for other diseases were Albendazole, Salbutamol, Tobramycin, Esomeprazole, Omeprazole, Mouthwash, Vitamin B1, B6 and B12, Doxicycline, Metronidazole, Diclofenac, Ranitidine, oral contraceptives, Paracetamol. No medication was taken by more than one subject except Esomeprazole, Omeprazole, Mouthwash, Vitamin B1, B6 and B12, Diclofenac and oral contraceptives which were taken by 2, 4, 2, 3 and 2 subjects respectively.

4.4.3 Distribution of Eye Checking Regularity (N=287)

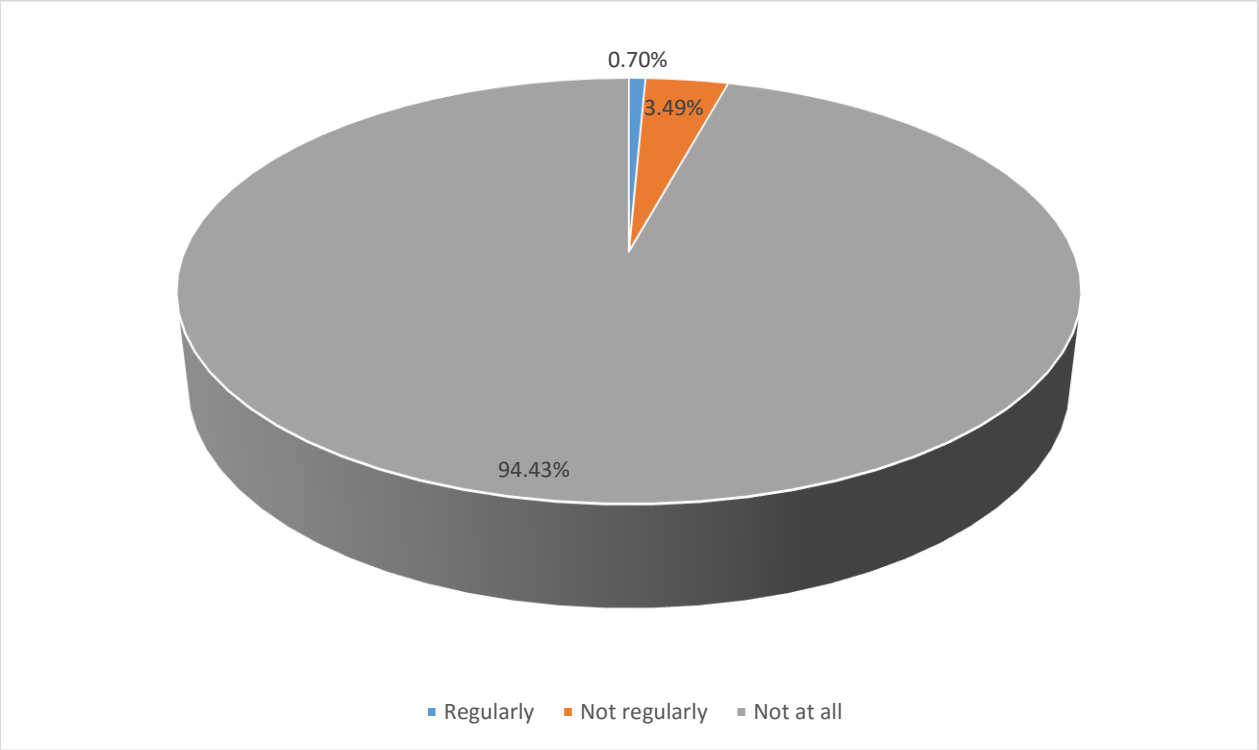

Fig 4.4.3: Distribution of Eye Checking Regularity (N=287)

Among the 287 subjects, 94.43% did not check eye at all, 3.49% checked eyes but not regularly and 0.70% checked eyes regularly.

4.4.4 Relation of Untreated Subjects and Presence of Asthenopic Symptoms (N=76)

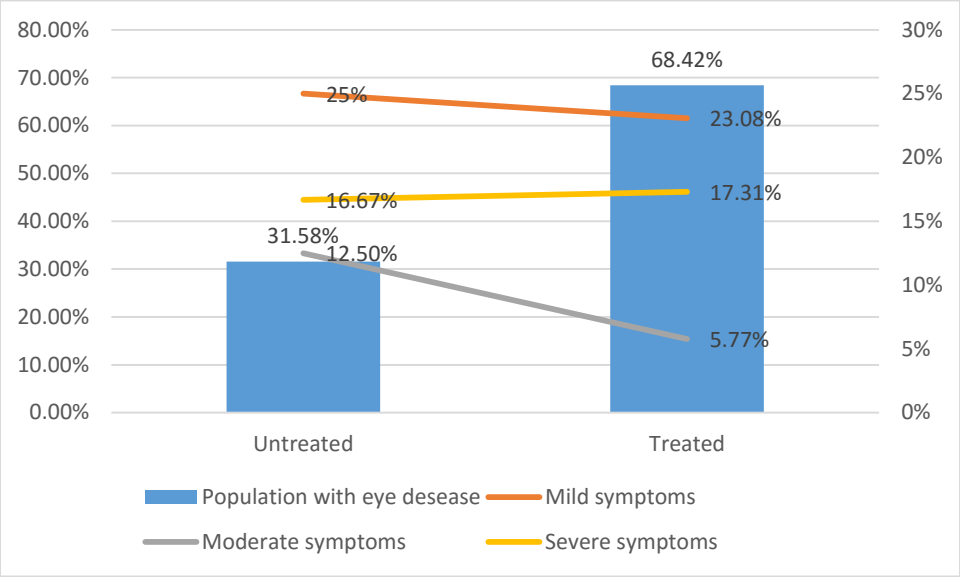

Fig 4.4.4: Relation of Untreated Subjects and Presence of Asthenopic Symptoms (N=76)

Mild asthenopic symptoms were present in 25% of the untreated subjects and 23.08% of the treated subjects. Moderate symtoms were present in 12.50% of untreated subjects and 5.77% of the treated subjects. Severe asthenopic symptoms were present in 16.67% of the untreated subjects and 17.31% of the treated subjects.

4.5 Asthenopic Symptoms

4.5.1 Distribution of Asthenopic and Non-asthenopic Subjects (N=287)

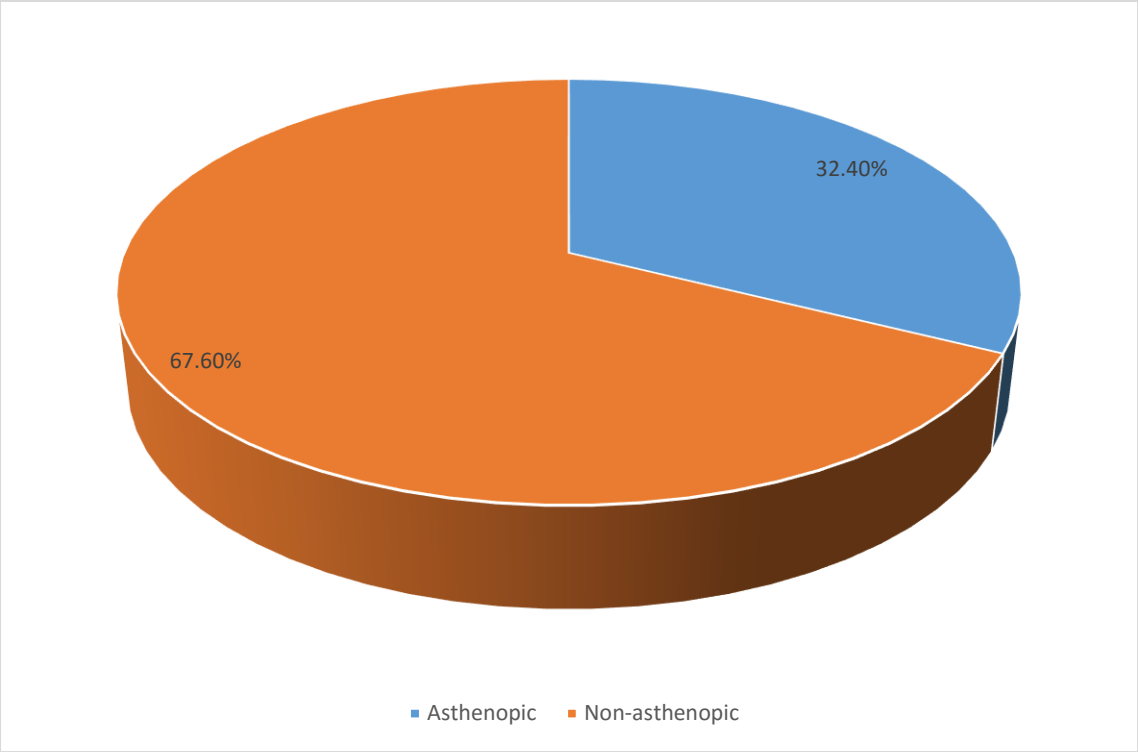

Fig 4.5.1: Distribution of Asthenopic and Non-asthenopic Subjects (N=287)

Among the total population, asthenopic symtoms were present in 67.60% and absent in 32.40%.

4.5.2 Time of Experiencing the Symptoms in the Workdays (N=93)

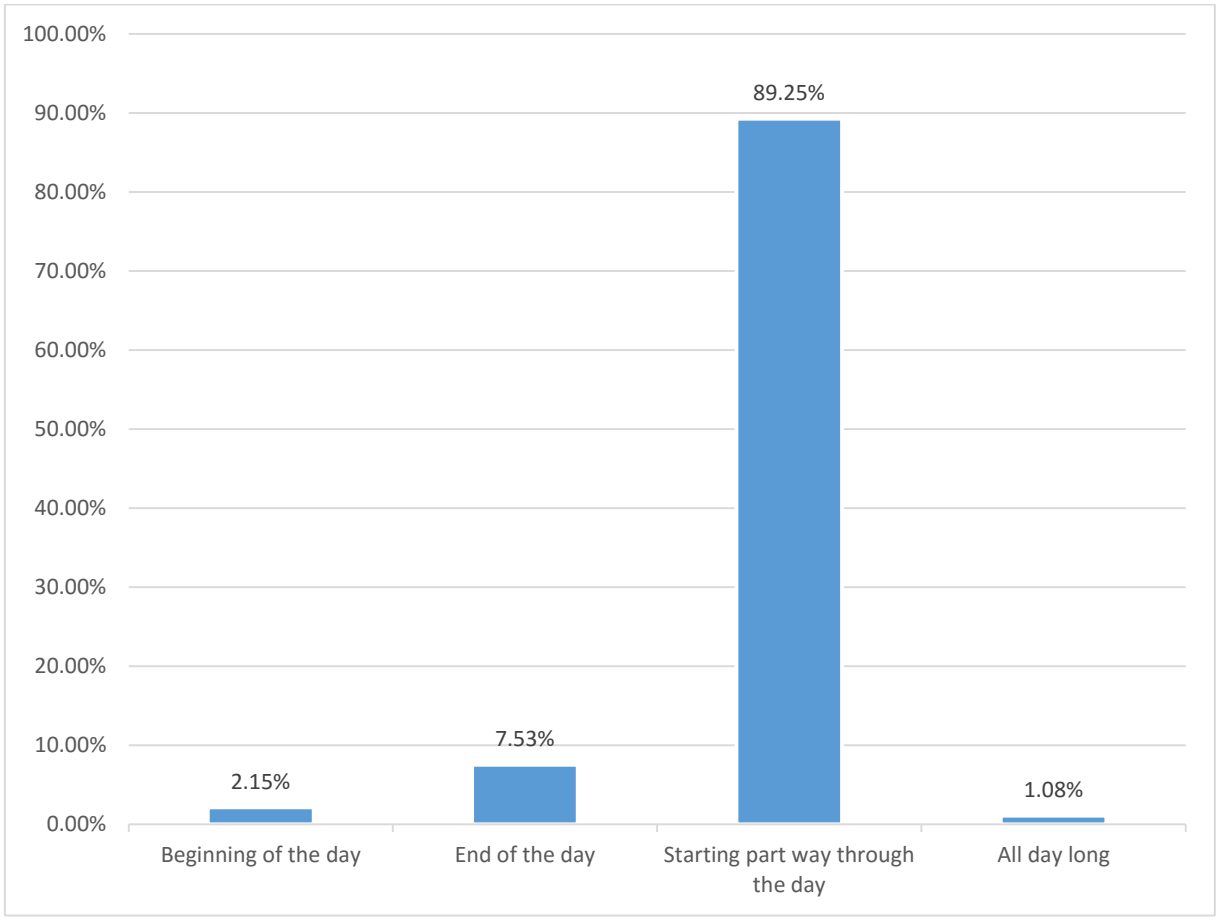

Fig 4.5.2: Time of Experiencing the Symptoms in the Workdays (N=93)

Among the total population, 2.15%, 7.53%, 89.25% and 1.08% experienced asthenopic symptoms at the beginning of the day, at the end of the day, starting part way through the day and all day long respectively.

4.5.3 Time Span of Suffering (N=93)

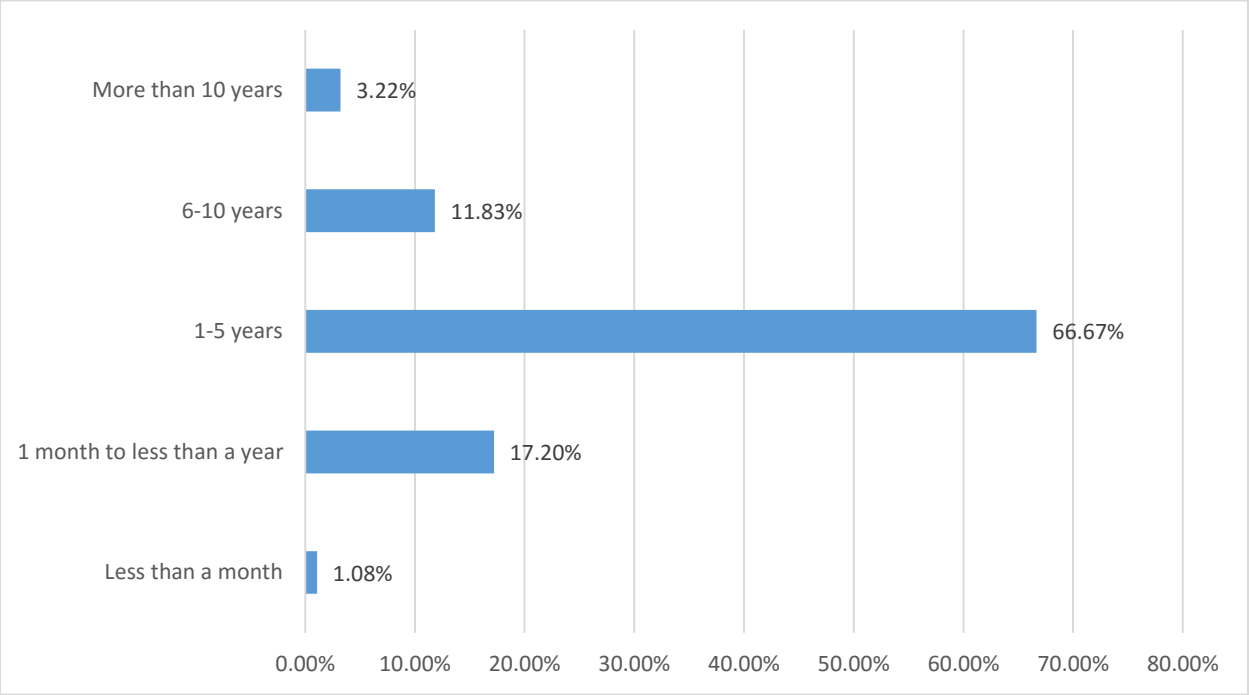

Fig 4.5.3: Time Span of Suffering (N=93)

Approximately 3.22%, 11.83%, 66.67%, 17.20% and 1.08% were suffering from asthenopic symptoms for more than 10 years, 6-10 years, 1-5 years, 1 month to less than year and less than a month respectively.

4.5.4 Distribution of Symptoms (N=93)

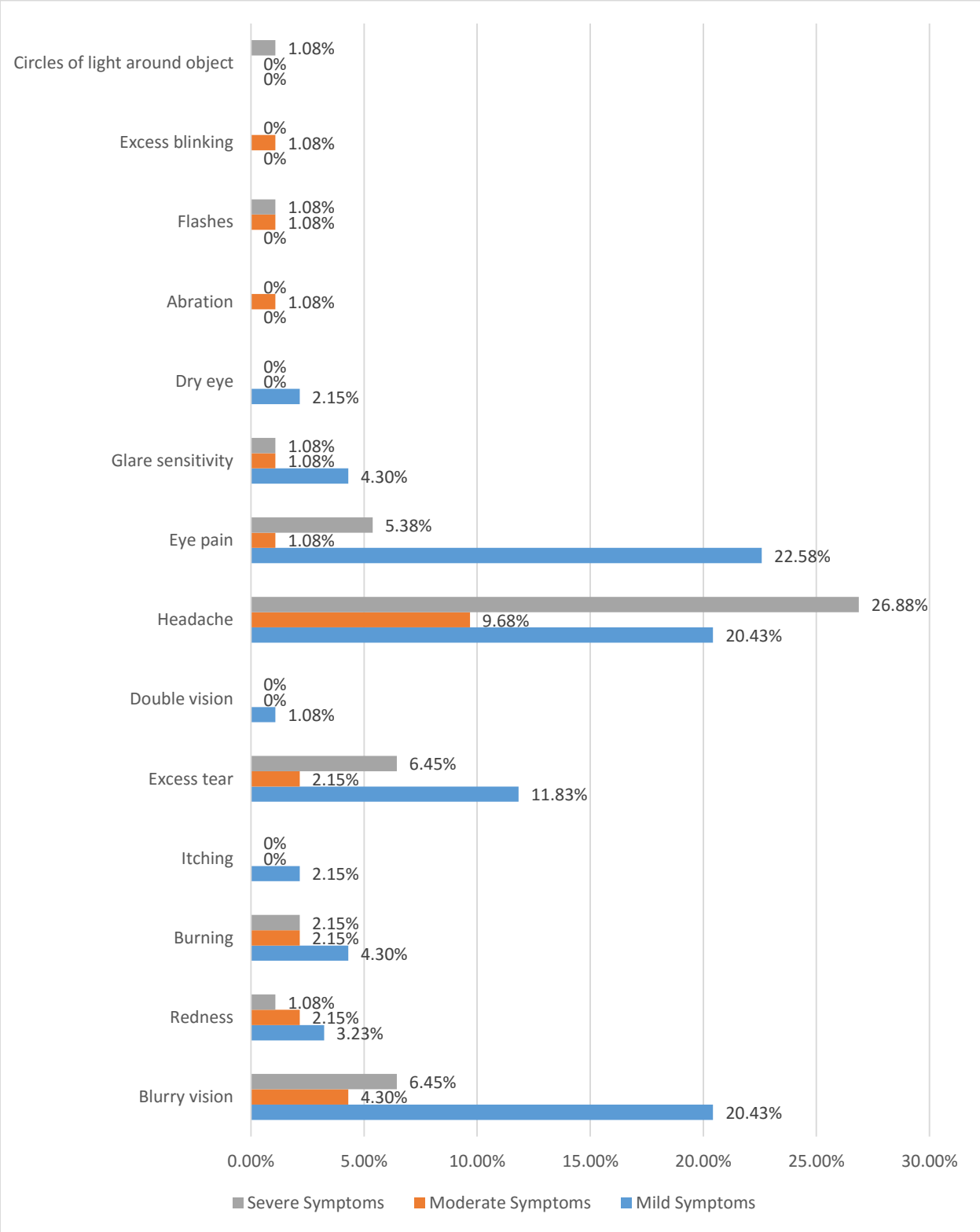

Fig 4.5.4: Distribution of Symptoms (N=93)

Circles of light around object, excess blinking, flashes, abrasion, dry eye, glare sensitivity, eye pain, headache, double vision, excess tear, itching, burning redness and blurry vision was present in severe form in 1.08%, 0%, 1.08%, 0%, 0%, 1.08%, 5.38%, 0%, 6.45%, 0%, 2.15%, 1.08%, 6.45%; in moderate form in 0%, 1.08%, 1.08%, 1.08%, 0%, 1.08%, 1.08%, 9.68%, 0%, 2.15%, 0%, 2.15%, 2.15%, 4.30% and in mild form in 0%, 0%, 0%, 0%, 2.15%, 4.30%, 22.58%, 20.43%, 1.08%, 11.83%, 2.15%, 4.30%, 3.23%, 20.43% of the asthenopic population respectively.

4.5.5 Time Taken for Symptoms to Emerge (N=93)

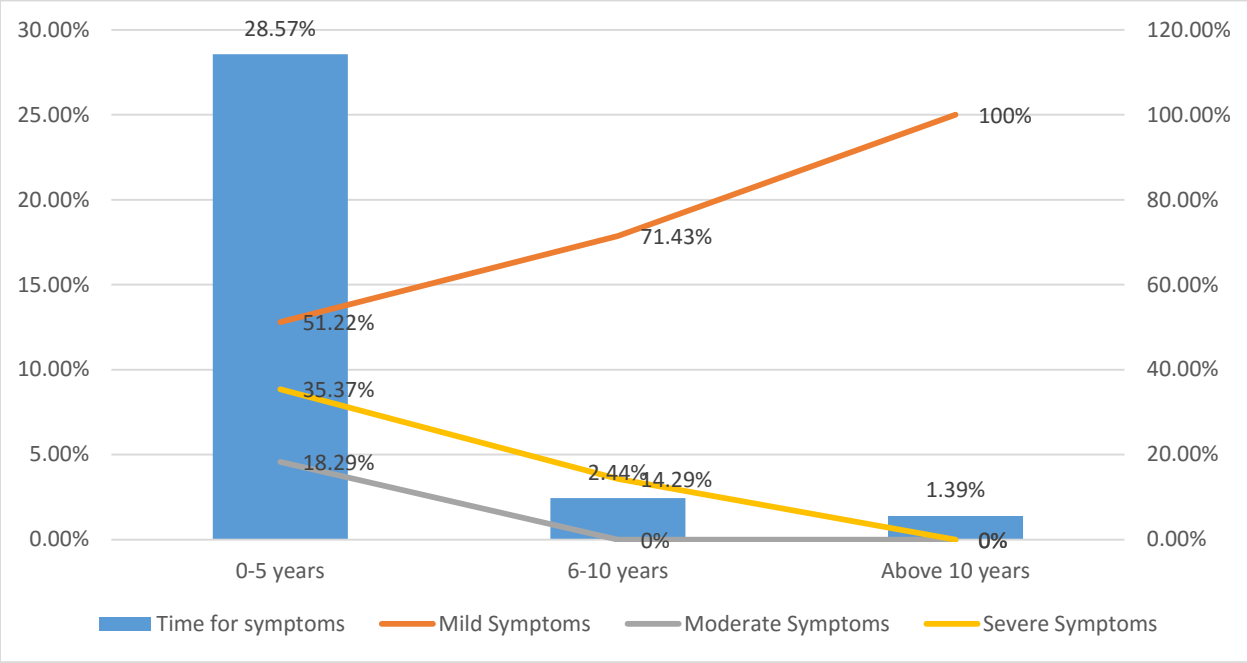

Fig 4.5.5: Time Taken for Asthenopic Symptoms to Emerge (N=93)

It took 0-5 years, 6-10 years, above 10 years for 28.57%, 2.44% and 1.39% of the asthenopic population respectively among which mild asthenopia was present in 51.22%, 71.43% and 100% respectively. Moderate asthenopia was present in 18.29%, 0% and 0% within the population for whom it took 0-5 years, 6-10 years and above 10 years respectively. Severe asthenopia was present in 35.37%, 14.39% and 0% within the population for whom it took 0-5 years, 6-10 years and above 10 years respectively.

4.6 Lifestyle Associated Factors

4.6.1 Sleep Related Factors

4.6.1.1 Relation with Sleep Hours and Asthenopic Symptoms (N=287)

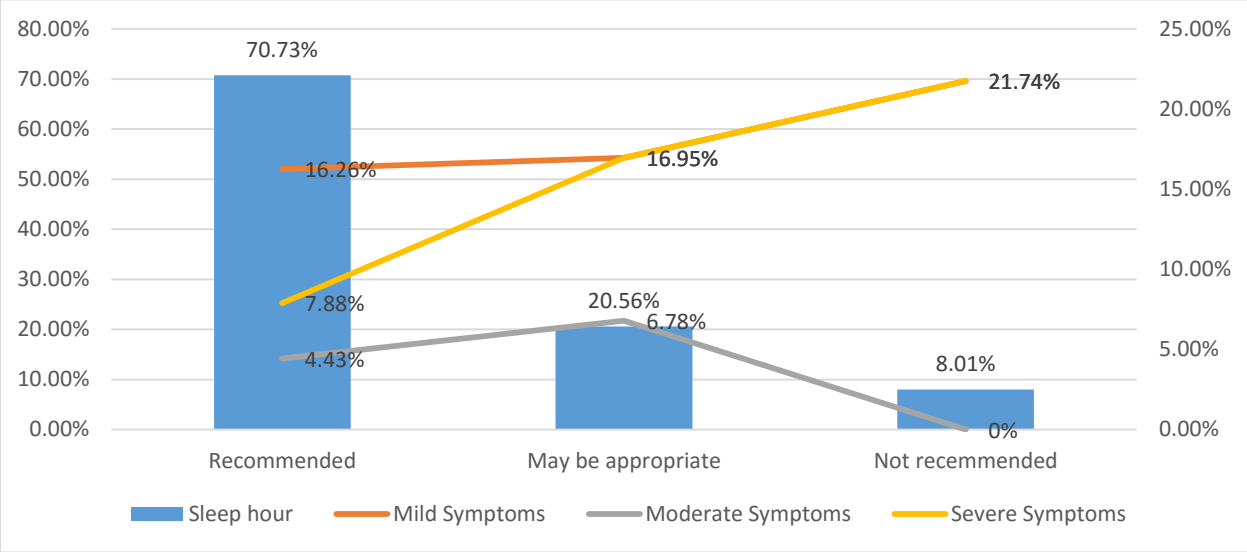

Fig 4.6.1.1: Relation with Sleep Hours and Asthenopic Symptoms (N=287)

Among the total population 70.73%, 20.26% and 8.01% sleeped in the "recommended", "may be appropriate" and "not recommended" durations respectively. Mild asthenopia was present in 16.26%, 16.95% and 8.01% of subjects sleeping in recommended, may be appropriate and not recommended durations respectively. Moderate asthenopia was present in 4.43%, 6.78% and 0% of subjects sleeping in recommended, may be appropriate and not recommended durations respectively. Severe asthenopia was present in 7.88%, 16.95% and 21.74% of subjects sleeping in recommended, may be appropriate and not recommended durations respectively.

4.6.1.2 Relation with Sleep Quality and Asthenopic Symptoms (N=287)

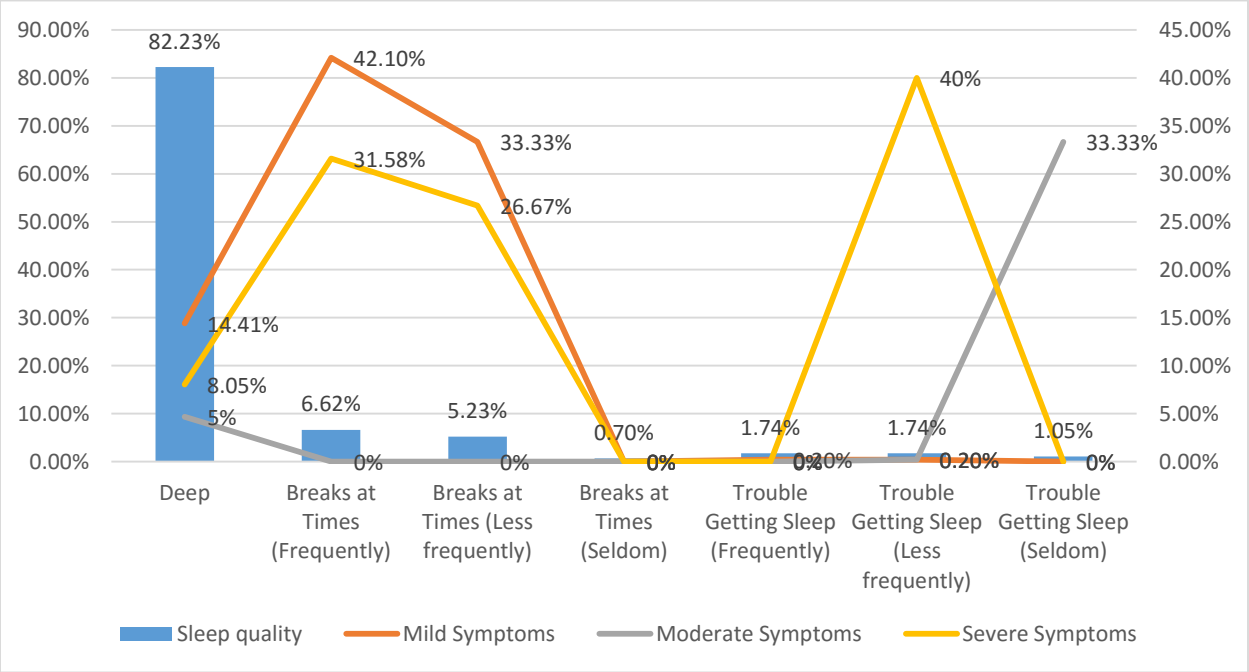

Fig 4.6.1.2: Relation with Sleep Quality and Asthenopic Symptoms (N=287)

Approximately 82.23%, 6.62%, 5.23%, 0.70%, 1.74%, 1.74%, 1.05% of subjects had deep sleep, sleep break at times frequently, break at times less frequently, break at times seldom, trouble getting sleep frequently, trouble getting sleep less frequently and trouble getting sleep seldom respectively. Mild asthenopia was present in 14.41%, 42.10%, 33.33%, 0%, 0% 0.20%, 0.20%, 0% of subjects having deep sleep, sleep break at times frequently, break at times less frequently, break at times seldom, trouble getting sleep frequently, trouble getting sleep less frequently and trouble getting sleep seldom respectively. Moderate asthenopia was present in 5%, 0%, 0%, 0%, 0% 0.20%, 33.33% of subjects having deep sleep, sleep break at times frequently, break at times less frequently, break at times seldom, trouble getting sleep frequently, trouble getting sleep less frequently and trouble getting sleep seldom respectively. Severe asthenopia was present in 8.05%, 31.58%, 26.67%, 0%, 0% 40%, 0%, 0% of subjects having deep sleep, sleep break at times frequently, break at times less frequently, break at times seldom, trouble getting sleep frequently, trouble getting sleep less frequently and trouble getting sleep seldom respectively.

4.6.2 Relation of the Habit of Physical Activity and Asthenopic Symptoms (N=287)

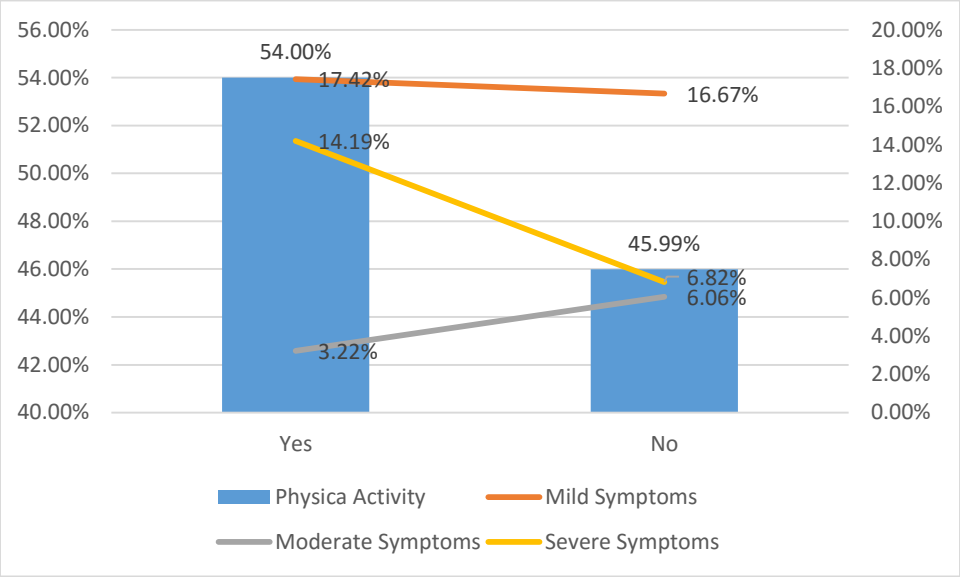

Fig 4.6.2: Relation of the Habit of Physical Activity and Asthenopic Symptoms (N=287)

Approximately 45.99% and 54.00% of the subjects had habit of physical activities (exercise or performing household chores) and did not have the habit respectively. Mild symptoms were present in 17.42% of subjects who did physical activity and 6.82% of subjects who did not do physical activity. Moderate symptoms were present in 3.22% of subjects who did physical activity and 6.06% of subjects who did not do physical activity. Severe symptoms were present in 14.19% of subjects who did physical activity and 6.82% of subjects who did not do physical activity.

4.6.3 Relation of Addiction and Asthenopic Symptoms (N=287)

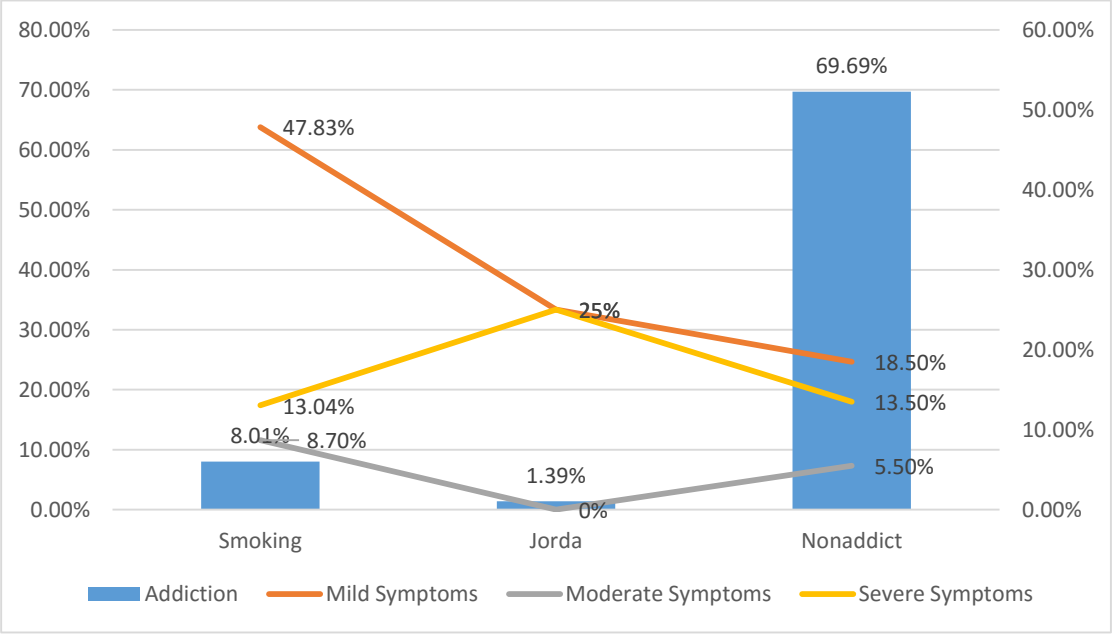

Fig 4.6.3: Relation of Addiction and Asthenopic Symptoms (N=287)

Approximately 8.01% and 1.39% were addicted to smoking and jorda (tobacco leaves for chewing) respectively. The rest (69.69%) were non-addicts. Mild symptoms were present in 47.83% of subjects who smoke, 25% of subjects were addicted to jorda and 18.50% of subjects who did not have any addiction. Moderate symptoms were present in 8.70% of subjects who smoked, 0% of subjects were addicted to jorda and 5.50% of subjects who did not have any addiction. Severe symptoms were present in 13.04% of subjects who smoke, 25% of subjects were addicted to jorda and 13.50% of subjects who did not have any addiction.

4.6.4 Relation of Comfort of Residence and Asthenopic Symptoms (N=287)

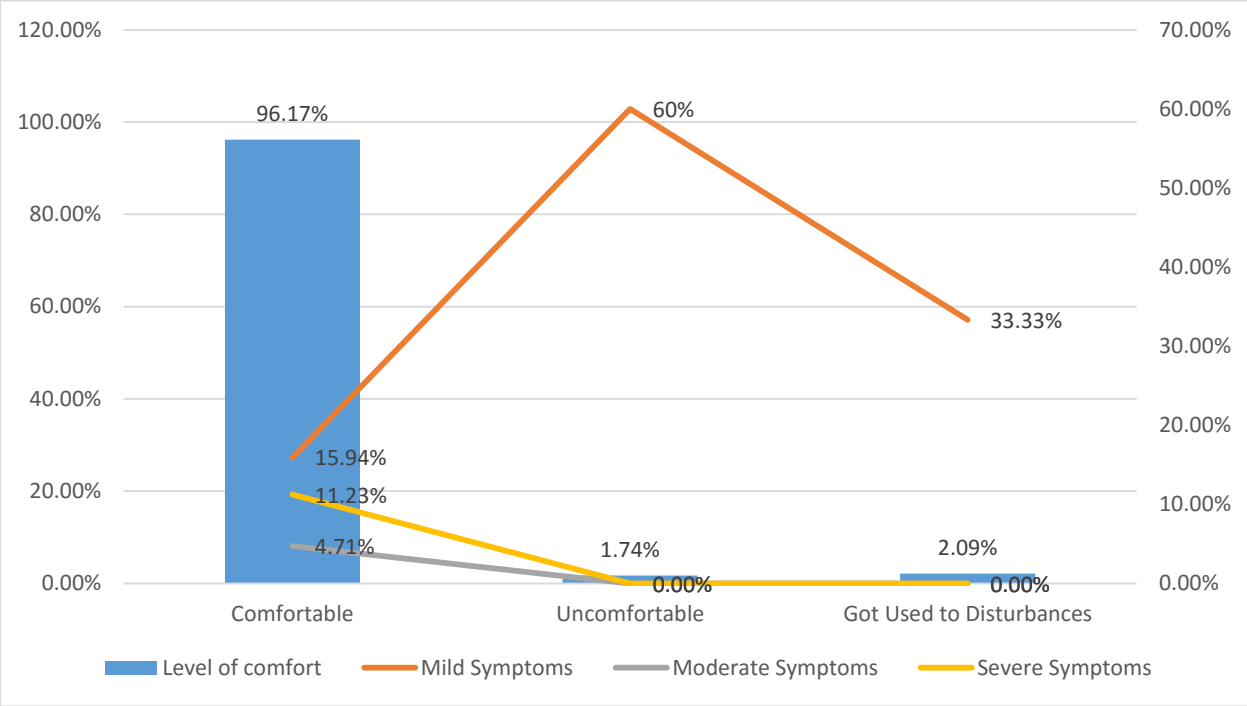

Fig 4.6.4: Relation of Comfort of Residence and Asthenopic Symptoms (N=287)

Approximately 96.17%, 1.74% and 2.09% had comfortable, uncomfortable residences and had disturbances but got used to it respectively. Mild symptoms were present in 15.64%, 60% and 33.33% of subjects who had comfortable, uncomfortable residences and had disturbances but got used to it respectively. Moderate symptoms were present in 4.71%, 0% and 0% of subjects who had comfortable, uncomfortable residences and had disturbances but got used to it respectively. Severe symptoms were present in 11.23%, 0% and 0% of subjects who had comfortable, uncomfortable residences and had disturbances but got used to it respectively.

4.5.5 Reasons for Discomfort of Residence (N=11)

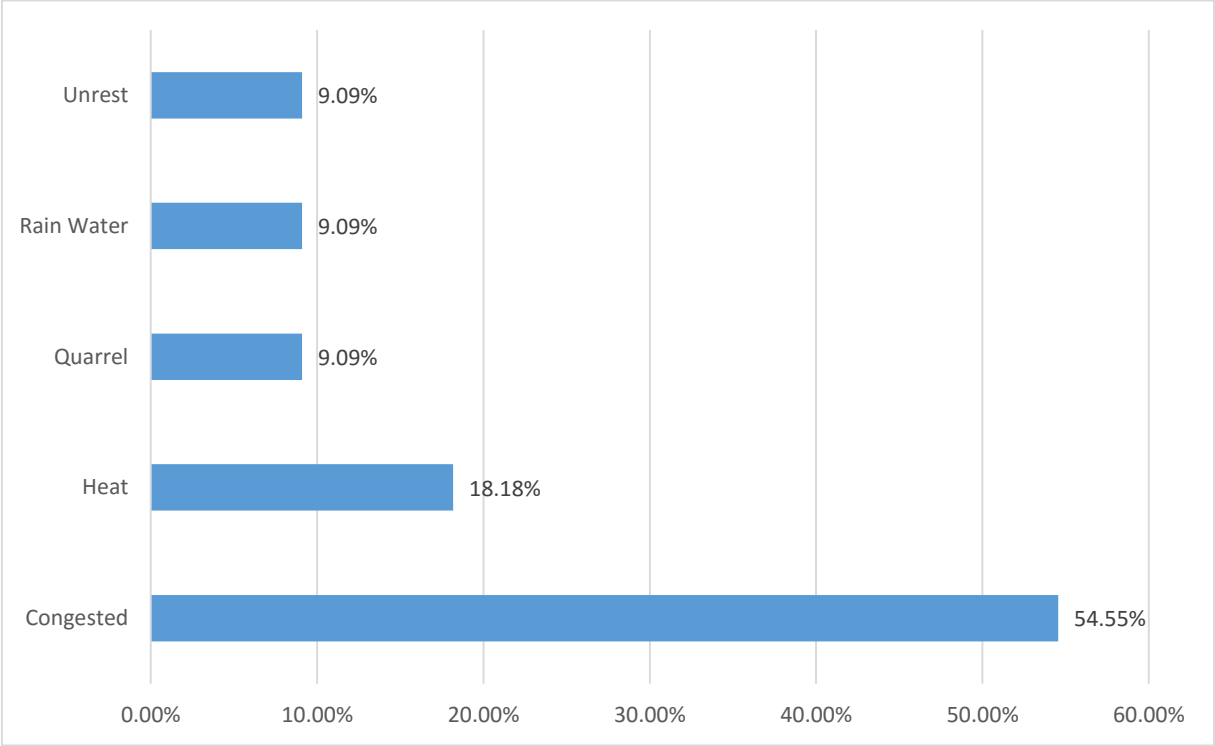

Fig 4.5.5: Reasons for Discomfort of Residence (N=11)

Among the subjects having uncomfortable residence and having disturbances but got used to it, 9.09%, 9.09%, 9.09%, 18.18% and 54.55% had unrest, rain water problem, quarrelsome environment, heat and congestion problems respectively.

4.6.6 Relation of Diet and Asthenopic Symptoms (N=287)

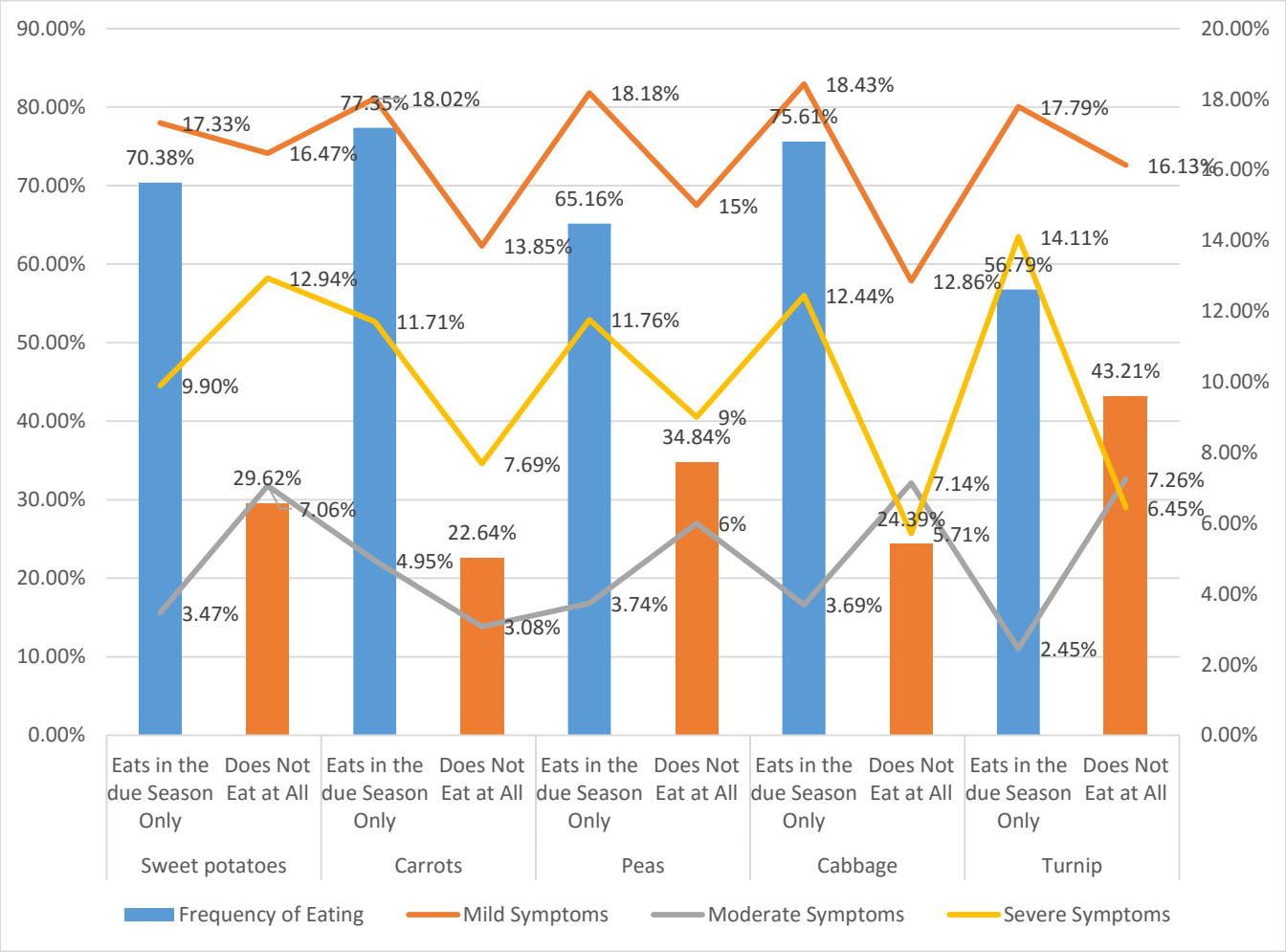

Fig 4.6.6a: Relation of Dietary Habit for Seasonally Available Vegetables and Asthenopic Symptoms (N=287)

Approximately 29.62%, 22.64%, 34.84%, 24.39% and 43.21% of subjects did not eat sweet potatoes, carrots, peas, cabbage and turnip at all respectively. Mild asthenopic symptoms were present in 16.47%, 13.85%, 15%, 12.86% and 16.13% of these subjects respectively. Moderate asthenopic symptoms were present in 29.62%, 3.08%, 6%, 7.14% and 7.26% of these subjects respectively. Severe asthenopic symptoms were present in 12.94%, 7.69%, 9%, 5.71% and 6.45% of these subjects respectively. Approximately 70.38%, 77.35%, 65.16%, 75.61% and 56.79% of subjects ate sweet potatoes, carrots, peas, cabbage and turnip in the due season respectively. Mild asthenopic symptoms were present in 17.33%, 77.35%, 18.18%, 18.43% and 17.79% of these subjects respectively. Moderate asthenopic symptoms were present in 3.47%, 4.95%, 3.74%,

3.69% and 2.45% of these subjects respectively. Severe asthenopic symptoms were present in 9.90%, 11.71%, 11.76%, 12.44% and 14.11% of these subjects respectively.

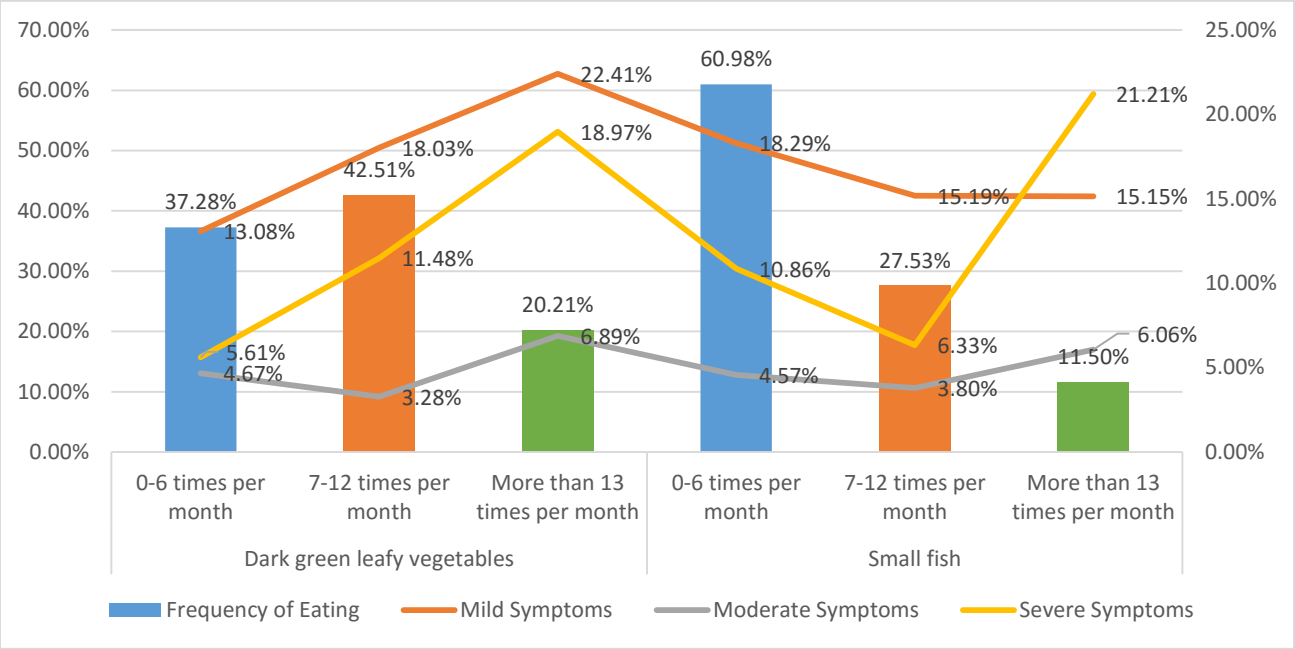

Fig 4.6.6b: Relation of Dietary Habit for Foods Available in All Seasons and Asthenopic Symptoms (N=287)

Approximately 20.21% and 11.50% of subjects ate dark green leafy vegetables and small fish more than 13 times per month respectively. Mild asthenopic symptoms were present in 22.41% and 15.15% of these subjects respectively. Moderate asthenopic symptoms were present in 6.89% and 6.06% of these subjects respectively. Severe asthenopic symptoms were present in 18.97% and 21.21% of these subjects respectively. Approximately 42.51% and 27.53% of subjects ate dark green leafy vegetables and small fish 7-12 times per month respectively. Mild asthenopic symptoms were present in 18.03% and 15.19% of these subjects respectively. Moderate asthenopic symptoms were present in 3.28% and 3.80% of these subjects respectively. Severe asthenopic symptoms were present in 11.48% and 6.33% of these subjects respectively. Approximately 37.28% and 60.98% of subjects ate dark green leafy vegetables and small fish more than 0-6 times per month respectively. Mild asthenopic symptoms were present in 13.08% and 18.29% of these subjects respectively. Moderate asthenopic symptoms were present in 4.67% and 4.57% of these subjects respectively. Severe asthenopic symptoms were present in 5.61% and 10.86% of these subjects respectively.

4.7 Work Associated Factors

4.7.1 Relation of Total Workhours and Asthenopic Symptoms (N=287)

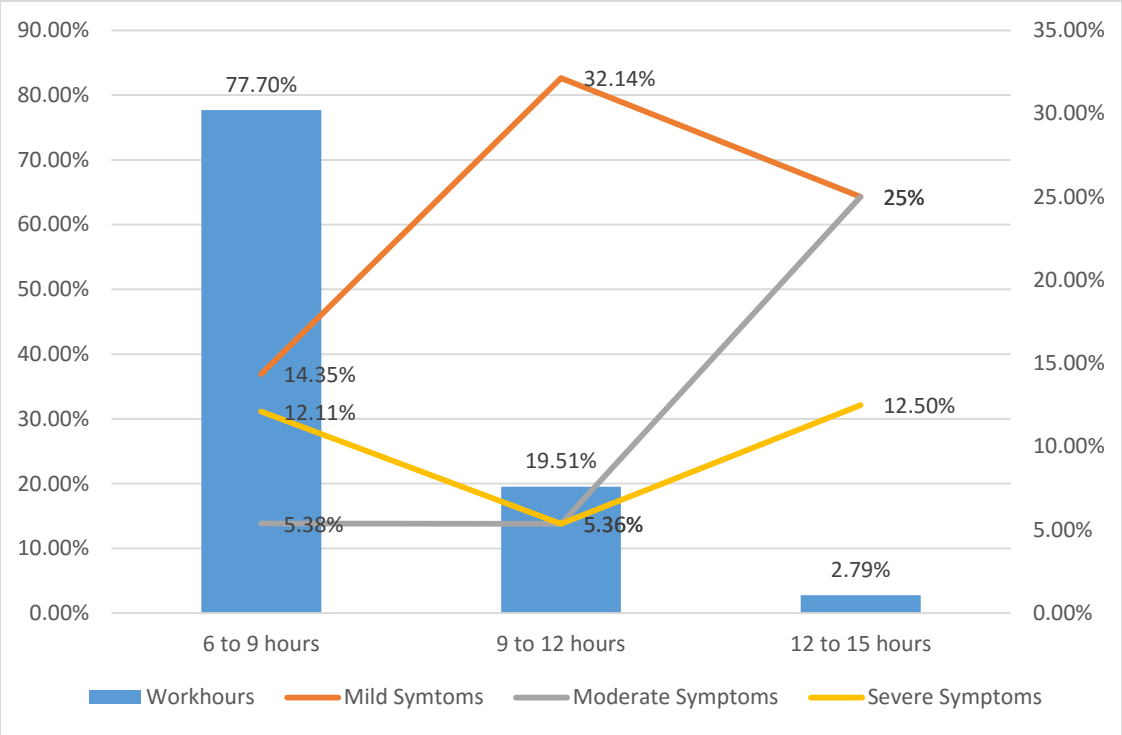

Fig 4.7.1: Relation of Total Workhours and Asthenopic Symptoms (N=287)

Approximately 77.70%, 19.51% and 2.79% of subjects worked 6-9 hours, 9-12 hours and 12-15 hours respectively. Mild asthenopia was present in 14.35%, 32.14%, 25% of the subjects working 6-9 hours, 9-12 hours and 12-15 hours respectively. Moderate asthenopia was present in 5.38%, 19.51%, 25% of the subjects working 6-9 hours, 9-12 hours and 12-15 hours respectively. Severe asthenopia was present in 12.11%, 5.36%, 12.50% of the subjects working 6-9 hours, 9-12 hours and 12-15 hours respectively.

4.7.2 Relation Relation of Number of Breaks and Asthenopic Symptoms (N=287)

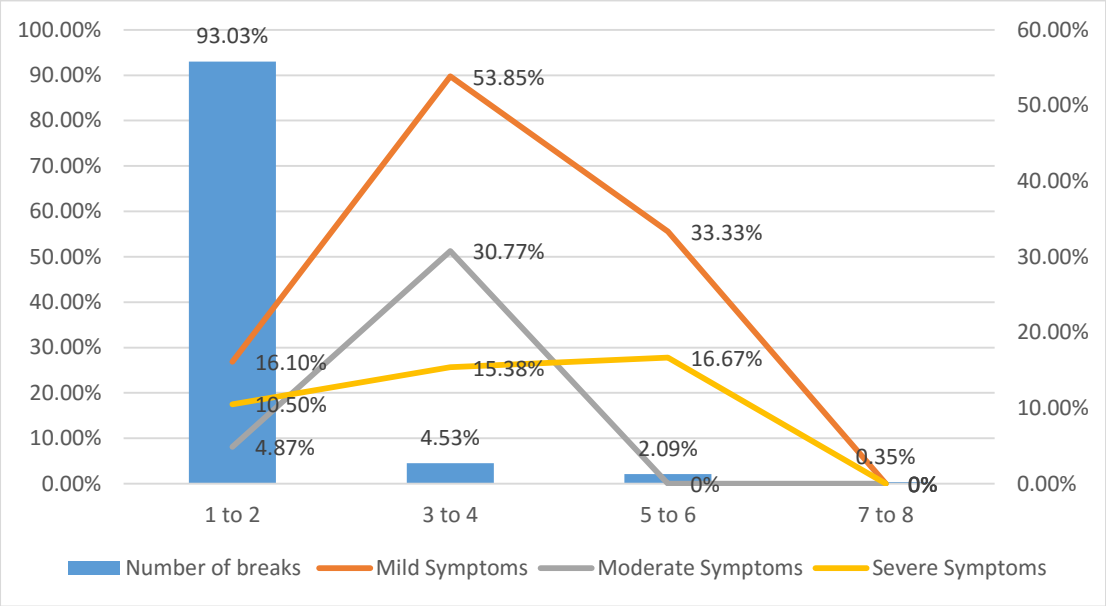

Fig 4.7.2: Relation of Number of Breaks and Asthenopic Symptoms (N=287)

Approximately 93.03%, 4.53%, 2.09%, 0.35% had breaks 1-2, 3-4, 5-6, 7-8 times. Mild asthenopia was present in 16.10%, 58.85%, 33.33% and 0.35% was present in subjects having breaks 1-2, 3-4, 5-6, 7-8 times. Moderate asthenopia was present in 93.03%, 30.77%, 2.09% and 0% was present in subjects having breaks 1-2, 3-4, 5-6, 7-8 times. Severe asthenopia was present in 10.50%, 15.38%, 16.67% and 0.35% was present in subjects having breaks 1-2, 3-4, 5-6, 7-8 times.

4.7.3 Relation of Average Duration of Breaks and Asthenopic Symptoms (N=287)

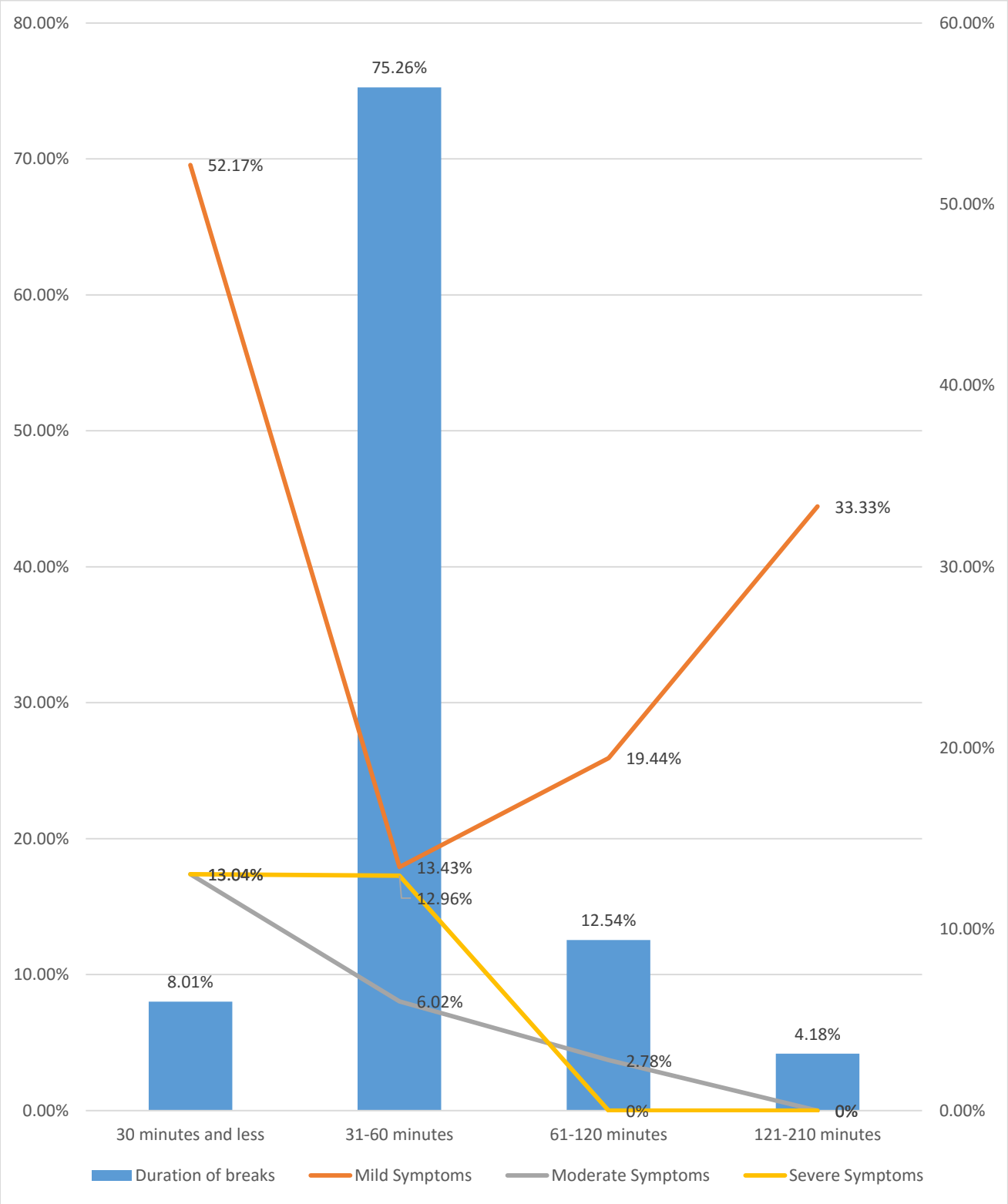

Fig 4.7.3: Relation of Average Duration of Breaks and Asthenopic Symptoms (N=287)

Approximately 8.01%, 75.29%, 12.54%, 4.18% had break durations 30 minutes and less, 31-60 minutes, 61-120 minutes, 121-210 minutes respectively. Mild asthenopia was present in 52.17%, 13.43%, 19.44%, 33.33% of subjects having break durations 30 minutes and less, 31-60 minutes, 61-120 minutes, 121-210 minutes respectively. Moderate asthenopia was present in 13.04%, 6.02%, 2.78%, 0% of subjects having break durations 30 minutes and less, 31-60 minutes, 61-120 minutes, 121-210 minutes respectively. Severe asthenopia was present in 13.04%, 12.96%, 0%, 0% of subjects having break durations 30 minutes and less, 31-60 minutes, 61-120 minutes, 121-210 minutes respectively.

4.7.4 Relation of Total Workdays and Asthenopic Symptoms (N=287)

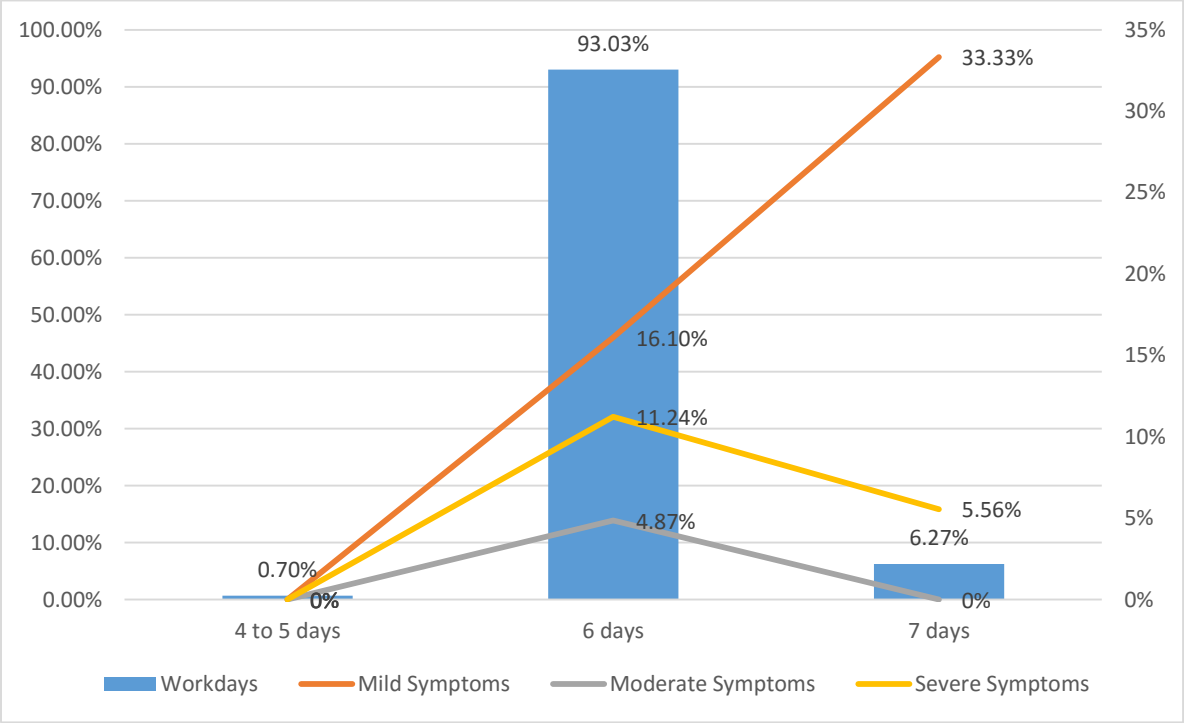

Fig 4.7.4: Relation of Total Workdays and Asthenopic Symptoms (N=287)

Approximately 0.70%, 93.03%, 6.27% had workdays 4-5, 6, 7 per week. Mild asthenopia was present in 0%, 16.10%, 33.33% of the subjects having workdays 4-5, 6, 7 per week respectively. Moderate asthenopia was present in 0%, 4.87%, 0% of the subjects having workdays 4-5, 6, 7 per week respectively. Severe asthenopia was present in 0%, 11.24%, 5.56% of the subjects having workdays 4-5, 6, 7 per week respectively.

4.7.5 Relation of Work Experience and Asthenopic Symptoms (N=287)

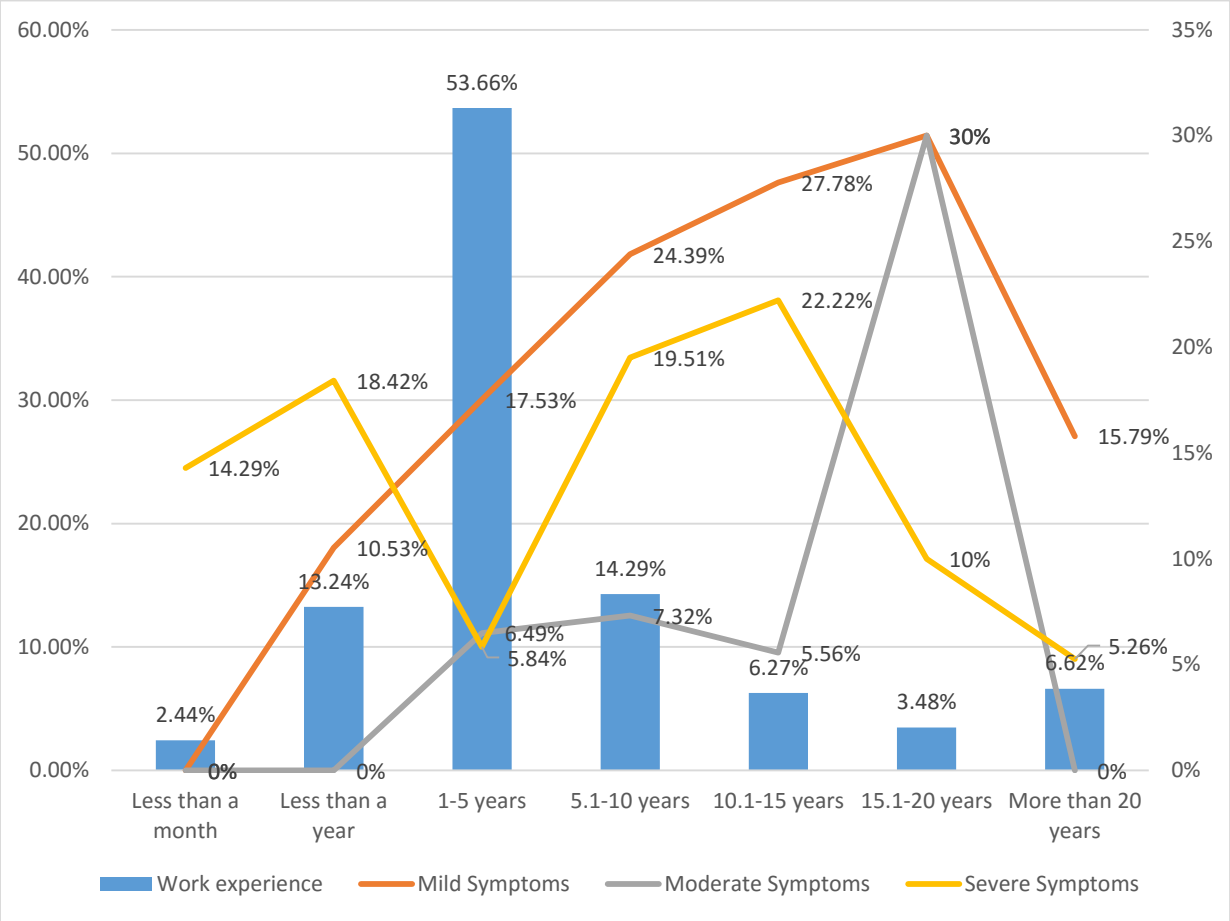

Fig 4.7.5: Relation of Work Experience and Asthenopic Symptoms (N=287)

Approximately 2.44%, 13.24%, 53.66%, 14.29%, 6.27%, 3.48%, 6.62% had work experience less than a month, less than a year, 1-5 years, 5.1-10 years, 10.1-15 years, 15.1-20 years, more than 20 years respectively. Mild asthenopia was present in 0%, 10.53%, 17.53%, 24.39%, 27.78%, 30%, 15.79% in subjects having work experience less than a month, less than a year, 1-5 years, 5.1-10 years, 10.1-15 years, 15.1-20 years, more than 20 years respectively. Moderate asthenopia was present in 0%, 0%, 6.49%, 7.32%, 5.56%, 30%, 0% in subjects having work experience less than a month, less than a year, 1-5 years, 5.1-10 years, 10.1-15 years, 15.1-20 years, more than 20 years respectively. Severe asthenopia was present in 14.29%, 18.42%, 5.84%, 19.51%, 22.22%, 10%, 5.265% in subjects having work experience less than a month, less than a year, 1-5 years, 5.1-10 years, 10.1-15 years, 15.1-20 years, more than 20 years respectively.

4.7.6 Relation of Time Taken for Each Unit and Asthenopic Symptoms (N=287)

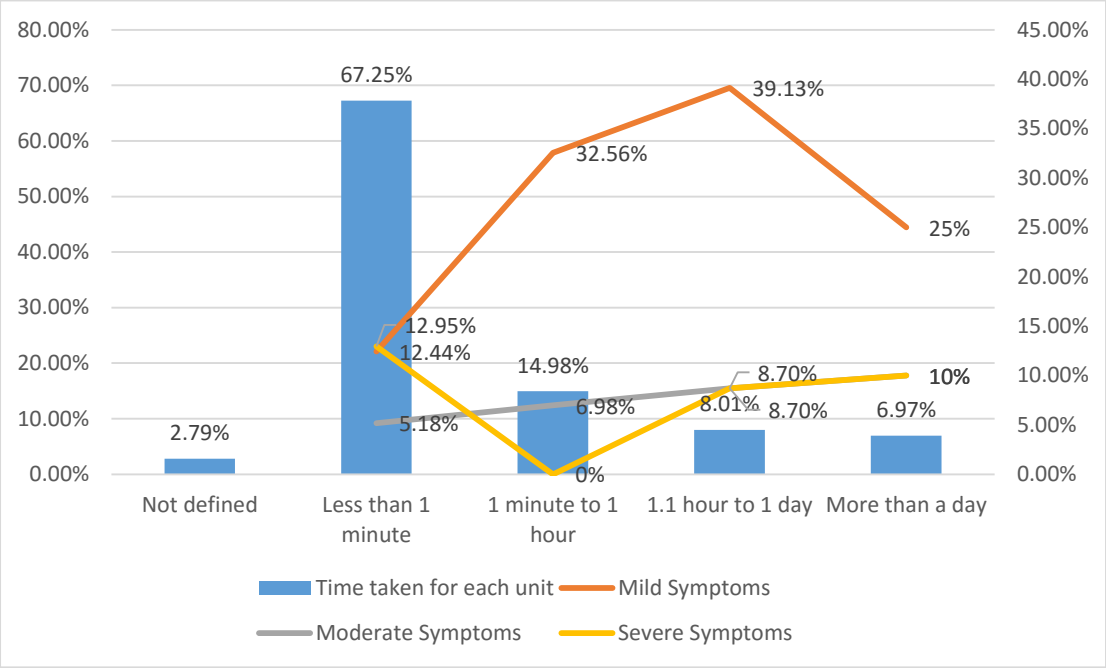

Fig 4.7.6: Relation of Time Taken for Each Unit and Asthenopic Symptoms (N=287)

Approximately 67.25%, 14.98%, 8.01%, 6.97% subjects produced each unit in less than 1 minute, 1 minute to 1 hour, 1.1 hour to 1 day and more than a day respectively. Time taken for each unit for 2.79% was not defined. Mild asthenopia was present in 12.44%, 32.56%, 39.13% and 25% of subjects producing each unit in less than 1 minute, 1 minute to 1 hour, 1.1 hour to 1 day and more than a day respectively. Moderate asthenopia was present in 5.18%, 6.98%, 8.70% and 10% of subjects producing each unit in less than 1 minute, 1 minute to 1 hour, 1.1 hour to 1 day and more than a day respectively. Severe asthenopia was present in 12.95%, 0%, 8.70% and 10% of subjects producing each unit in less than 1 minute, 1 minute to 1 hour, 1.1 hour to 1 day and more than a day respectively.

4.7.7 Relation of Number of Units Produced per Day and Asthenopic Symptoms (N=287)

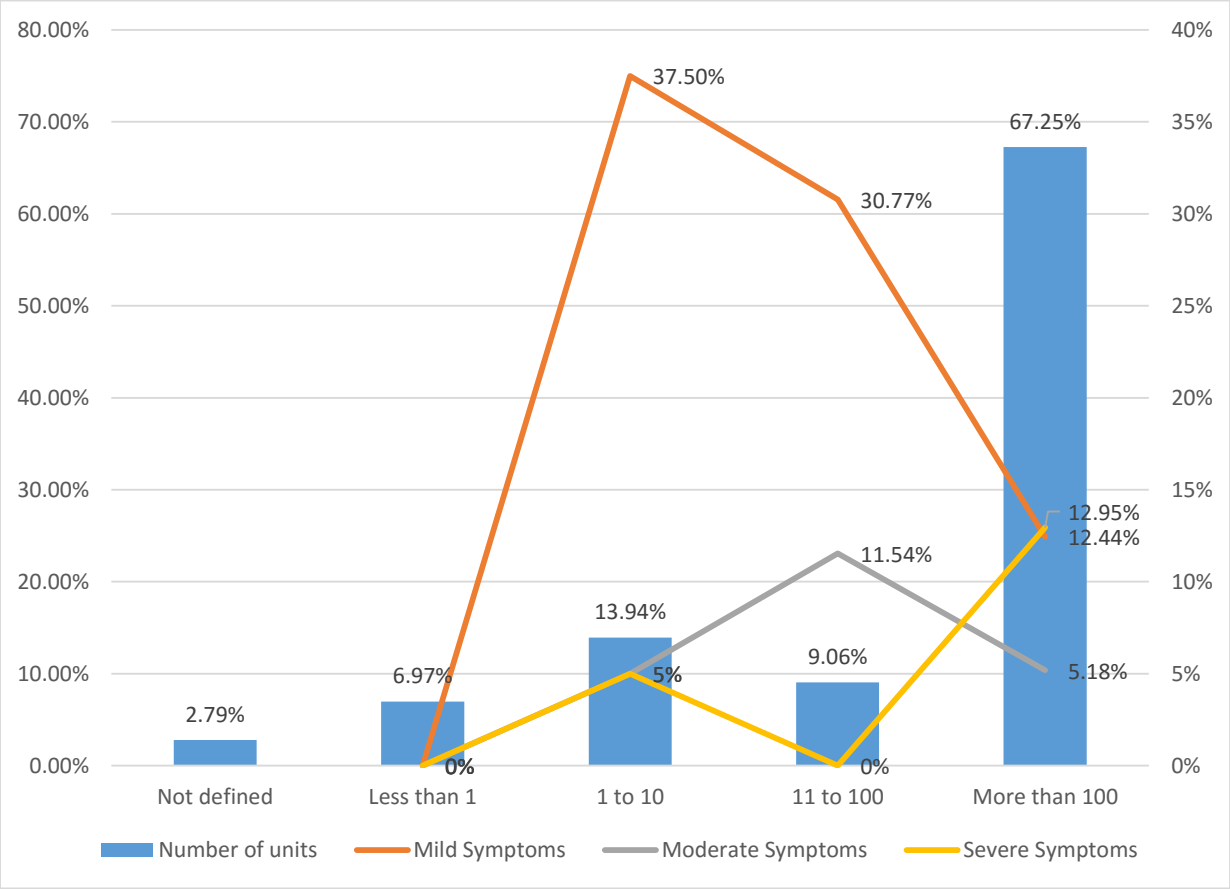

Fig 4.7.7: Relation of Number of Units Produced per Day and Asthenopic Symptoms (N=287)

Approximately 6.97%, 13.94%, 9.06%, 67.25% of subjects produced less than 1, 1-10, 11-100, more than 100 units per day respectively. It was not defined for 2.79%. Mild asthenopic symptoms were present in 0%, 37.50%, 30.77%, 12.44% subjects producing less than 1, 1-10, 11-100, more than 100 units per day respectively. Moderate asthenopic symptoms were present in 0%, 5%, 11.54%, 5.18% subjects producing less than 1, 1-10, 11-100, more than 100 units per day respectively. Severe asthenopic symptoms were present in 0%, 5%, 0%, 12.95% subjects producing less than 1, 1-10, 11-100, more than 100 units per day respectively.

4.7.8 Relation of Blinking or Eye Rest Frequency during Work and Asthenopic Symptoms (N=287)

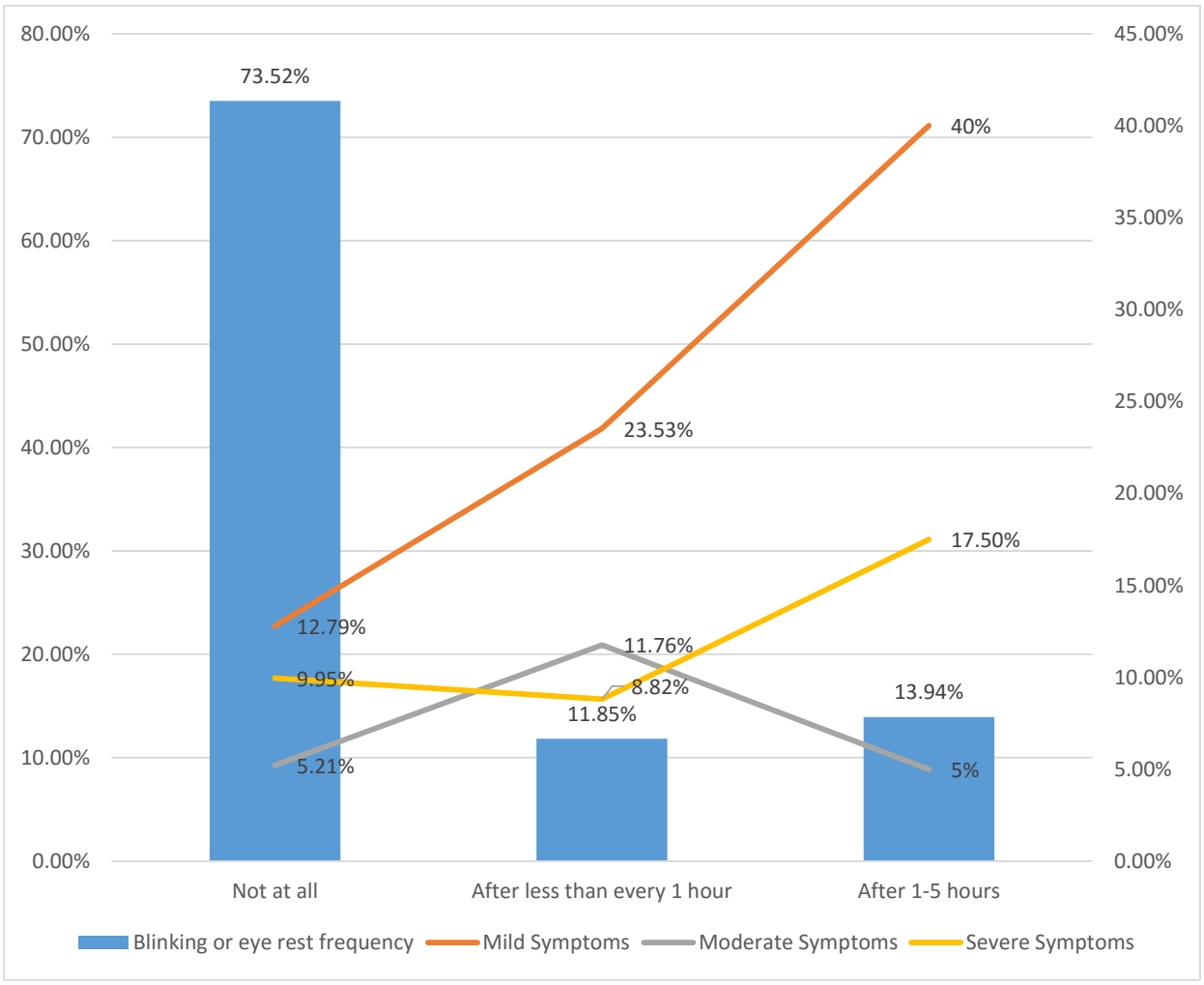

Fig 4.7.8: Relation of Blinking or Eye Rest Frequency during Work and Asthenopic Symptoms (N=287)

Approximately 73.52%, 11.85%, 13.94% of the subjects blinked or took rest for eyes not at all, after less than 1 hour, after 1-5 hour respectively. Mild asthenopia was present in 12.79%, 23.53%, 40% of the subjects who blinked or took rest for eyes not at all, after less than 1 hour, after 1-5 hour respectively. Moderate asthenopia was present in 5.21%, 11.76%, 5% of the subjects who blinked or took rest for eyes not at all, after less than 1 hour, after 1-5 hour respectively. Severe asthenopia was present in 9.95%, 8.82%, 17.50% of the subjects who blinked or took rest for eyes not at all, after less than 1 hour, after 1-5 hour respectively.

4.7.9 Relation of Duration of Working at a Stretch and Asthenopic Symptoms (N=287)

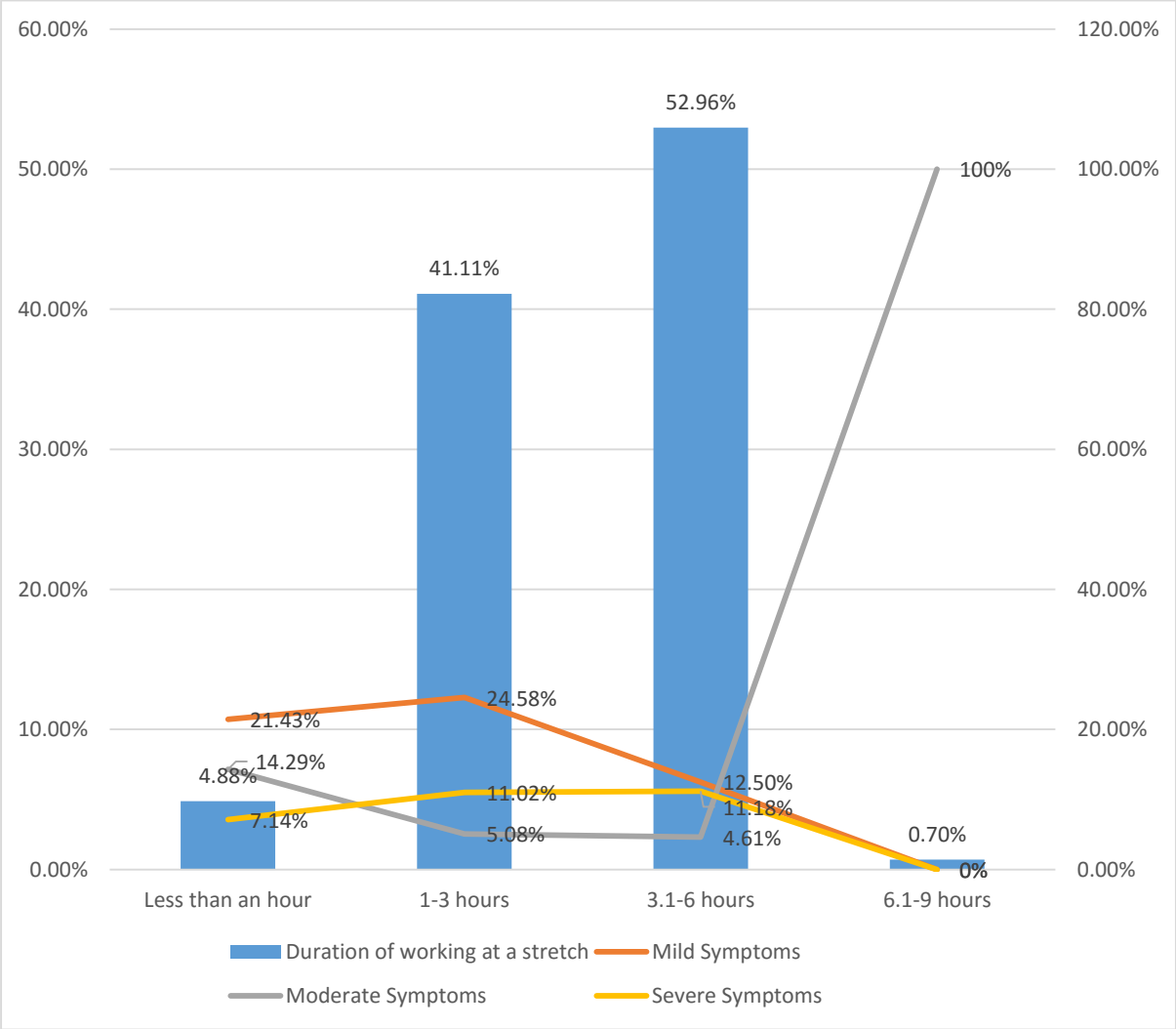

Fig 4.7.9: Relation of Duration of Working at a Stretch and Asthenopic Symptoms (N=287)

Approximately 4.88%, 41.11%, 52.96%, 0.70% could work at a stretch for less than an hour, 1-3 hours, 3.1-6 hours, 6.1-9 hours respectively. Mild symptoms were present in 21.43%, 24.58%, 12.50%, 0% subjects who could work at a stretch for less than an hour, 1-3 hours, 3.1-6 hours, 6.1-9 hours respectively. Moderate symptoms were present in 14.29%, 5.08%, 4.61%, 100% subjects who could work at a stretch for less than an hour, 1-3 hours, 3.1-6 hours, 6.1-9 hours respectively. Severe symptoms were present in 7.14%, 11.02%, 52.96%, 0% subjects who could work at a stretch for less than an hour, 1-3 hours, 3.1-6 hours, 6.1-9 hours respectively.

4.7.10 Relation of Brightness of the Workplace and Asthenopic Symptoms (N=287)

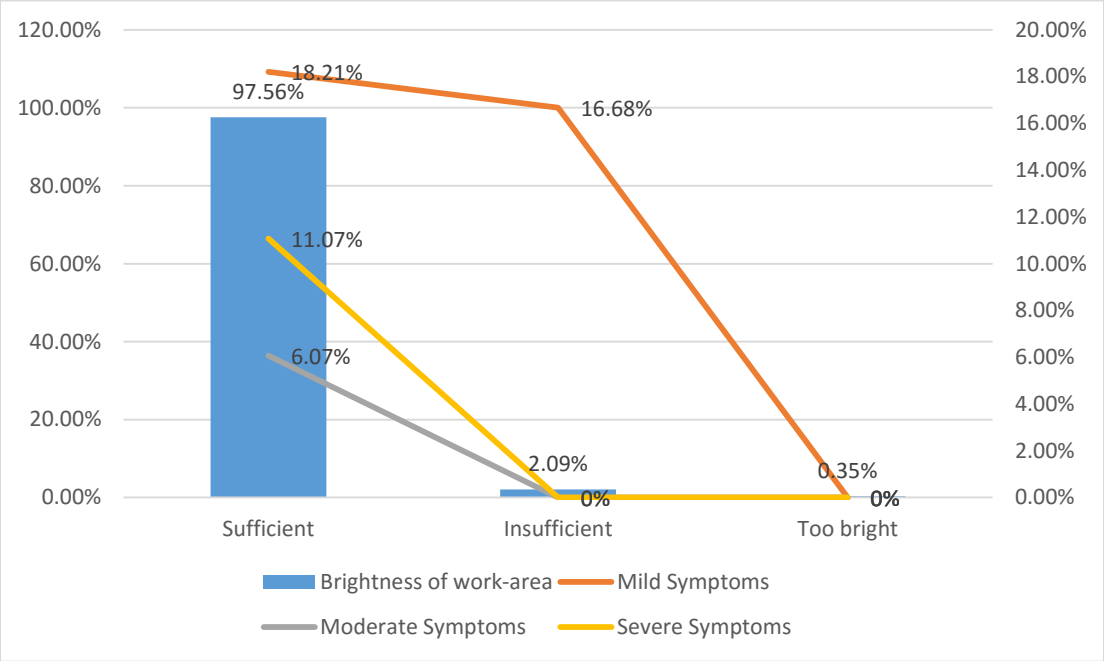

Fig 4.7.10: Relation of Brightness of the Workplace and Asthenopic Symptoms (N=287)

Approximately 97.56%, 2.09%, 0% worked in sufficient brightness, insufficient brightness and high brightness respectively. Mild symptoms were present in 18.21%, 16.68%, 0.35% of subjects who worked in sufficient brightness, insufficient brightness and high brightness respectively. Moderate symptoms were present in 6.07%, 0%, 0% of subjects who worked in sufficient brightness, insufficient brightness and high brightness respectively. Severe symptoms were present in 11.07%, 0%, 0% of subjects who worked in sufficient brightness, insufficient brightness and high brightness respectively.

4.7.11 Relation of Aeration of the Workplace and Asthenopic Symptoms (N=287)

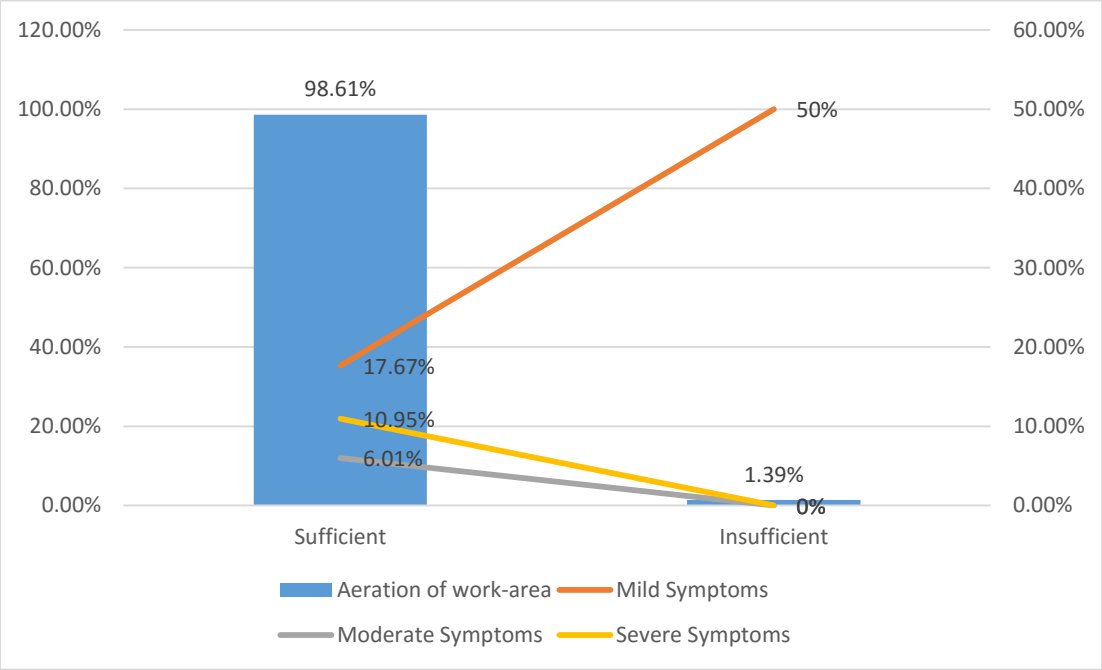

Fig 4.7.11: Relation of Aeration of the Workplace and Asthenopic Symptoms (N=287)

Approximately 98.61% and 1.39% of subjects worked in sufficient aeration and insufficient aeration respectively. Mild symptoms were present in 17.67% and 50% of subjects who worked in sufficient aeration and insufficient aeration respectively. Moderate symptoms were present in 6.01%% and 1.39% of subjects who work in sufficient aeration and insufficient aeration respectively. Severe symptoms were present in 10.95% and 1.39% of subjects who worked in sufficient aeration and insufficient aeration respectively.

4.7.12 Relation of Temperature of the Workplace and Asthenopic Symptoms (N=287)

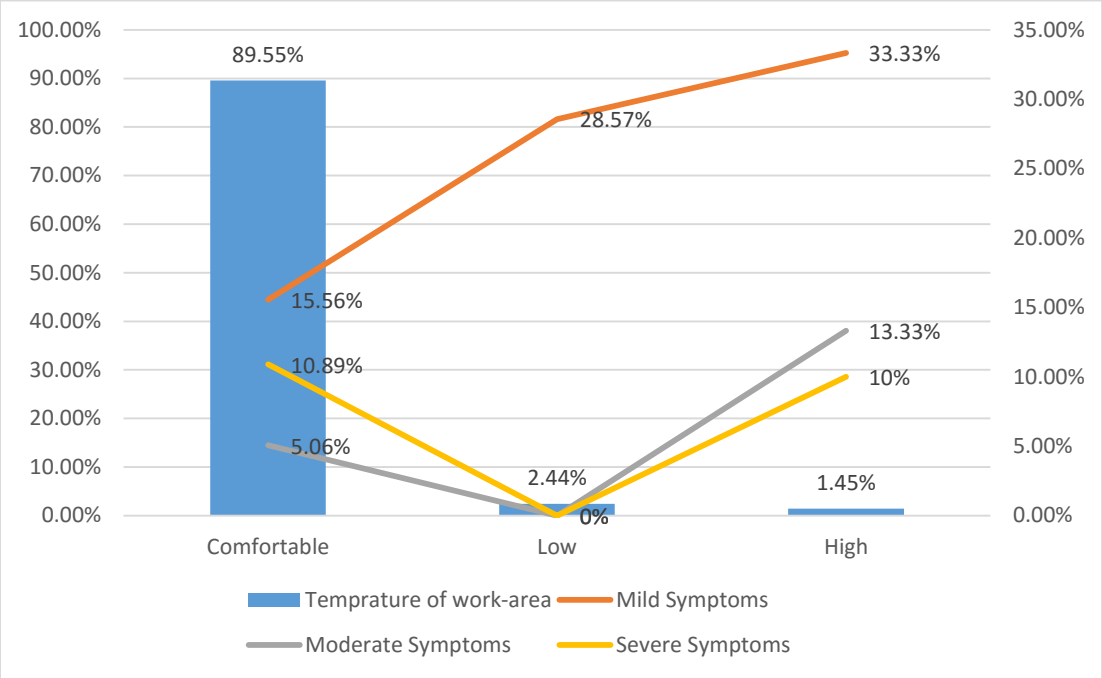

Fig 4.7.12: Relation of Temperature of the Workplace and Asthenopic Symptoms (N=287)

Approximately 89.55%, 2.44%, 1.45% worked in comfortable temperarature, low temperarature and high temperature. Mild symptoms were present in 15.56%, 28.57%, 33.33% of subjects who work in comfortable temperarature, low temperarature and high temperature. Moderate symptoms were present in 5.06%, 0%, 13.33% of subjects who worked in comfortable temperarature, low temperarature and high temperature. Severe symptoms were present in 10.89%, 2.44%, 10% of subjects who worked in comfortable temperarature, low temperarature and high temperature.

4.7.13 Relation of Noise of the Workplace and Asthenopic Symptoms (N=287)

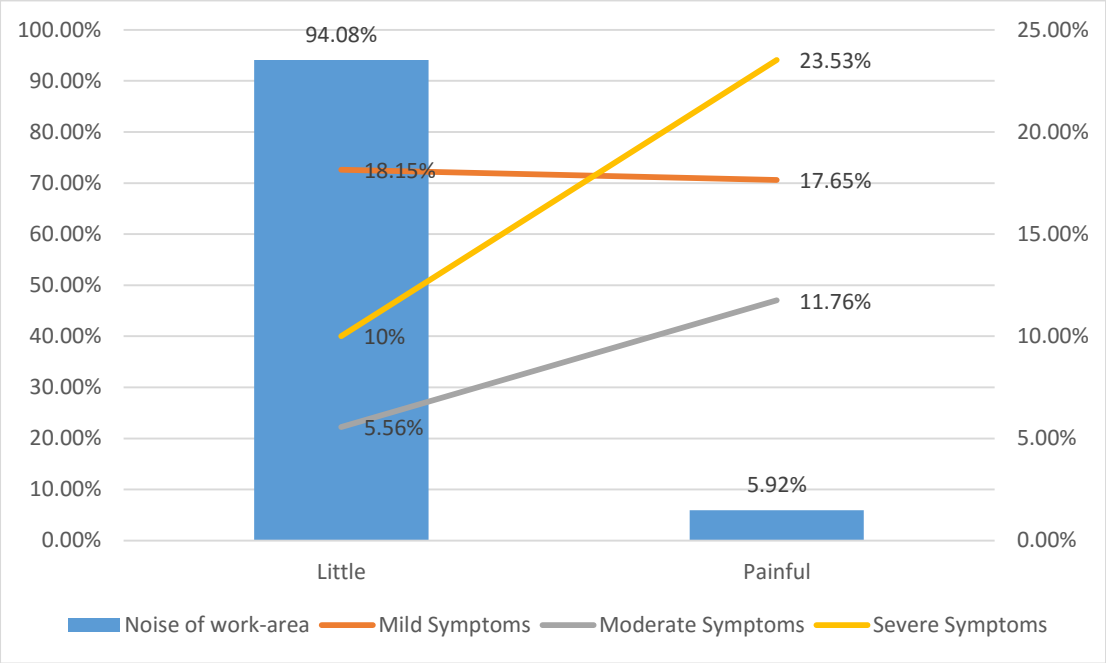

Fig 4.7.13: Relation of Noise of the Workplace and Asthenopic Symptoms (N=287)

Approximately 94.08% and 5.92% worked in little and painful noise respectively. Mild symptoms were present 18.15% and 17.65% subjects who worked in little and painful noise respectively. Moderate symptoms were present 5.56% and 11.76% subjects who worked in little and painful noise respectively. Severe symptoms were present 10% and 23.53% subjects who worked in little and painful noise respectively.

4.8 Psychology Associated Factors

4.8.1 Relation of Rest and Asthenopic Symptoms (N=287)

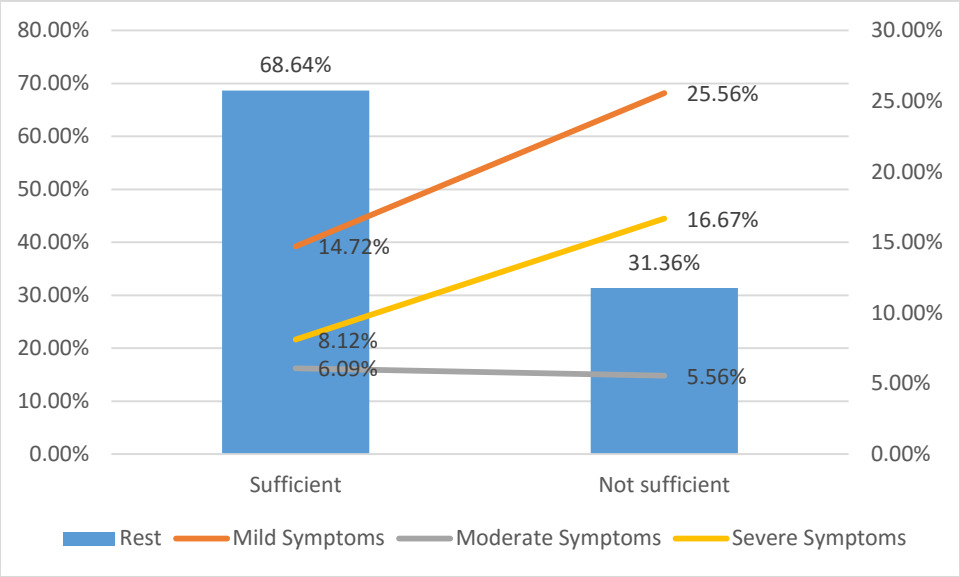

Fig 4.8.1: Relation of Rest and Asthenopic Symptoms (N=287)

Approximately 68.64% and 31.36% of workers got sufficient and insufficient rest respectively. Mild symptoms were present in 14.72% and 25.56% of the subjects who got sufficient and insufficient rest respectively. Moderate symptoms were present in 6.09% and 5.56% of the subjects who got sufficient and insufficient rest respectively. Severe symptoms were present in 8.12%% and 16.67% of the subjects who got sufficient and insufficient rest respectively.

4.8.2 Relation of Family Affair Stress and Asthenopic Symptoms (N=287)

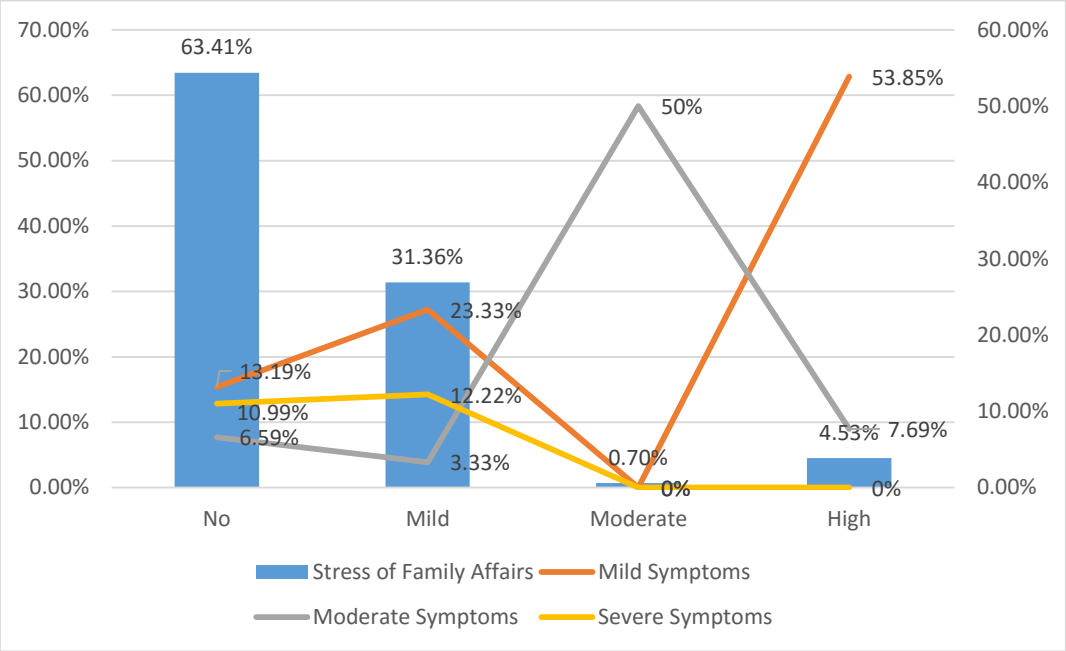

Fig 4.8.2: Relation of Family Stress and Asthenopic Symptoms (N=287)

Approximately 63.41%, 31.36%, 0.70%, 4.53% of subjects were not stressed with family affair, mildly stressed with family affair, moderately stressed with family affair, highly stressed with family affairs respectively. Mild asthenopia was present in 13.19%, 23.33%, 0%, 53.85% of subjects who were not stressed with family affair, mildly stressed with family affair, moderately stressed with family affair, highly stressed with family affairs respectively. Moderate asthenopia was present in 6.59%, 3.33%, 50%, 7.79% of subjects who were not stressed with family affair, mildly stressed with family affair, moderately stressed with family affair, highly stressed with family affairs respectively. Severe asthenopia was present in 10.99%, 12.22%, 0%, 0% of subjects who were not stressed with family affair, mildly stressed with family affair, moderately stressed with family affair, highly stressed with family affairs respectively.

4.8.3 Relation of Family Stress Frequency and Asthenopic Symptoms (N=287)

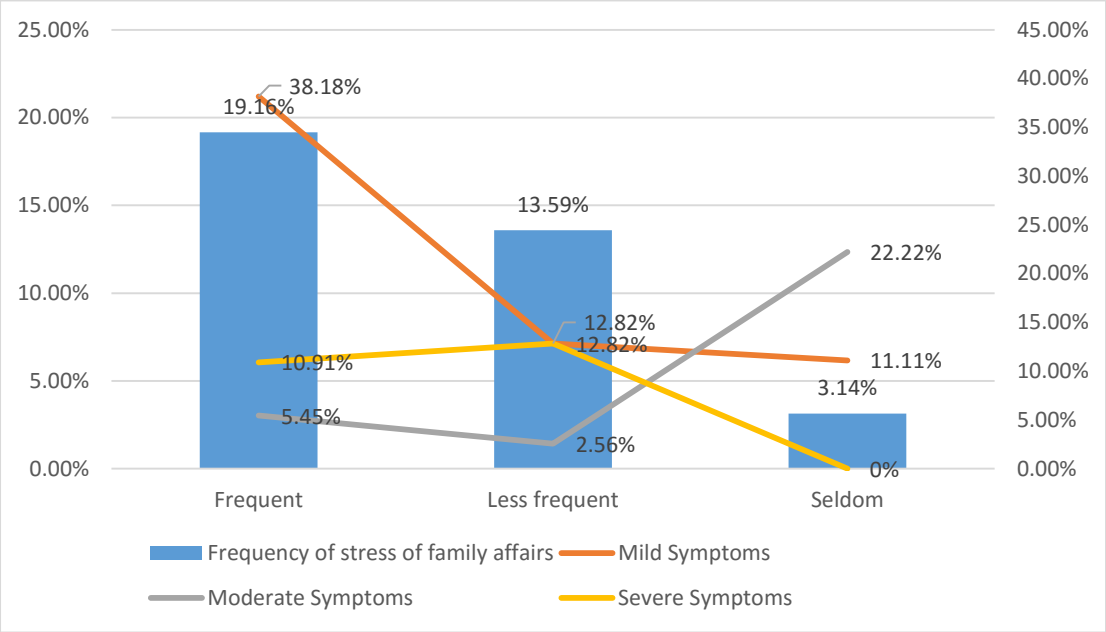

Fig 4.8.3: Relation of Family Stress Frequency and Asthenopic Symptoms (N=287)

Approximately 19.16%, 12.82%, 11.11% of the total stressed population were stressed with family affairs frequently, less frequently, seldom respectively. Mild symptoms were present in 38.18%, 12.82%, 11.11% of subjects who were stressed with family affairs frequently, less frequently, seldom respectively. Moderate symptoms were present in 5.45%, 2.56%, 22.22% of subjects who were stressed with family affairs frequently, less frequently, seldom respectively. Severe symptoms were present in 10.91%, 12.82%, 0% of subjects who were stressed with family affairs frequently, less frequently, seldom respectively.

4.8.4 Relation of Stress of Household Chores and Asthenopic Symptoms (N=287)

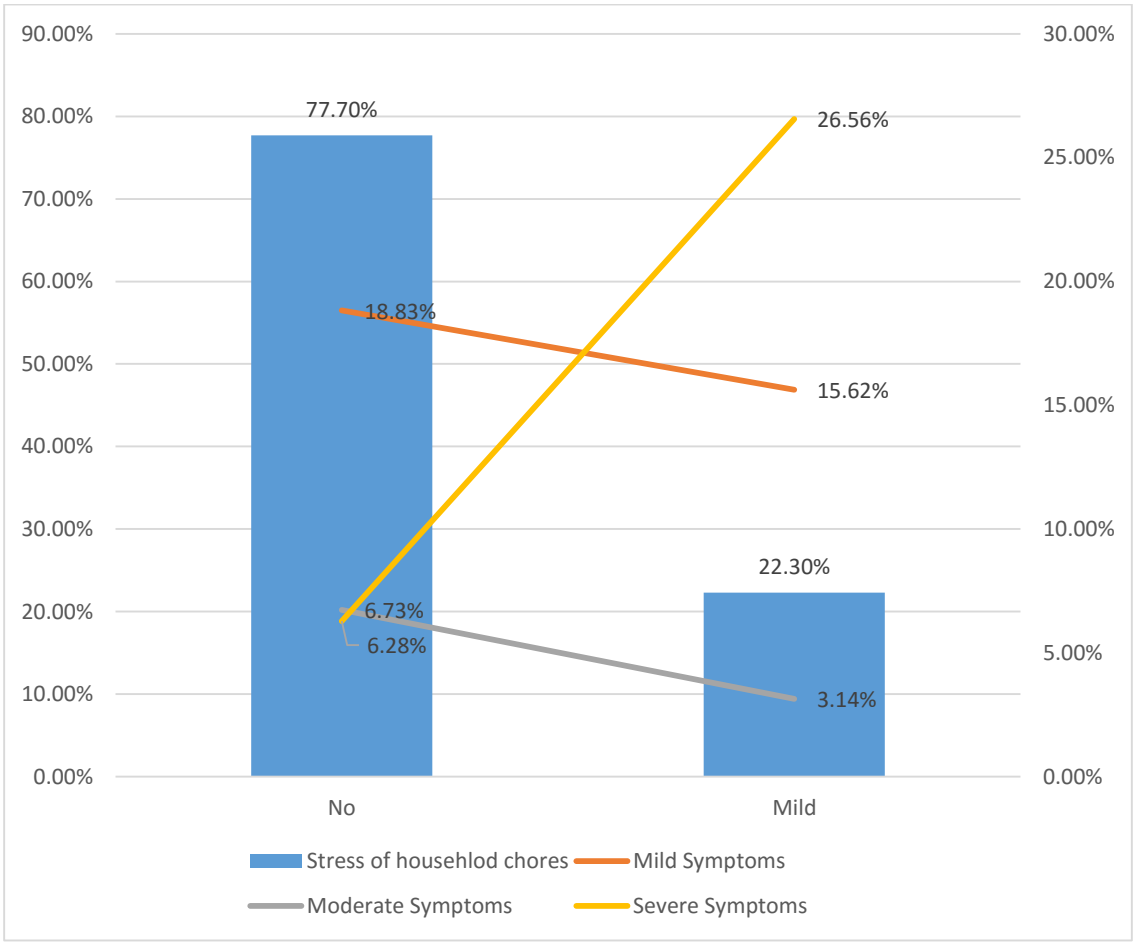

Fig 4.8.4: Relation of Stress of Household Chores and Asthenopic Symptoms (N=287)

Approximately 77.70% and 22.30% were not stressed with household chores and mildly stressed with household chores respectively. Mild symptoms were present in 18.83% and 15.62% of subjects who were not stressed with household chores and mildly stressed with household chores respectively. Moderate symptoms were present in 6.73% and 3.14% of subjects who were not stressed with household chores and mildly stressed with household chores respectively. Severe symptoms were present in 6.28% and 26.56% of subjects who were not stressed with household chores and mildly stressed with household chores respectively.

4.8.5 Relation of Work-stress and Asthenopic Symptoms (N=287)

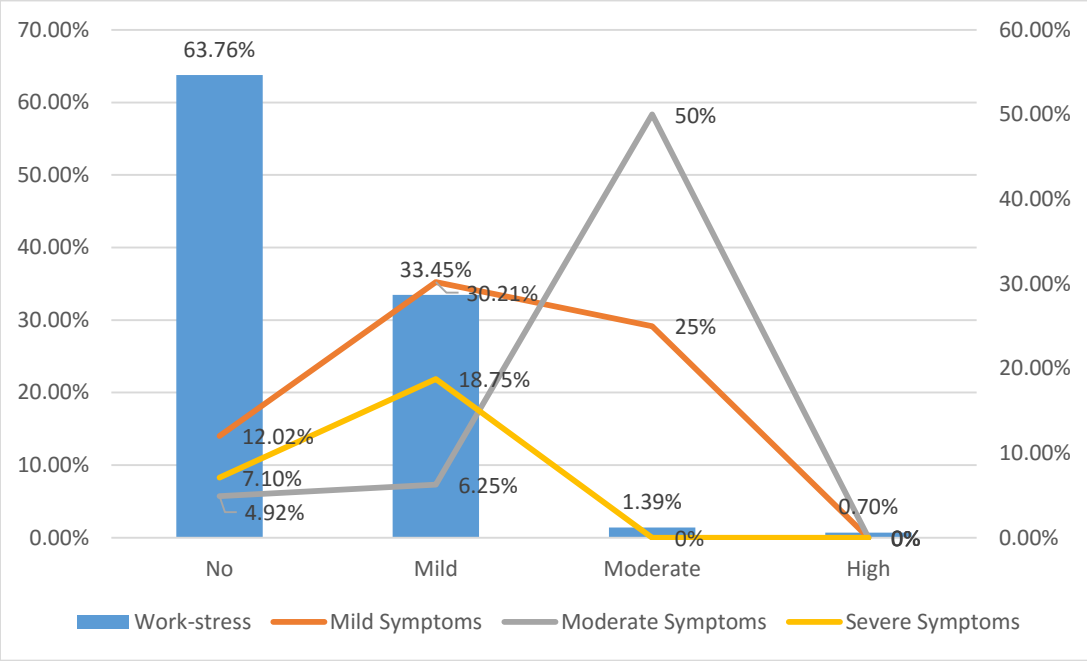

Fig 4.8.5: Relation of Work-stress and Asthenopic Symptoms (N=287)

Approximately 63.76%, 33.45%, 1.39% and 0.70% were not stressed with work, mildly stressed with work, moderately stressed with work and highly stressed with work respectively. Mild symptoms were present in 12.02%, 30.21%, 25%, 0.70% subjects who were not stressed with work, mildly stressed with work, moderately stressed with work, highly stressed with work respectively. Moderately symptoms were present in 4.92%, 6.25%, 50%, 0.70% subjects who were not stressed with work, mildly stressed with work, moderately stressed with work, highly stressed with work respectively. Severe symptoms were present in 7.10%, 18.75%, 0%, 0% subjects who were not stressed with work, mildly stressed with work, moderately stressed with work, highly stressed with work respectively.

4.9 Computer Associated Factors for Computer Vision Syndrome

4.9.1 Relation of Viewing Distance from Screen and Asthenopic Symptoms(N=32)

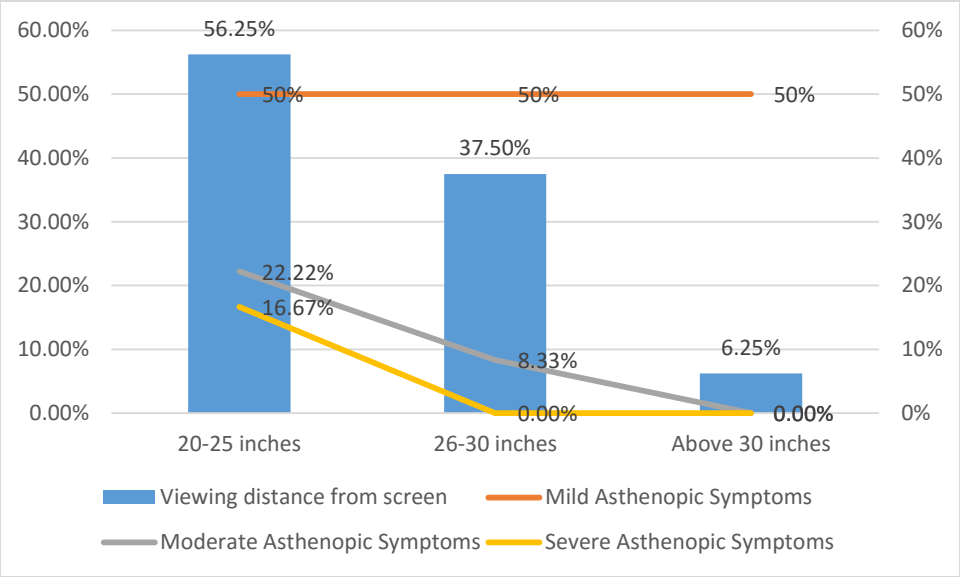

Fig 4.9.1: Relation of Viewing Distance from Screen and Asthenopic Symptoms (N=32)

Approximately 56.25%, 37.50%, 6.25% of the computer operators had viewing distance from screen 20-25 inches, 26-30 inches, above 30 inches respectively. Mild symptoms were present in 50% of each the computer operators who had viewing distance from screen 20-25 inches, 26-30 inches, above 30 inches respectively. Moderate symptoms were present in 22.22%, 8.33%, 0% of the computer operators who had viewing distance from screen 20-25 inches, 26-30 inches, above 30 inches respectively. Severe symptoms were present in 16.67%, 0%, 0% of the computer operators who had viewing distance from screen 20-25 inches, 26-30 inches, above 30 inches respectively.

4.9.2 Relation of Viewing Distance from Screen and Extraocular Symptoms (N=32)

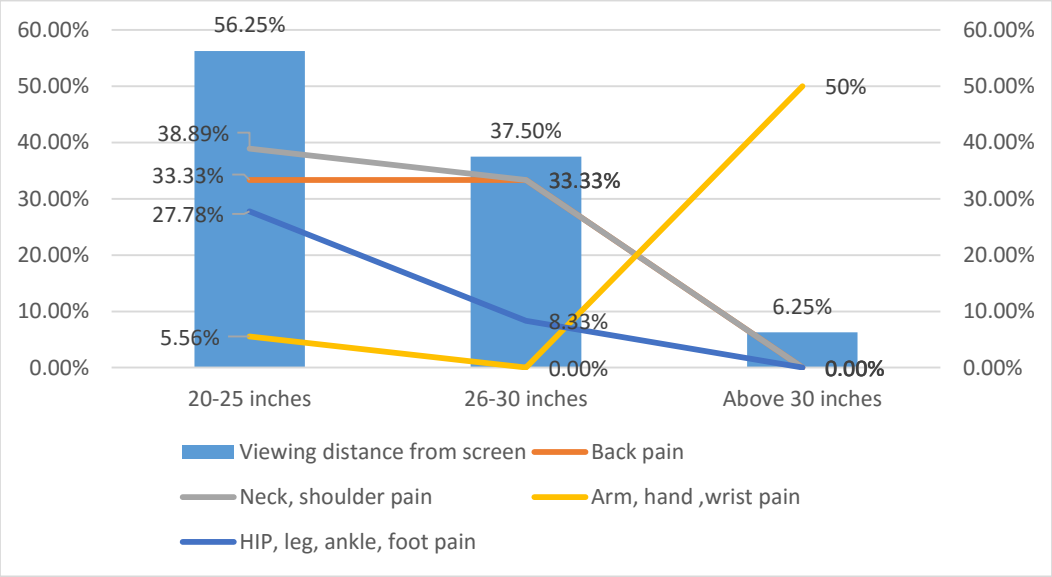

Fig 4.9.2: Relation of Viewing Distance from Screen and Extraocular Symptoms (N=32)

Back pain was present in 33.33%, 33.33%, 0% of the computer operators who had viewing distance from screen 20-25 inches, 26-30 inches, above 30 inches respectively. Neck and shoulder pain was present in 33.33%, 33.33%, 0% of the computer operators who had viewing distance from screen 20-25 inches, 26-30 inches, above 30 inches respectively. Arms, hands and wrist pain was present in 5.56%, 0%, 50% of the computer operators who had viewing distance from screen 20-25 inches, 26-30 inches, above 30 inches respectively. Hip, leg, asnkle and foot pain was present in 5.56%, 0%, 50% of the computer operators who had viewing distance from screen 20-25 inches, 26-30 inches, above 30 inches respectively.

4.9.3 Relation of Viewing Distance from Keyboard and Asthenopic Symptoms (N=32)

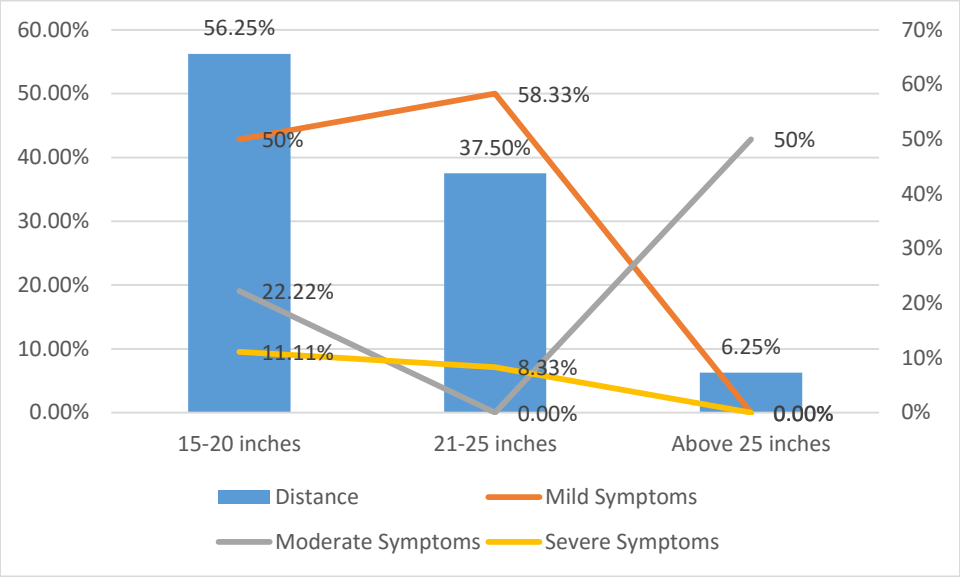

Fig 4.9.3: Relation of Viewing Distance from Keyboard and Asthenopic Symptoms (N=32)

Approximately 56.25%, 58.33%, 6.25% of the computer operators had viewing distance from keyboard 15-20 inches, 21-25 inches, above 25 inches respectively. Mild symptoms were present in 50%, 58.33%, 0% of the computer operators who had viewing distance from keyboard 15-20 inches, 21-25 inches, above 25 inches respectively. Moderate symptoms were present in 22.22%, 0%, 50% of the computer operators who had viewing distance from keyboard 15-20 inches, 21-25 inches, above 25 inches respectively. Severe symptoms were present in 56.25%, 37.50%, 0% of the computer operators who had viewing distance from keyboard 15-20 inches, 21-25 inches, above 25 inches respectively.

4.9.4 Relation of Viewing Distance from Keyboard and Extraocular Symptoms (N=32)

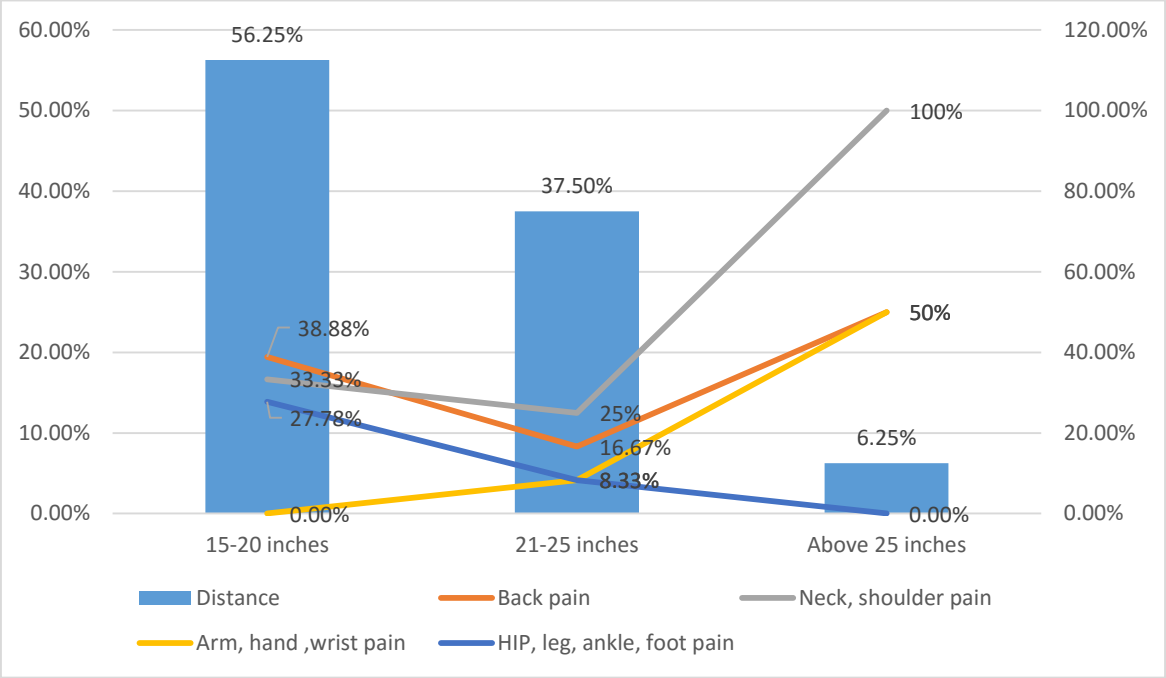

Fig 4.9.4: Relation of Viewing Distance from Keyboard and Extraocular Symptoms (N=32)

Back pain was present in 38.88%, 16.67%, 50% of the computer operators who had viewing distance from keyboard 15-20 inches, 21-25 inches, above 25 inches respectively. Neck and shoulder pain was present in 33.33%, 25%, 100% of the computer operators who had viewing distance from keyboard 15-20 inches, 21-25 inches, above 25 inches respectively. Arms, hands and wrist pain was present in 0%, 8.33%, 50% of the computer operators who had viewing distance from keyboard 15-20 inches, 21-25 inches, above 25 inches respectively. Hip, leg, ankle and foot pain was present in 27.78%, 8.33%, 0% of the computer operators who had viewing distance from keyboard 15-20 inches, 21-25 inches, above 25 inches respectively.

4.9.5 Relation of Center of the Monitor and Asthenopic Symptoms (N=32)

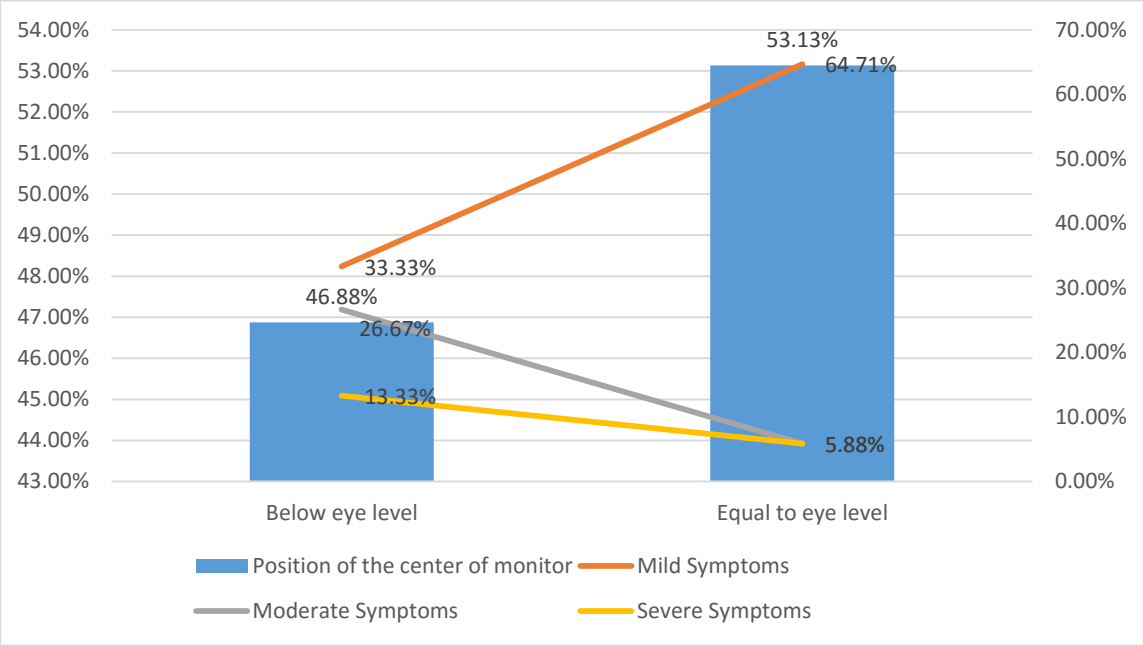

Fig 4.9.5: Relation of Center of the Monitor and Asthenopic Symptoms (N=32)

Approximately 46.88% and 53.13% of computer operators had center of the monitor below and equal to eye level respectively. Mild symptoms were present in 33.33% and 53.13% of the computer operators who had center of the monitor below and equal to eye level respectively. Moderate symptoms were present in 26.67% and 5.88% of the computer operators who had center of the monitor below and equal to eye level respectively. Severe symptoms were present in 13.33% and 5.88% of the computer operators who had center of the monitor below and equal to eye level respectively.

4.9.6 Relation of Center of the Monitor and Extraocular Symptoms (N=32)

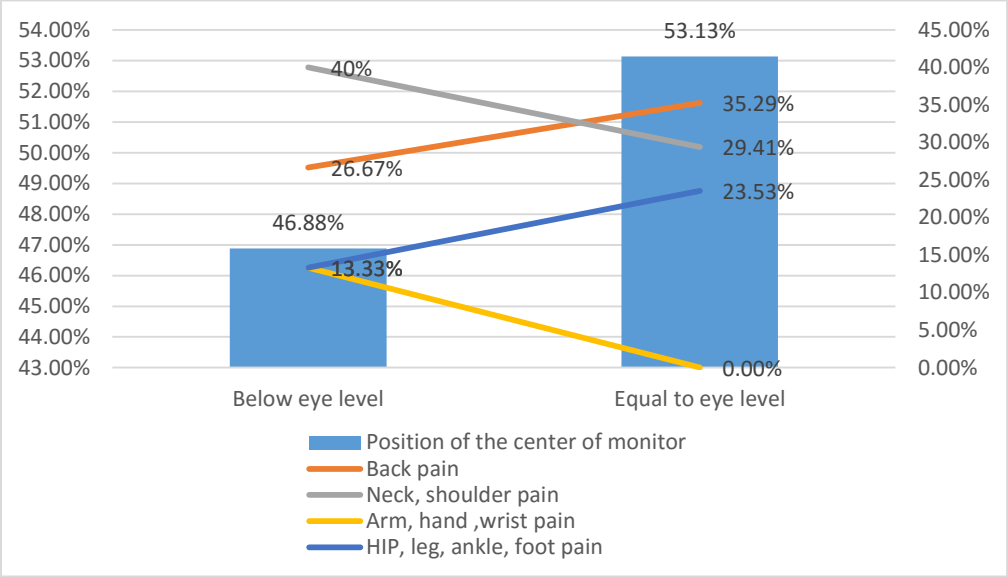

Fig 4.9.6: Relation of Center of the Monitor and Extraocular Symptoms (N=32)

Back pain was present in 26.67% and 35.29% of the computer operators who had center of the monitor below and equal eye level respectively. Neck and shoulder pain was present in 40% and 29.41% of the computer operators who had center of the monitor below and equal to eye level respectively. Arms, hands and wrist pain was present in 13.33% and 0% of the computer operators who had center of the monitor below and above eye level respectively. Hip, leg, ankle and foot pain was present in 13.33% and 23.53% of the computer operators who had center of the monitor below and equal to eye level respectively.

4.9.7 Relation of Use of Computer at Home and Asthenopic Symptoms (N=32)

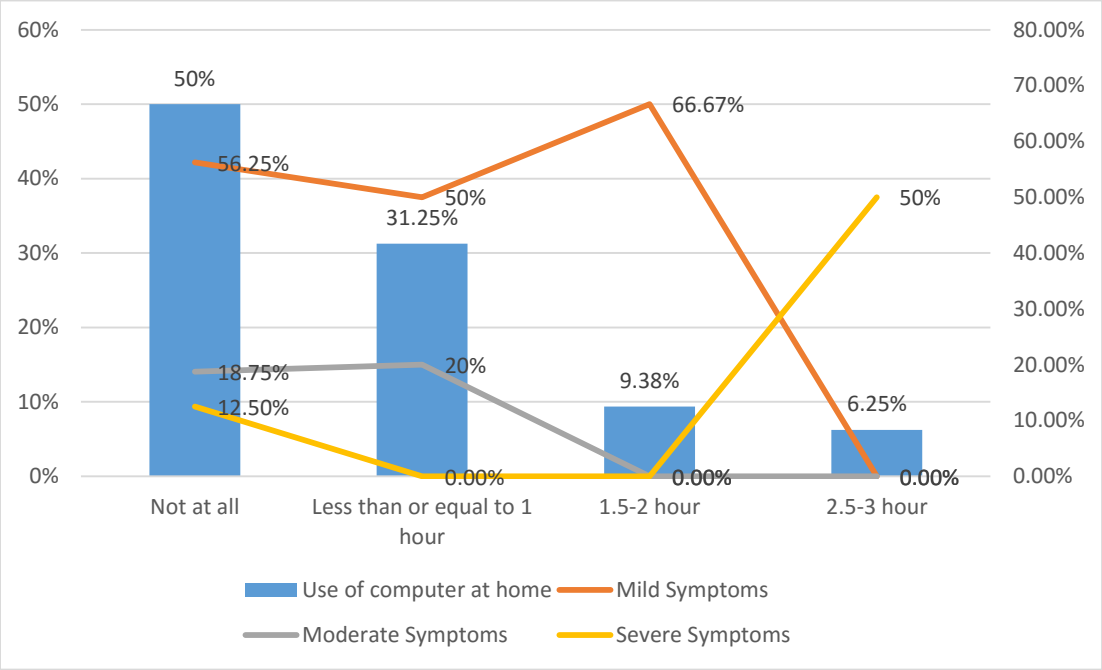

Fig 4.9.7: Relation of Use of Computer at Home and Asthenopic Symptoms (N=32)

Approximately 50%, 31.25%, 9.38%, 6.25% of the computer operators did not use computer at home, used computer at home for less than or equal to 1 hour, 1.5-2 hour, 2.5-3 hour respectively. Mild symptoms were present in 56.25%, 50%, 66.67%, 0% of the computer operators who did not use computer at home, used computer at home for less than or equal to 1 hour, 1.5-2 hour, 2.5-3 hour respectively. Moderate symptoms were present in 18.75%, 31.25%, 0%, 0% of the computer operators who did not use computer at home, used computer at home for less than or equal to 1 hour, 1.5-2 hour, 2.5-3 hour respectively. Severe symptoms were present in 12.50%, 0%, 0%, 50% of the computer operators who did not use computer at home, used computer at home for less than or equal to 1 hour, 1.5-2 hour, 2.5-3 hour respectively.

4.9.8 Relation of Use of Computer at Home and Extraocular Symptoms (N=32)

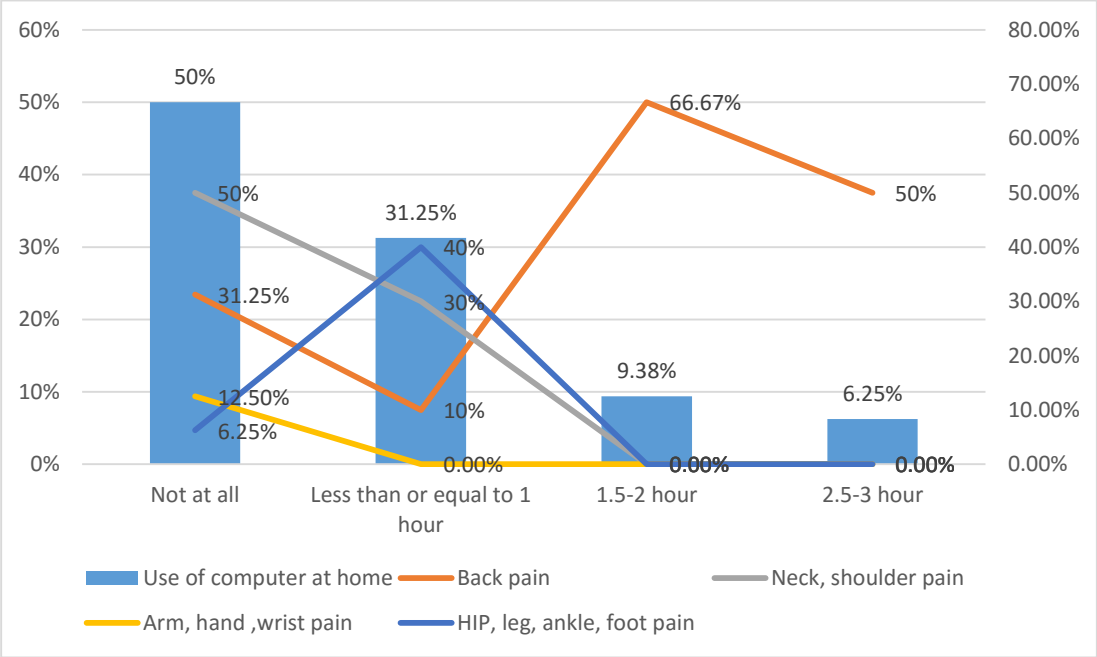

Fig 4.9.8: Relation of Use of Computer at Home and Extraocular Symptoms (N=32)

Back pain was present in 31.25%, 10%, 66.67%, 50% of the computer operators who did not use computer at home, used computer at home for less than or equal to 1 hour, 1.5-2 hour, 2.5-3 hour respectively. Neck and shoulder pain was present in 50%, 30%, 0%, 0% of the computer operators who did not use computer at home, used computer at home for less than or equal to 1 hour, 1.5-2 hour, 2.5-3 hour respectively. Arms, hands and wrist pain was present in 50%, 0%, 0%, 0% of the computer operators who did not use computer at home, used computer at home for less than or equal to 1 hour, 1.5-2 hour, 2.5-3 hour respectively. Hip, leg, ankle and foot pain was present in 6.25%, 40%, 0%, 0% of the computer operators who did not use computer at home, used computer at home for less than or equal to 1 hour, 1.5-2 hour, 2.5-3 hour respectively.

4.9.9 Relation of Height of Chair and Extraocular Symptoms (N=32)

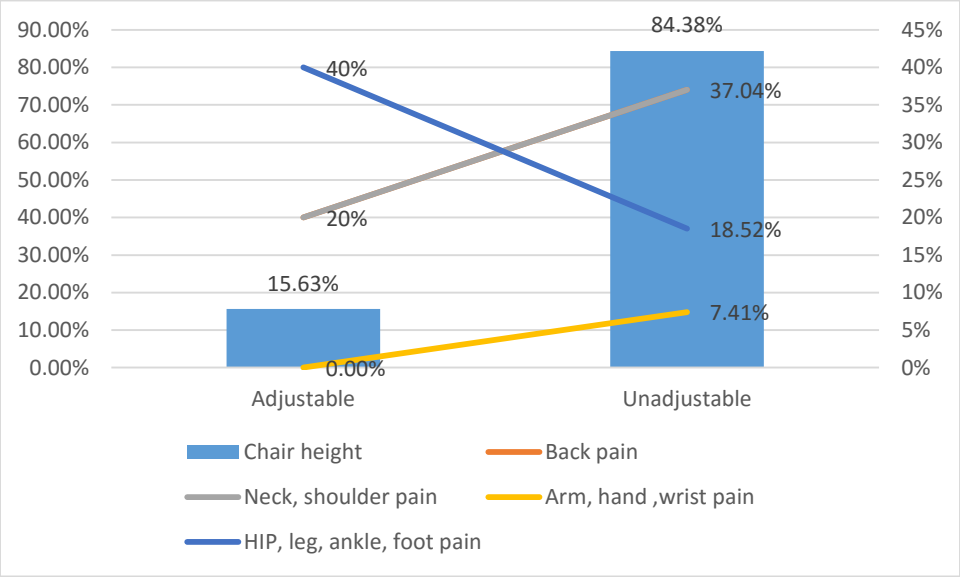

Fig 4.9.8: Relation of Height of Chair and Extraocular Symptoms (N=32)

Approximately 15.63% and 37.04% of the computer operators had chair with adjustable and unadjustable height respectively. Back pain was present in 20% and 37.04% of the computer operators who had adjustable and unadjustable height of chair respectively. Neck and shoulder pain was present in 20% and 37.04% of the computer operators who had adjustable and unadjustable height of chair respectively. Arms, hands and wrist pain was present in 0% and 7.41% of the computer operators who had adjustable and unadjustable height of chair respectively. Hip, leg, ankle and foot pain was present in 40% and 18.25% of the computer operators who had adjustable and unadjustable height of chair respectively.

4.9.10 Relation of Backrest of Chair and Extraocular Symptoms (N=32)

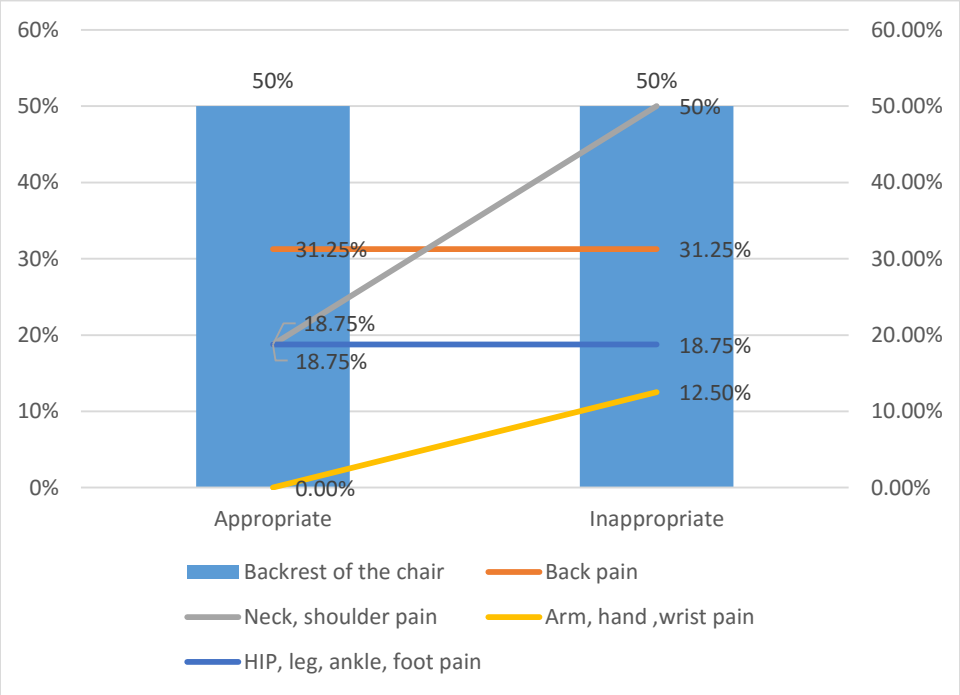

Fig 4.9.10: Relation of Backrest of Chair and Extraocular Symptoms (N=32)

Approximately 50% and 50% of the computer operators had appropriate and inappropriate backrest of chair respectively. Back pain was present in 31.25% and 31.25% of the computer operators who had appropriate and inappropriate backrest of chair respectively. Neck and shoulder pain was present in 18.75% and 50% of the computer operators who had appropriate and inappropriate backrest of chair respectively. Arms, hands and wrist pain was present in 0% and 12.50% of the computer operators who had appropriate and inappropriate backrest of chair respectively. Hip, leg, ankle and foot pain was present in 18.75% and 18.75% of the computer operators who had appropriate and inappropriate backrest of chair respectively.

4.9.11 Relation of Space at desk and Extraocular Symptoms (N=32)

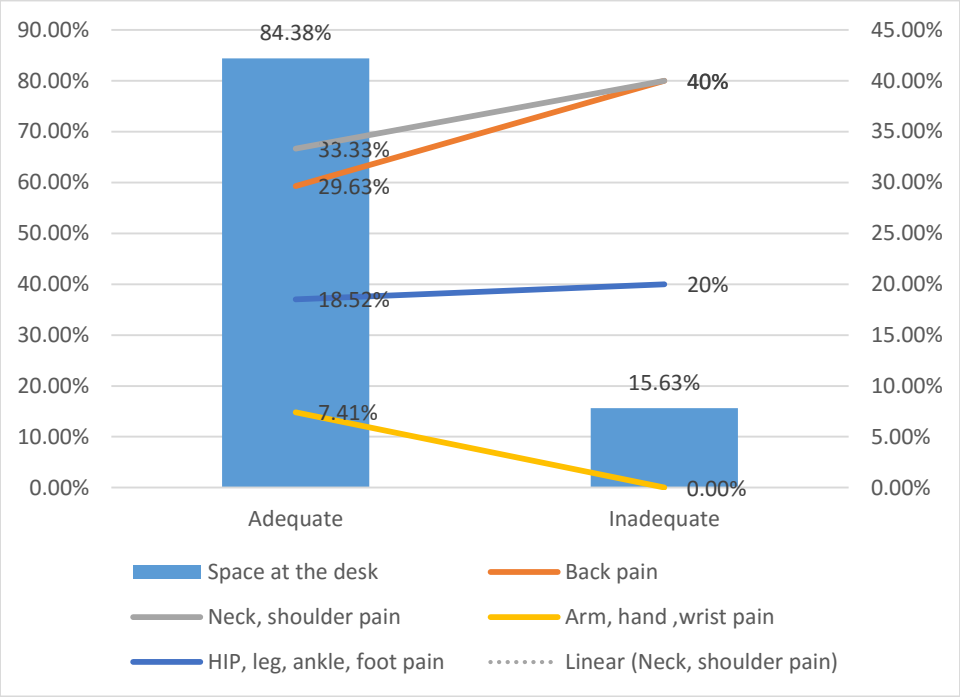

Fig 4.9.11: Relation of Space at desk and Extraocular Symptoms (N=32)

Approximately 84.38% and 15.63% of the computer operators had adequate and inadequate space at desk respectively. Back pain was present in 29.63% and 40% of the computer operators who have adequate and inadequate space at desk respectively. Neck and shoulder pain was present in 33.33% and 40% of the computer operators who had adequate and inadequate space at desk respectively. Arms, hands and wrist pain was present in 7.41% and 0% of the computer operators who had adequate and inadequate space at desk respectively. Hip, leg, ankle and foot pain was present in 18.52% and 20% of the computer operators who had adequate and inadequate space at desk respectively.

4.9.12 Relation of Space of Seat Pan and Extraocular Symptoms (N=32)

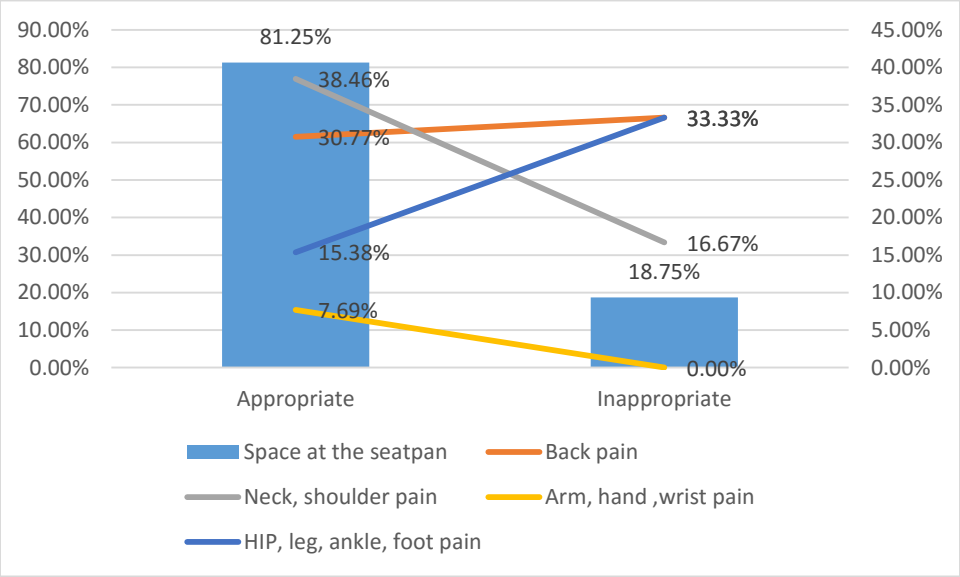

Fig 4.9.12: Relation of Space of Seat Pan and Extraocular Symptoms (N=32)

Approximately 81.25% and 18.75% of the computer operators had appropriate and inappropriate space of seat pan respectively. Back pain was present in 30.77% and 33.33% of the computer operators who had appropriate and inappropriate space of seat pan respectively. Neck and shoulder pain was present in 38.46% and 16.67% of the computer operators who had appropriate and inappropriate space of seat pan respectively. Arms, hands and wrist pain was present in 7.69% and 0% of the computer operators who had appropriate and inappropriate space of seat pan respectively. Hip, leg, ankle and foot pain was present in 15.38% and 33.33% of the computer operators who had appropriate and inappropriate space of seat pan respectively.

4.9.13 Relation of Age and Extraocular Symptoms (N=32)

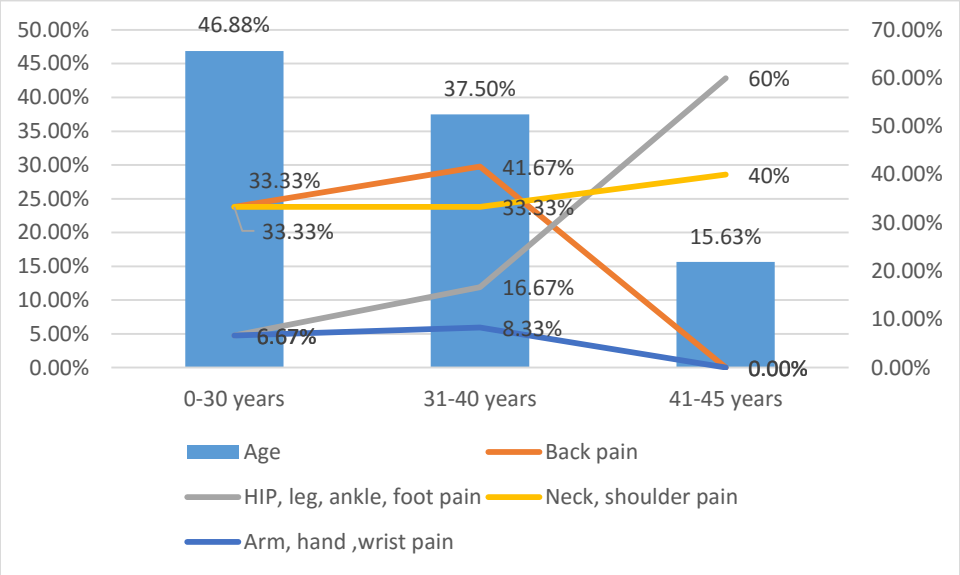

Fig 4.9.13: Relation of Age and Extraocular Symptoms (N=32)

Approximately 46.88%, 37.50% and 15.63% of the computer operators were aged 0-30 years, 31-40 years and 41-45 years respectively. Back pain was present in 33.33%, 41.67% and 0% of the computer operators who were aged 0-30 years, 31-40 years and 41-45 years respectively. Neck and shoulder pain was present in 33.33%, 33.33% and 40% of the computer operators who were aged 0-30 years, 31-40 years and 41-45 years respectively. Arms, hands and wrist pain was present in 6.67%, 8.33% and 0% of the computer operators who were aged 0-30 years, 31-40 years and 41-45 years respectively. Hip, leg, ankle and foot pain was present in 6.67%, 16.67% and 60% of the computer operators who were aged 0-30 years, 31-40 years and 41-45 years respectively.

4.9.14 Relation of Number of Breaks and Extraocular Symptoms (N=32)

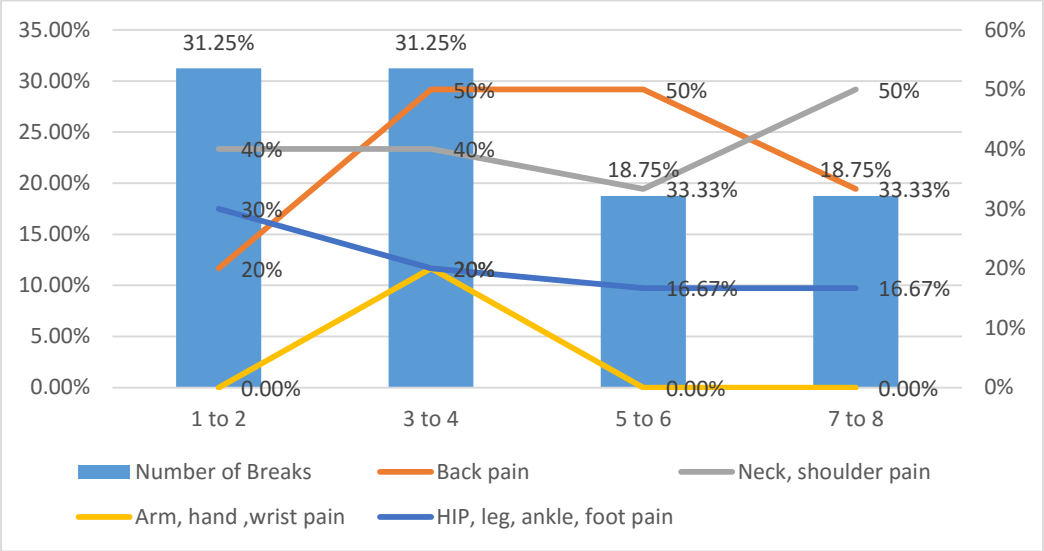

Fig 4.9.14: Relation of Number of Breaks and Extraocular Symptoms (N=32)

Approximately 31.25%, 31.25%, 18.75% and 18.75% of the computer operators had breaks 1-2 times, 3-4 times, 5-6 times, 7-8 times per day respectively. Back pain was present in 20%, 31.25%, 18.75%, and 18.75% of the computer operators who had breaks 1-2 times, 3-4 times, 5-6 times, 7-8 times respectively. Neck and shoulder pain was present in 20%, 31.25%, 18.75%, and 18.75% of the computer operators who had breaks 1-2 times, 3-4 times, 5-6 times, 7-8 times respectively. Arms, hands and wrist pain was present in 0%, 20%, 0%, and 0% of the computer operators who had breaks 1-2 times, 3-4 times, 5-6 times, 7-8 times respectively. Hip, leg, ankle and foot pain was present in 0%, 20%, 0%, and 0% of the computer operators who had breaks 1-2 times, 3-4 times, 5-6 times, 7-8 times respectively.

4.9.15 Relation of Duartion of Breaks and Extraocular Symptoms (N=32)

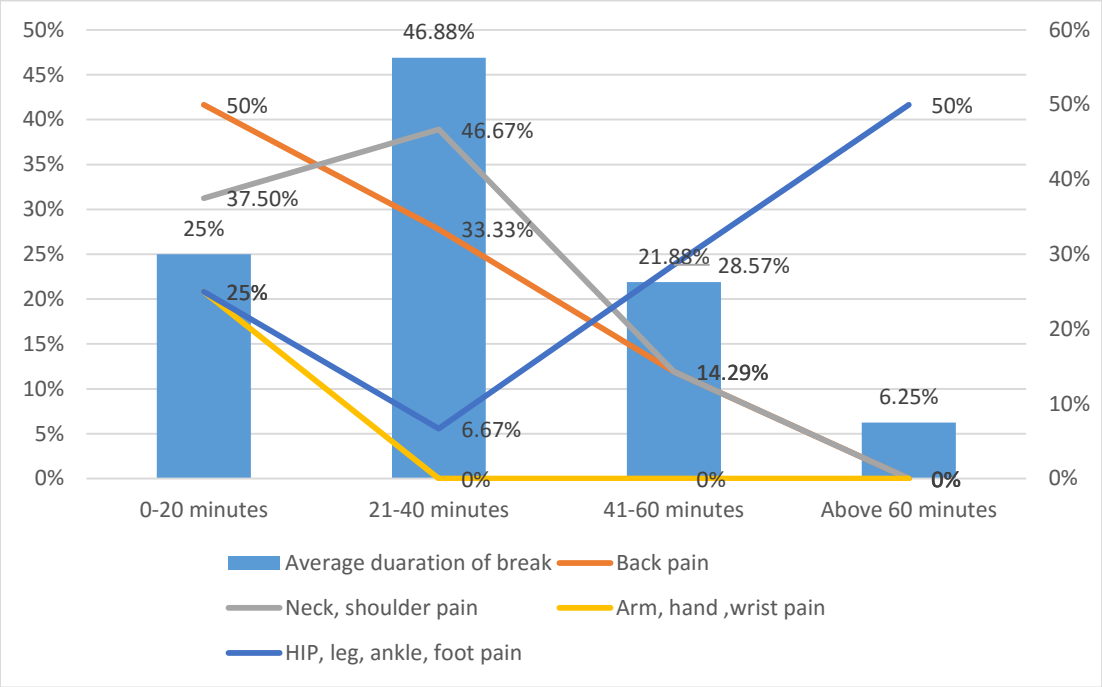

Fig 4.9.15: Relation of Duartion of Breaks and Extraocular Symptoms (N=32)

Approximately 25%, 46.88%, 21.88%, 6.25% of computer operators had durations of breaks 0-20 minutes, 21-40 minutes, 41-60 minutes, above 60 minutes respectively. Back pain was present in 50%, 33.33%, 14.29% and 0% of computer operators who had durations of breaks 0-20 minutes, 21-40 minutes, 41-60 minutes, above 60 minutes respectively. Neck and shoulder pain was present in 37.5%, 46.67%, 14.29% and 0% of computer operators who had durations of breaks 0-20 minutes, 21-40 minutes, 41-60 minutes, above 60 minutes respectively. Arms, hands and wrist pain was present in 25%, 0%, 0% and 0% of computer operators who had durations of breaks 0-20 minutes, 21-40 minutes, 41-60 minutes, above 60 minutes respectively. Hip, leg, ankle and foot pain was present in 25%, 6.67%, 28.57% and 50% of computer operators who had durations of breaks 0-20 minutes, 21-40 minutes, 41-60 minutes, above 60 minutes respectively.

4.9.16 Relation of Workdays and Extraocular Symptoms (N=32)

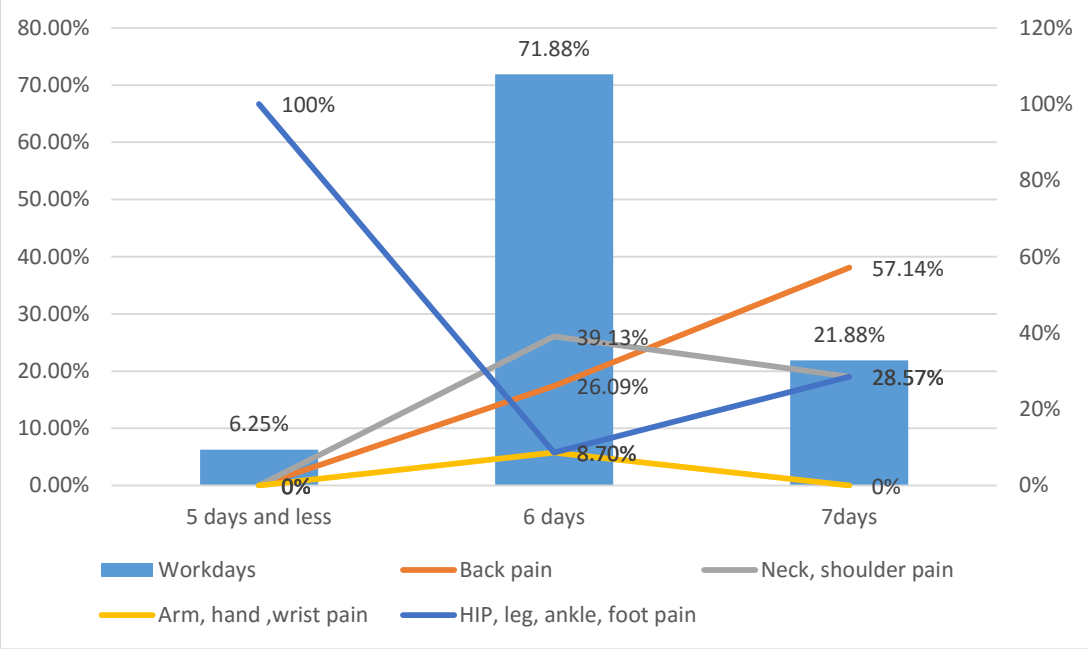

Fig 4.9.16: Relation of Workdays and Extraocular Symptoms (N=32)

Approximately 6.25%, 71.88%, 21.88% of the computer operators had workdays 5 days and less, 6 days, 7 days respectively. Back pain was present in 0%, 26.09%, 57.14% of the computer operators who had workdays 5 days and less, 6 days, 7 days respectively. Neck and shoulder pain was present in 0%, 39.13%, 28.57% of the computer operators who had workdays 5 days and less, 6 days, 7 days respectively. Arms, hands and wrist pain was present in 0%, 8.70%, 0% of the computer operators who had workdays 5 days and less, 6 days, 7 days respectively. Hip, leg, ankle and foot pain was present in 100%, 8.7%, 28.57% of the computer operators who had workdays 5 days and less, 6 days, 7 days respectively.

4.9.17 Relation of Work Experience and Extraocular Symptoms (N=32)

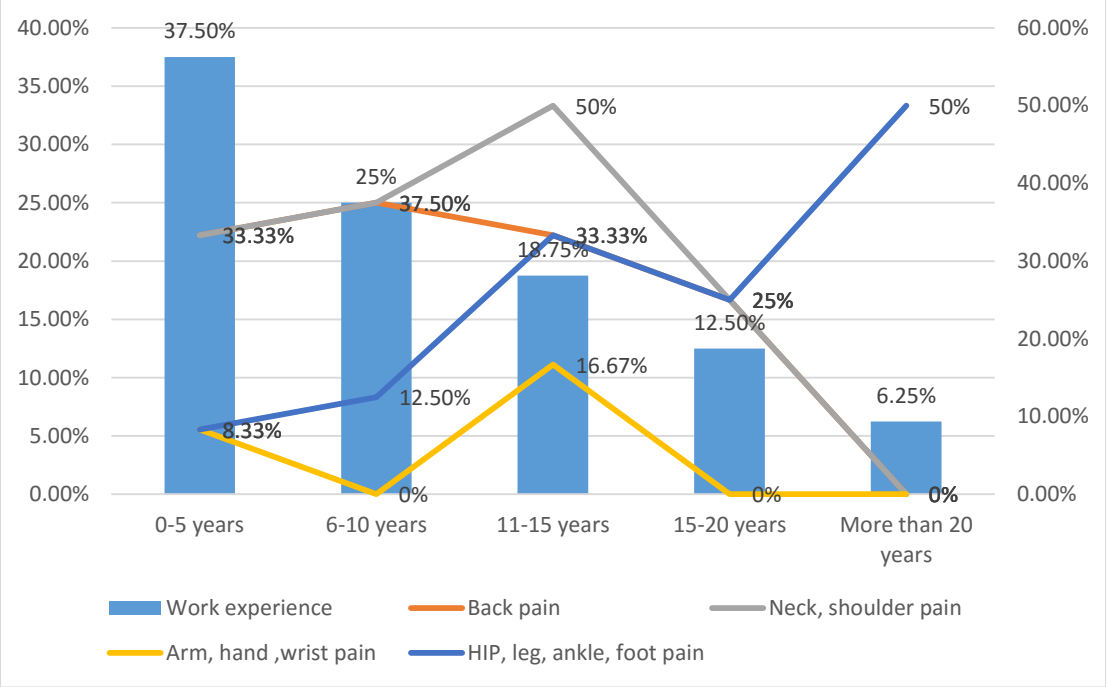

Fig 4.9.17: Relation of Work Experience and Extraocular Symptoms (N=32)

Approximately 37.50%, 25%, 18.75%, 12.50%, 6.25% of the computer operators had work experience 0-5 years, 6-10 years, 11-15 years, 15-20 years and more than 20 years respectively. Back pain was present in 33.33%, 37.50%, 33.33%, 25% and 0% of the computer operators having work experience 0-5 years, 6-10 years, 11-15 years, 15-20 years and more than 20 years respectively. Neck and shoulder pain was present in 33.33%, 37.50%, 50%, 25% and 0% of the computer operators having work experience 0-5 years, 6-10 years, 11-15 years, 15-20 years and more than 20 years respectively. Arms, hands and wrist pain was present 8.33%, 0%, 16.67%, 0% and 0% of the computer operators having work experience 0-5 years, 6-10 years, 11-15 years, 15-20 years and more than 20 years respectively. Back pain was present in 8.33%, 12.50%, 33.33%, 25% and 50% of the computer operators having work experience 0-5 years, 6-10 years, 11-15 years, 15-20 years and more than 20 years respectively.

4.9.18 Relation of Time Taken for Each Unit and Extraocular Symptoms (N=32)

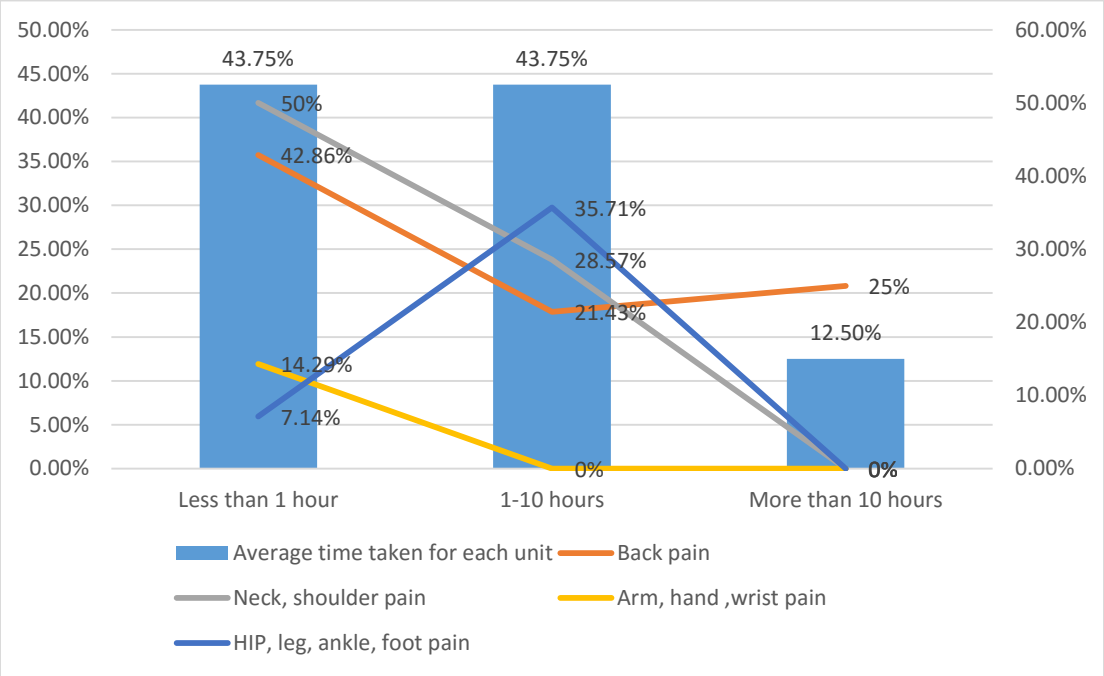

Fig 4.9.18: Relation of Time Taken for Each Unit and Extraocular Symptoms (N=32)

Approximately 43.75%, 43.75% and 12.50% of the computer operators took less than an hour, 1-10 hours, more than 10 hours to finish a unit respectively. Back pain was present in 42.86%, 21.43%, 25% of the computer operators who took less than an hour, 1-10 hours, more than 10 hours to finish a unit respectively. Neck and shoulder pain was present in 50%, 28.57%, 0% of the computer operators who took less than an hour, 1-10 hours, more than 10 hours to finish a unit respectively. Arms, hands and wrist pain was present in 14.29%, 0%, 0% of the computer operators who took less than an hour, 1-10 hours, more than 10 hours to finish a unit respectively. Hip, leg, ankle and foot pain was present in 7.14%, 35.71%, 0% of the computer operators who took less than an hour, 1-10 hours, more than 10 hours to finish a unit respectively.

4.9.19 Relation of Number of Units and Extraocular Symptoms (N=32)

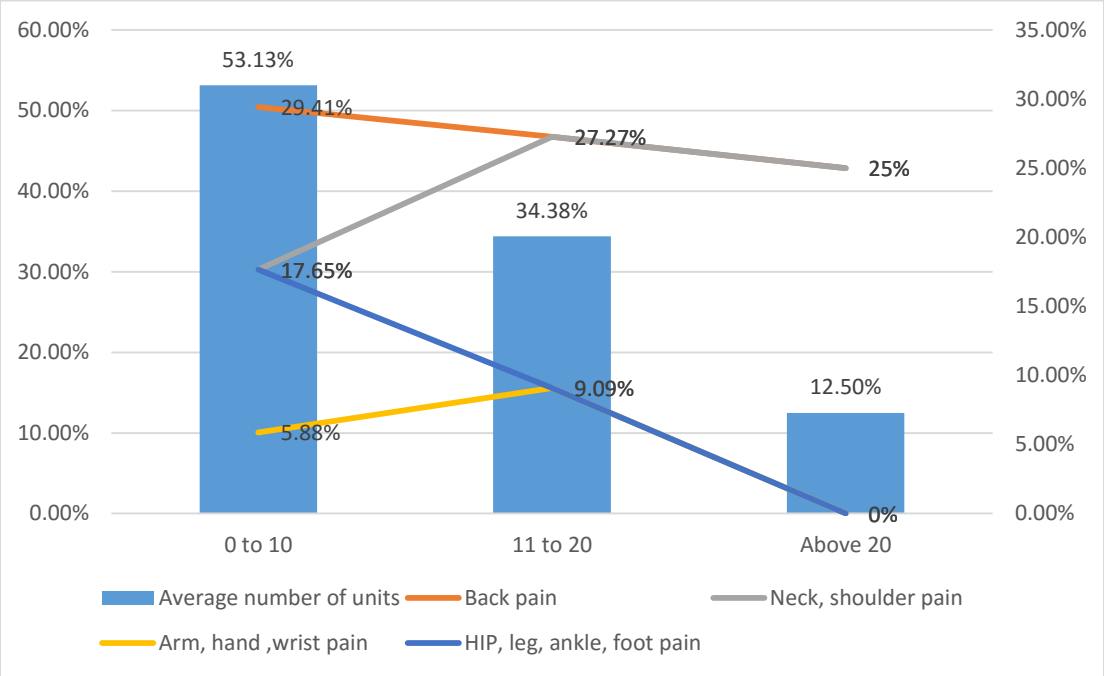

Fig 4.9.19: Relation of Number of Units and Extraocular Symptoms (N=32)

Approximately 53.13%, 34.38%, 12.50% of the computer operators finished 0-10, 11-20, above 20 units respectively. Back pain was present in 29.41%, 27.27%, 25% of the computer operators who took less than an hour, 1-10 hours, more than 10 hours to finish a unit respectively. Neck and shoulder pain was present in 17.65%, 27.27%, 25% of the computer operators who took less than an hour, 1-10 hours, more than 10 hours to finish a unit respectively. Arms, hands and wrist pain was present in 5.88%, 9.09%, 0% of the computer operators who took less than an hour, 1-10 hours, more than 10 hours to finish a unit respectively. Hip, leg, ankle and foot pain was present in 17.65%, 9.09%, 0% of the computer operators who took less than an hour, 1-10 hours, more than 10 hours to finish a unit respectively.

4.9.20 Distribution of Extraocular Symptoms

4.9.20.1 Distribution of Back Pain (N=32)

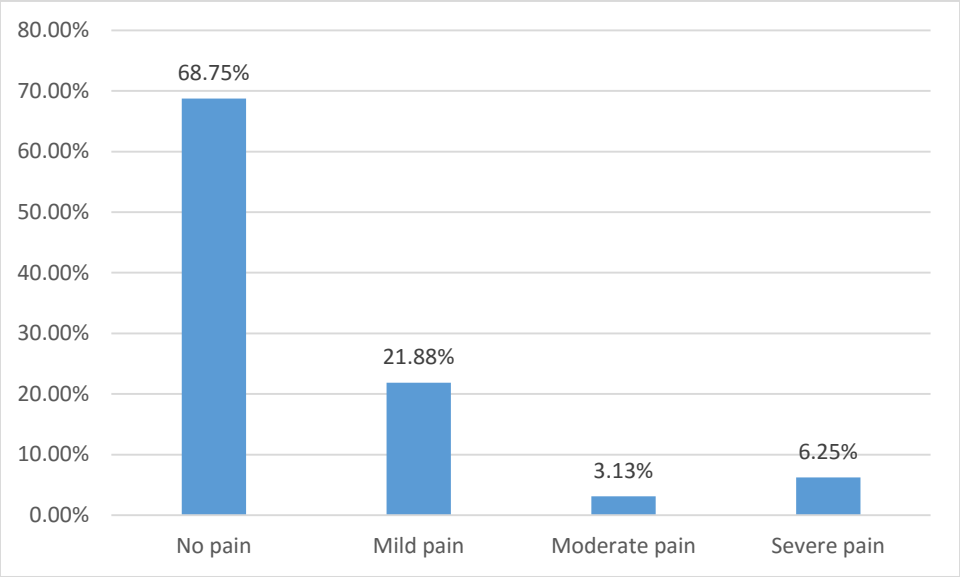

Fig 4.9.20.1a: Distribution of Back Pain Intensities (N=32)

Approximately 68.75% of computer operators had no back pain. Among the rest, 21.88%, 3.13% and 6.25% was comprised of subjects with mild, moderate and severe pain.

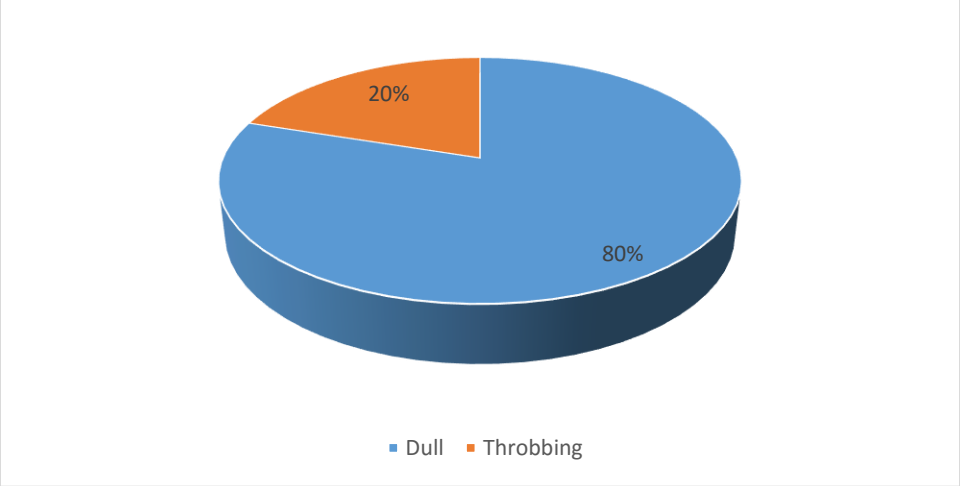

Fig 4.9.20.1b: Distribution of Back Pain Type (N=10)

Approximately 80% and 20% of the subjects with back pain felt dull and throbbing pain respectively.

4.9.20.2 Distribution of Neck and Shoulder Pain (N=32)

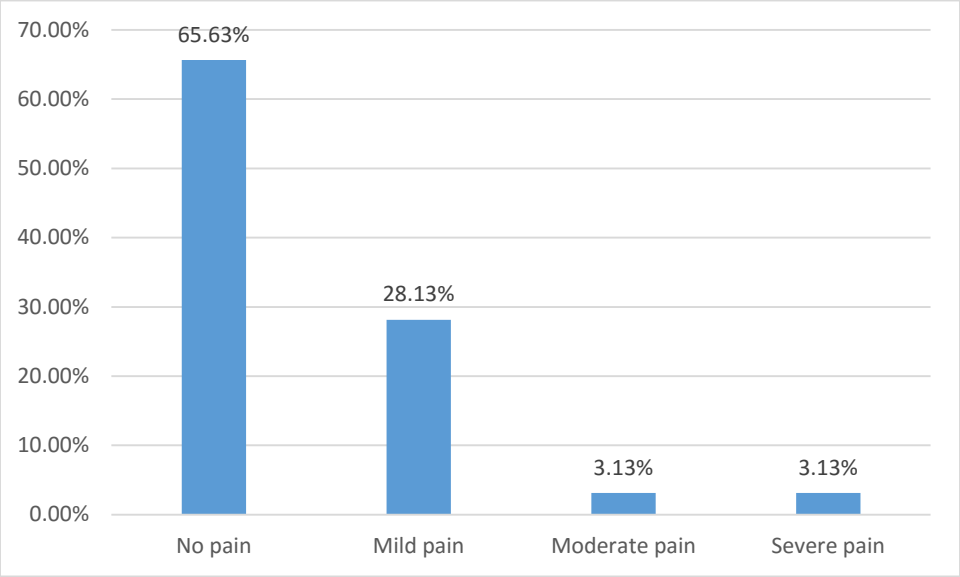

Fig 4.9.20.2a: Distribution of Neck and Shoulder Pain Intensities (N=32)

Approximately 65.63% of computer operators had no neck and shoulder pain. Among the rest, 28.13%, 3.13% and 3.13% was comprised of subjects with mild, moderate and severe pain.

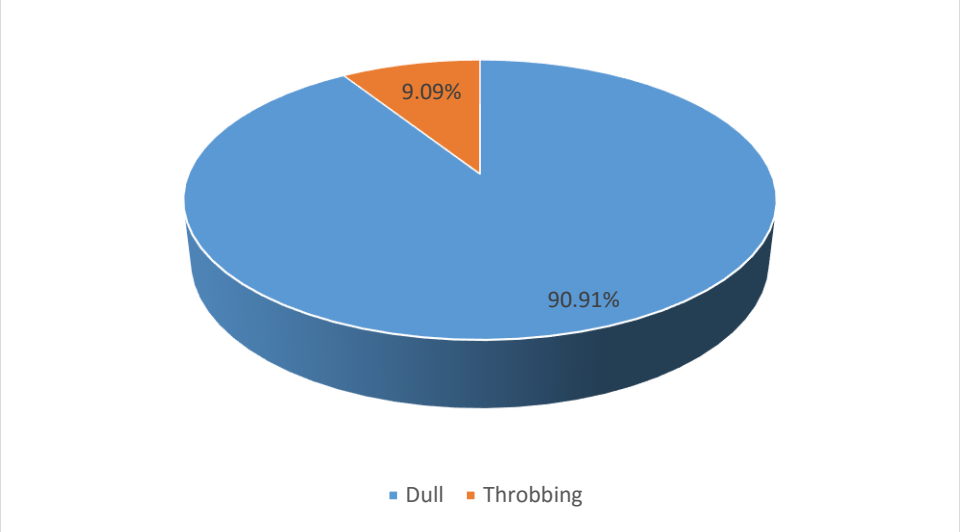

Fig 4.9.20.2b: Distribution of Neck and Shoulder Pain Type (N=11)

Approximately 90.91% and 9.09% of the subjects with neck pain feel dull and throbbing pain respectively.

4.9.20.3 Distribution of Arms, Hands and Wrist Pain (N=32)

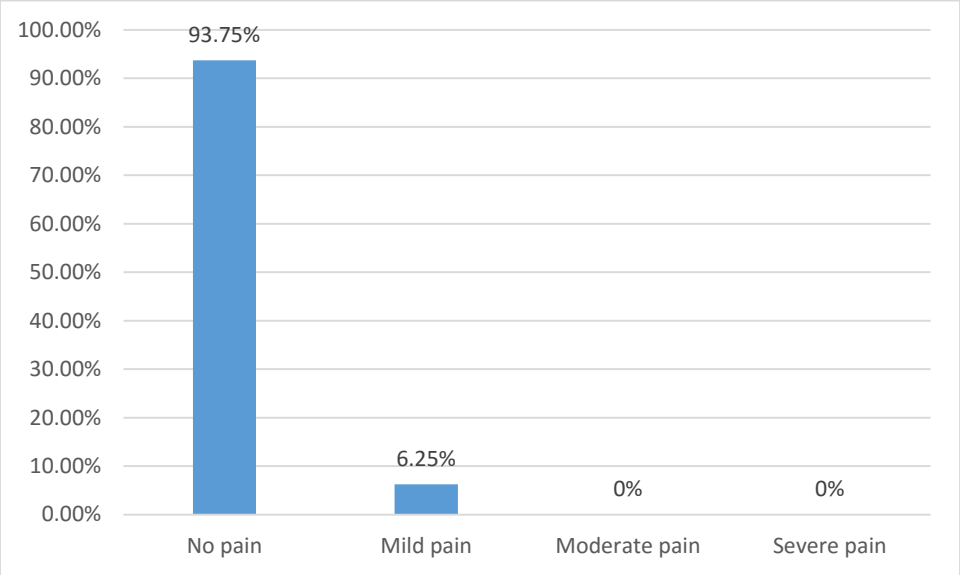

Fig 4.9.20.3a: Distribution of Arms, Hands and Wrist Pain Intensities (N=32)

Approximately 93.75% of computer operators had no arms, hands and wrist pain. Among the rest, 6.25%, 0% and 0% was comprised of subjects with mild, moderate and severe pain.

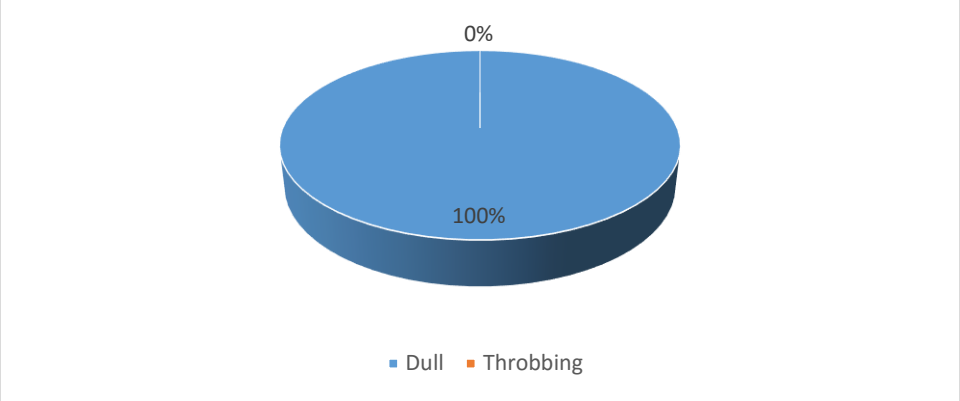

Fig 4.9.20.3b: Distribution of Arms, Hands and Wrist Pain Type (N=2)

Approximately 100% and 0% of the subjects with arms, hands and wrist pain felt dull and throbbing pain respectively.

4.9.20.4 Distribution of Hip, Leg, Ankle and Foot Pain (N=32)

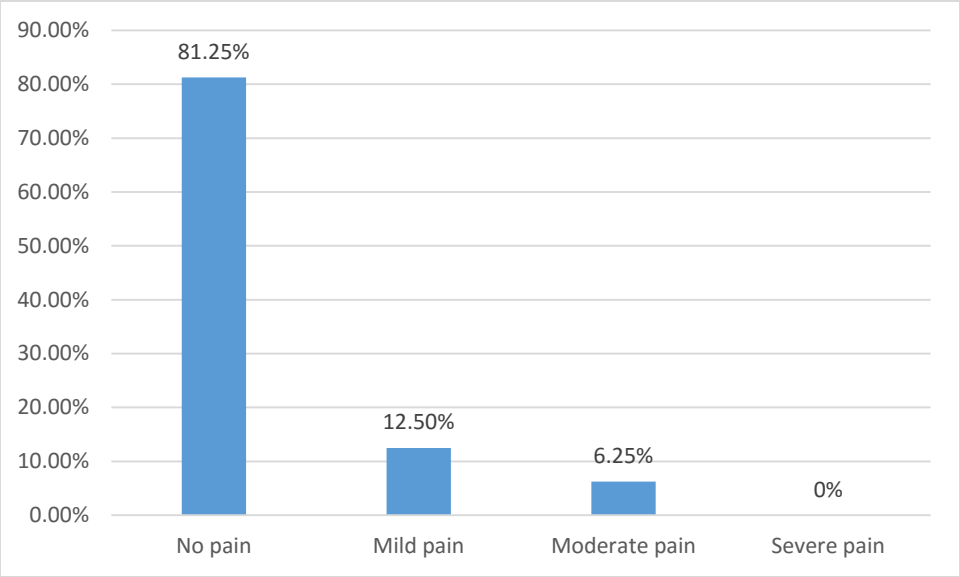

Fig 4.9.20.4a: Distribution of Hip, Leg, Ankle and Foot Pain Intensities (N=32)

Approximately 81.25% of computer operators had no hip, leg, ankle and foot pain. Among the rest, 12.50%, 6.25% and 0% was comprised of subjects with mild, moderate and severe pain.

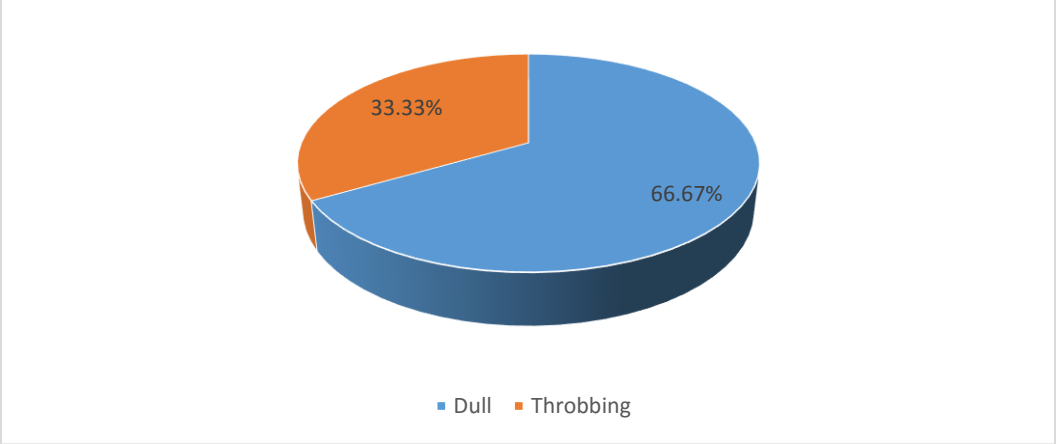

Fig 4.9.20.4b: Distribution of Hip, Leg, Ankle and Foot Pain Type (N=6)

Approximately 66.67% and 33.33% of the subjects had arms, hands and wrist pain felt dull and throbbing pain respectively.

Chapter 5

Discussion and Conclusion

5.1 Discussion

In the results section, the collected data was plotted in combination graphs where distribution of variables were demonstrated along with their impact on asthenopia and computer vision syndrome where applicable.

Mild, moderate and severe asthenopic symptoms altogether were the most frequent among the computer operators (46.88%, 11.15% and 12.50% respectively).

Among the subjects female constituted the larger population (66.90%). Mild and moderate symptoms were more frequent in the male counterparts (30.53% and 7.37% respectively) and it was contrary in the case of severe symptoms (14.06% in female). No relation of the frequency of asthenopia with the increase in age was observed.

The largest fractions of most eye-protective nutrients (e.g., vitamin A, lutein and zeaxanthin) are stored in adipose tissue. Thus, higher body fat percentage and BMI may compete with the retina for uptake of these nutrients, resulting in less incorporation in the retina and lower macular pigment (Han *et al*., 2013). For this reason, BMI was taken into consideration. According to WHO, BMI ≥25.00 and ≥30.00 is categorized as overweight and obesity respectively. 8.71% and 1.74% of the subjects fall into this category. On the other hand, <18.5 is categorized as underweight (WHO, 2015). 31.07% of the subjects fell into this category. No relation of the frequency of asthenopia with the increase of BMI was observed but a rise in mild symptoms (60%) was observed in the obese subjects.

For visual acuity, categorization of International Council of Ophthalmology, Australia was followed. It is as follows, normal vision >= 0.8, mild vision loss < 0.8 and >= 0.3, moderate vision loss < 0.3 and >= 0.125, severe vision loss < 0.125 and >= 0.05, profound vision loss < 0.05 and >= 0.02 (International Council of Ophthalmology, 2002)

Difference in visual acuity between two eyes was not observed much. Frequency was the highest for normal vision for far vision. Mild vision loss was observed in 37.63% in the right eye and 35.89% in the left eye in term of far vision. No subject was found to be suffering from profound vision loss. A similar scenario was observed for near vision (67.60% for both right and left eye). No relation of the frequency of asthenopia with the decrease in visual acuity was observed. But a rise in the percentage of moderate and severe symptoms was observed in case of moderate far

vision loss (23.80% and 46.15% respectively). Approximately 50% of the subjects with severe near vision loss had mild asthenopic symptoms.

Approximately 26.48% of the subjects were found to currently having or previously had eye disease. Among the eye diseases frequency of hypermetropia and myopia were the most prominent (4.53% both). 26.83% had family members with eye diseases. Among the eye diseases of family members frequency of myopia was the most prominent (6.27%). Myopia is a hereditary disorder (Lang, Amann and Grossman, 2000). So, 6.27% subjects were at the risk of myopia.

hypermetropia, myopia and cataract are hereditary disorders (Basak, 2013). Among ocular diseases of family members, hypermetropia (3.48%), myopia (6.27%) and cataract (4.18%) were the most prominent. So, the respective subjects were at the risk of those diseases.

Diabetes and hypertension can be genetically inherited and create eye complications (Basak, 2013). Among the general diseases of family members diabetes and hypertension were the most prominent (5.23% and 4.53% respectively). So, the respective subjects were at the risk of eye complications.

Among the subjects with eye diseases 31.58% did not receive any treatment. Majority of the subjects did not check eyes at all (94.43%). Increase in the frequency of mild and moderate symptoms were observed in the subjects with untreated conditions (25% and 12.50% respectively).

Administration of oral contraceptives is a risk factor of conjunctivitis, keratitis, iritis, lacrimal disease, strabismus, cataract, glaucoma, retinal detachment, and retinal vascular lesions (Vessey *et al*., 1998). Two subjects were reported to take oral contraceptives. So they were at the risk of those disorders.

Approximately 32.40% of the subjects were asthenopic. Majority of the subjects experienced the symptoms part way through the day (89.25%) and had been suffering for 1 to 5 years (66.67%). Among the asthenopic symptoms eye pain (22.58% for mild), headache (20.43% for mild and 26.88% for severe) and blurry vision (20.43% for mild) were the most prominent. In the study conducted by Akinbinu and Mashalla in 2013, double vision was experienced by 12.95%, watery eyes were reported by 10.79%, blurry vision and redness were experienced by 10.07 and 4.31%, respectively (Akinbinu and Mashalla, 2013). In another study, 55%, 61%, 46% and 87% of the subjects reported burning sensation in eyes, headache, redness in their eyes and eye fatigue

respectively (Sen and Richardson, 2010). For most of the asthenopic subjects (28.57%) it took 0-5 years for the symptoms to emerge.

To analyze sleep pattern, sleep guideline of National Sleep Foundation was followed. Majority of the subjects were found to follow the pattern categorized as "Recommended" which suggests 9-11 hours for aged 6-13 years, 8-10 hours for aged 14-17 years and 7-9 hours for aged 18-64 years (Sleepfoundation.org, 2015). Increase in the frequency of mild and severe symptoms were observed for "May be Appropriate" and "Not Recommended" category. Most of the subjects (82.23%) reported to have deep sleep. 42.10% and 31.58% of the subjects who frequently experienced sleep disturbances suffered from mild and severe asthenopic symptoms respectively. Approximately 40% and 33.33% of the subjects having trouble getting sleep less frequently and seldom respectively experienced severe and moderate symptoms correspondingly.

No significant relation of asthenopia with physical activity (exercise or carrying out household chores) was observed. Mild symptoms were found in increased proportion among the population addicted to smoking (47.83%) and jorda (25%), which is tobacco leaf used for chewing.

About 60% of the population living in uncomfortable residence experience mild symptoms. Among the reasons of discomfort congested residence was the most prominent (54.55% of the population living in uncomfortable residence).

Eye protective nutrients vitamin A, lutein and zeaxanthin are found in pea, turnip, small fish, dark green leafy vegetables, carrot, turnip etc. (Brown *et al*., 1998; Han *et al*., 2013; Johnson and Rasmussen, 2013; Semba and Dagnelie, 2003; Roos, Islam and Thilsted, 2003). Another eye protective nutrient β-carotene is found in sweet potato and cabbage (Bovell-Benjamin, 2007; Singh *et al*., 2006). All of the above mentioned foods are locally available. Among them in pea, turnip, carrot, turnip, sweet potato and cabbage are available in specific seasons only. Small fish and dark green leafy vegetables are found in all seasons.

For all the seasonally available vegetables proportion of the subjects who ate was higher than the subjects who did not eat. Severe symptoms were higher in the subjects who did not eat sweet potato, pea, cabbage and turnip than the subjects who eat. Such relation was also seen for moderate symptoms in term of sweet potato.

Proposed relationships of asthenopia and various factors related to work pattern and environment were evaluated. Among those factors, relationships of increase in asthenopia frequency were observed with decreased duration of breaks (for moderate symptoms), increased number of work days (for mild symptoms), increased amount of time taken to finish each unit (for moderate symptoms), insufficient aeration (for mild symptoms), high and low temperature (for mild symptoms) and painful noise (for mild and severe symptoms).

Not having sufficient rest (for mild and severe symptoms), frequent stress from family affairs (for mild symptoms) and mild stress of household chores (for severe symptoms) were the psychology related factors observed to have impact on the increase of asthenopic symptoms frequency.

Han *et al*. in 2013 found no significant relation of smoking, drinking and doing exercises with asthenopia. Intake of green leafy vegetables, air quality, sleep quality and good mental state were found to be preventative against asthenopia. Eye or systemic disease, taking medicine, unsuitable indoor temperature, noise and family history were found to be promoting asthenopia (Han *et al*., 2013).

Factors which showed to have relation with increasing extraocular and asthenopic symptoms of computer vision syndrome were: decrease in viewing distance from screen (for moderate asthenopic symptoms and neck, shoulder, hip pain), decrease in viewing distance from keyboard (for severe asthenopic symptoms and arm, wrist, hip pain), center of the monitor being equal to eye level (for mild and severe asthenopic symptoms and back and hip pain), using chair with unadjustable height (back, neck, shoulder, arm, hand and wrist pain), using chair with inappropriate backrest (for neck, shoulder, arm hand and wrist pain), inadequate space at the desk (for back, neck, shoulder, hip, leg, ankle and foot pain), inadequate space of seat pan (for back, hip, leg, ankle and foot pain), higher age (for hip, leg, ankle and foot pain) and increase in the number of workdays (for back pain). One of the previous studies found that visual complaints were related to viewing distance from the screen and visual complaints were more pronounced at viewing distance of less than 10inches and less at 20-30inches and 30-40inches (Chiemeke, Akhahowa and Ajayi, 2007). Another study revealed 50% of the subjects having low back pain did not have an adjustable backrest (Sen and Richardson, 2010). Most of the subjects suffering from extraocular symptoms reported the pain to be felt dull.

5.2 Conclusion

Asthenopia and computer vision syndrome is present in visually demanding job holder in a smaller but substantial fraction. Though these ailments cannot lead to any permanent damage, it lowers the living standards, disintegrates job performance and hampers production in quantity and quality.

These condition can easily be avoided by simply raising awareness. Adopting postures during working, taking adequate rest in between works and following a suitable pattern of working can easily resolve this.

The limitation of the study was small population and lack of sophisticated equipment for diagnosis. Study on asthenopia should be done in large population and on more sorts of visually demanding occupations.

Chapter 6

References

Abdi, S. and Rydberg, A. (2005) Asthenopia in Schoolchildren, Orthoptic and Ophthalmological Findings and Treatment. *Documenta Ophthalmologica*, 111(2), 65-72.

Akinbinu, T. and Mashalla, Y. (2013) Knowledge of computer vision syndrome among computer users in the workplace in Abuja, Nigeria. *Journal of Physiology and Pathophysiology*, [online] 4(4), 58,59 Available at: http://www.academicjournals.org/JPAP [Accessed 18 Sep. 2015].

Barthakur, R. (2013) Computer Vision Syndrome. *Internet Journal of Medical Update*, [online] 8(2), 1-2. Available at: http://www.akspublication.com/Editorial_Jul2013_.pdf [Accessed 18 Sep. 2015].

Basak, S. (2013) Essentials of Ophthalmology. 5th ed. Kolkata: Current Books International, pp 1-410.

Bovell-Benjamin, A. (2007) Sweet Potato: A Review of its Past, Present, and Future Role in Human Nutrition. Advances in Food and Nutrition Research, [online] 52,1-59 Available at: http://www.sciencedirect.com/science/article/pii/S1043452606520017 [Accessed 30 Dec. 2015].

Brown, N., Bron, A., Harding, J. and Dewar, H. (1998) Nutrition supplements and the eye. Eye, [online] 12(1), 127-133 Available at: https://www.researchgate.net/profile/Anthony_Bron/publication/13668890_Nutrition_supplements_and_the_eye/links/0a85e532ed3a109bd4000000.pdf [Accessed 30 Dec. 2015].

Bye, L., Modi, N. and Stanford, M. (2013). Basic sciences for ophthalmology. Oxford: Oxford University Press, pp.1-92, 121-146.

Chiemeke, S., Akhahowa, A. and Ajayi, O. (2007) Evaluation of Vision-Related Problems amongst Computer Users: A Case Study of University of Benin, Nigeria. In: *World Congress on Engineering*. London: Citeseer.

Dehghani, A., Tavakoli, M., Akhlaghi, M., Beni, A. and Eslami, F. (2008) Prevalence of ocular symptoms and signs among professional computer users in Isfahan, Iran. *Journal of Research in Medical Sciences*, [online] 13(6), 303-304. Available at: http://www.jrms.mui.ac.ir/index.php/jrms/article/view/1856 [Accessed 18 Sep. 2015].

Gray, H., Williams, P. and Bannister, L. (2008) Gray's anatomy. 20th ed. New York: Churchill Livingstone, pp.657-697.

Han, C., Liu, R., Liu, R., Zhu, Z., Yu, R. and Ma, L. (2013) Prevalence of asthenopia and its risk factors in Chinese college students. *International Journal of Opthalmology*, [online] 6(5), 718 Available at: http://www.ncbi.nlm.nih.gov/pubmed/24195055 [Accessed 18 Sep. 2015].

International Council of Ophthalmology, (2002) Visual Standards Aspects and Ranges of Vision Loss with Emphasis on Population Surveys. Sydney.

Johnson, E. and Rasmussen, H. (2013) Nutrients for the aging eye. CIA, [online] 8, 741 Available at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3693724/ [Accessed 30 Dec. 2015].

Lang, G., Amann, J. and Grossman, J. (2000) Ophthalmology. Stuttgart: Thieme, pp.17-445.

Lovasik, J. and Szymkiw, M. (1885) Effects of aniseikonia, anisometropia, accommodation, retinal illuminance, and pupil size on stereopsis. *Investigative Ophthalmology & Visual Science*, [online] 26(5), 741-750 Available at: http://iovs.arvojournals.org/article.aspx?articleid=2177150 [Accessed 20 Sep. 2015].

Martini, F. and Nath, J. (2009) *Fundamentals of anatomy & physiology*. 8th ed. San Francisco, CA: Pearson Benjamin Cummings, pp.566-576.

Ministry of Finance, Government of the People's Republic of Bangladesh, (2015) *Bangladesh Economic Review 2015*. p.98.

Mocci, F. (2001) Psychological factors and visual fatigue in working with video display terminals. *Occupational and Environmental Medicine*, 58(4), 267-271.

Nakaishi, H. and Yamada, Y. (1999) Abnormal tear dynamics and symptoms of eyestrain in operators of visual display terminals. *Occupational and Environmental Medicine*, 56(1), 6-9.

Rajabi-Vardanjani, H., Habibi, E., Pourabdian, S., Dehghan, H. and Maracy, M. (2014) Designing and Validation a Visual Fatigue Questionnaire for Video Display Terminals Operators. *International Journal of Preventative Medicine*, [online] 5(7), 841-848 Available at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4124561/ [Accessed 18 Sep. 2015].

Roos, N., Islam, M. and Thilsted, S. (2003) Small fish is an important dietary source of vitamin A and calcium in rural Bangladesh. International Journal of Food Sciences and Nutrition, 54(5), 329-339.

Semba, R. and Dagnelie, G. (2003) Are lutein and zeaxanthin conditionally essential nutrients for eye health?. Medical Hypotheses, [online] 61(4), 465-472 Available at: http://www.sciencedirect.com/science/article/pii/S0306987703001981 [Accessed 30 Dec. 2015].

Sen, A. and Richardson, S. (2010) A Study of Computer-Related Upper Limb Discomfort And Computer Vision Syndrome. *Journal of Human Ergology*, [online] 36(2), 45,46 Available at: https://www.jstage.jst.go.jp/article/jhe1972/36/2/36_2_45/_article [Accessed 18 Sep. 2015].

Singh, J., Upadhyay, A., Bahadur, A., Singh, B., Singh, K. and Rai, M. (2006). Antioxidant phytochemicals in cabbage (Brassica oleracea L. var. capitata). Scientia Horticulturae, 108(3), pp.233-237.

Stüdeli, T. and Menozzi, M. (2003) Effect of Subjective and Objective Workload on Asthenopia at VDU Workplaces. *International Journal of Occupational Safety and Ergonomics*, [online] 9(4), 1-2 Available at: http://www.tandfonline.com/doi/abs/10.1080/10803548.2003.11076581 [Accessed 18 Sep. 2015].

Subratty, A. and Korumtollee, F. (2005) Occupational overuse syndrome among keyboard users in Mauritius. *Indian Journal of Occupational and Environmental Medicine*, 9(2), 71.

Tsai, J., Denniston, A., Murray, P., Huang, J. and Aldad, T. (2011) *Oxford American handbook of ophthalmology*. Oxford: Oxford University Press, pp.6.

Vertinsky, T. and Forster, B. (2005) Prevalence of Eye Strain Among Radiologists: Influence of Viewing Variables on Symptoms. *American Journal of Roentgenology*, 184(2), 681-686.

Vessey, M., Hannaford, P., Mant, J., Painter, R., Frith, P. and Chappel, D. (1998) Oral contraception and eye disease: findings in two large cohort studies. *British Journal of Ophthalmology*, 82(5), 538-542.

WHO. (2015) *Global Database on Body Mass Index*. [online] Apps.who.int. Available at: http://apps.who.int/bmi/index.jsp?introPage=intro_3.html [Accessed 30 Sep. 2015].