**"Effectiveness of Integrated Scapular Muscle Training Program in Improving Scapular Asymmetry, Rounded Shoulder Posture, Cervical Range of Motion and Ergonomic Ability among IT Professionals with Scapular Dyskinesis"**

# A

## Thesis Submitted

## for the award of Degree of

## Doctor of Philosophy

## in

## Physiotherapy

## ( Under the faculty of Allied Health Sciences)

**MALWANCHAL UNIVERSITY INDORE MADHYA PRADESH**


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**2026**

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This is to certify that I, **Dr. Neha Gaur(PT)** have completed the Ph.D. work on the topic,"**Effectiveness of Integrated Scapular Muscle Training Program in Improving Scapular Asymmetry, Rounded Shoulder Posture, Cervical Range of Motion and Ergonomic Ability among IT Professionals with Scapular Dyskinesis**". under the guidance of **Dr. Reshma Khurana** Research Supervisor, Malwanchal University for the partial fulfilment of the requirement for the degree of Doctor of Philosophy, Malwanchal University. This is an original piece of work & I have not submitted it earlier elsewhere.

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# ACKNOWLEDGEMENT

I express my sincere gratitude to all those who supported and guided me throughout the completion of this research work entitled ***"Effectiveness of Integrated Scapular Muscle Training Program in Improving Scapular Asymmetry, Rounded Shoulder Posture, Cervical Range of Motion and Ergonomic Ability among IT Professionals with Scapular Dyskinesis."***

I am highly thankful to my respected Research Supervisor, **Dr. Reshma Khurana**, Department of Physiotherapy, Malwanchal University, Indore, for her valuable guidance, continuous encouragement, expert suggestions, and constant support during every stage of the study. Her motivation and academic insight greatly contributed to the successful completion of this research.

I express my sincere thanks to the authorities of **Malwanchal University, Indore**, for providing the necessary facilities, academic environment, and support required for conducting this study.

I am also grateful to all the IT professionals who willingly participated in this research and cooperated throughout the assessment and intervention process.

I would like to thank all the faculty members, colleagues, friends, and well-wishers for their encouragement and assistance during the research period.

Finally, I express my heartfelt gratitude to my family members for their unconditional support, patience, motivation, and encouragement throughout my academic journey.

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# ABSTRACT

This study aimed to assess the effectiveness of an Integrated Scapular Muscle Training Program for IT workers with scapular dyskinesis.

One hundred and fifty participants were selected and randomly assigned to an experimental and a control group. Structured scapular muscle training program was given to the experimental group for 6-8 weeks, whereas the control group continued their routine activities.

Scapular asymmetry was assessed using the Lateral Scapular Slide Test (LSST), rounded shoulder posture was evaluated through the table to acromion distance method, cervical range of motion was measured with a universal goniometer and ergonomic ability was evaluated with RULA and ROSA scores.

The findings of the study showed that all the outcome variables improved significantly in the experimental group ($p < 0.001$) and did not improve in the control group. There was also a strong correlation between scapular stability and ergonomic risk score.

The study findings conclude that the Integrated Scapular Muscle Training Program can be effective in enhancing posture, mobility and ergonomic function among IT workers.

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# LIST OF ABBREVIATIONS

| Abbreviation | Full Form |
|---|---|
| LSST | Lateral Scapular Slide Test |
| ROM | Range of Motion |
| RULA | Rapid Upper Limb Assessment |
| ROSA | Rapid Office Strain Assessment |
| WRMSDs | Work-Related Musculoskeletal Disorders |
| IT | Information Technology |
| SPSS | Statistical Package for the Social Sciences |
| BMI | Body Mass Index |
| SD | Standard Deviation |
| ANOVA | Analysis of Variance |
| CI | Confidence Interval |
| cm | Centimeter |
| mm | Millimeter |
| kg | Kilogram |
| min | Minute |
| sec | Second |
| $H_0$ | Null Hypothesis |
| $H_1$ | Alternative Hypothesis |
| FITT | Frequency, Intensity, Time and Type |
| RCT | Randomized Controlled Trial |
| EMG | Electromyography |
| NSAIDs | Non-Steroidal Anti-Inflammatory Drugs |
| NRS | Numerical Rating Scale |
| WHO | World Health Organization |
| UQYBT | Upper Quarter Y Balance Test |
| VAS | Visual Analogue Scale |

# CHAPTER 1

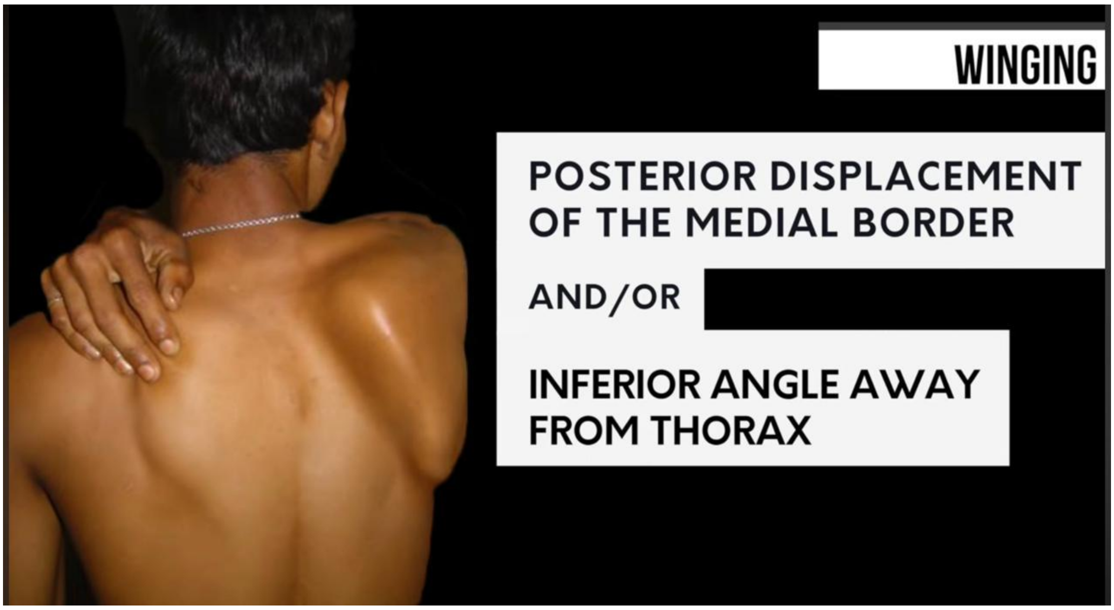
# INTRODUCTION

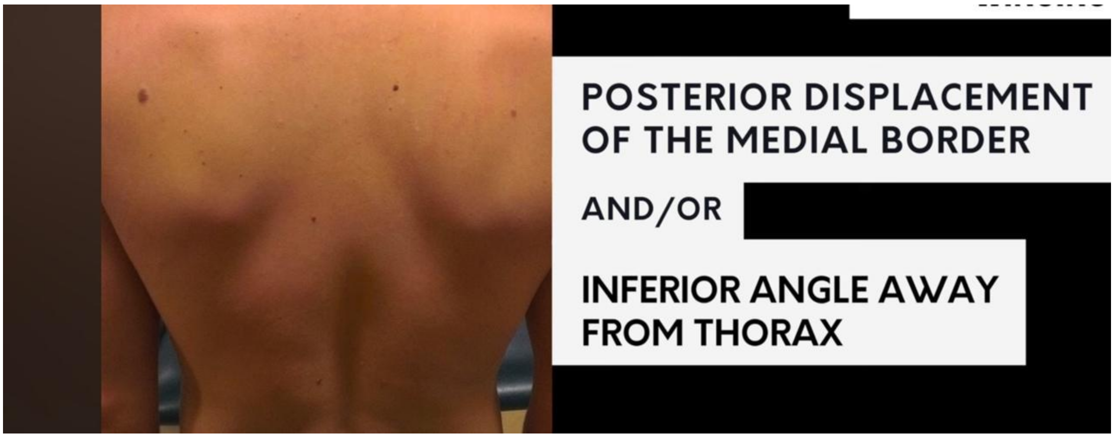
## 1.1Background of the Study

Over the past decades, the nature of the workplace has undergone much change because of the rapid technological advancement. IT professionals tend to spend most of their time sitting before the computer screens with six and more hours or even longer operating key boards, mice and screens. Despite these advances in technology that have led to increased efficiency and productivity, there are a few occupational health challenges that have been brought about especially those associated with musculoskeletal disorders.

According to Patel et al., (2021), musculoskeletal disorders in the workplace particularly in the neck, shoulder and upper back regions may be regarded as some of the most prevalent health problems among computer-based workers. Prolonged sitting postures, repetitive upper limbs, lack of rest breaks and inadequate workstation designs are often related to these disorders. Sustained mechanical forces are applied to the muscles around the cervical spine and shoulder girdle when a person sits in one position for a long time. In the long term, this prolonged stress can cause muscular fatigue, imbalance and postural deviations.

It is a strong fixation for the humerus movement and also aids in the coordinated action of shoulder complex. Normal scapular motion demands the coordinated contraction of a few muscles among them being the trapezius, serratus anterior, rhomboids and levator scapulae. In the movement of the arms when such muscles work together they maintain the position and smooth scapulohumeral rhythm of the scapula.






However, over the years, with poor posture and muscle imbalance this coordination may be broken, and the result of this is a condition known as scapular dyskinesis. Scapular dyskinesia is an abnormal movement during its activity. It can be manifested either as the winging of the scapula, or the asymmetry of the right and left scapulae, or as excessive protraction of the scapula. These changes in scapular mechanics have the capacity to decrease shoulder stability, and are associated with pain, limitation of range of movement, as well as functional performance.

However, after years of poor posture and muscle imbalances this may not be in good order, and this can be the cause of a disorder known as scapular dyskinesis. During the shoulder activity, atypical positions or movement of the scapula is called scapular dyskinesis. It can be manifested either as the winging of the scapula, or the asymmetry of the right and left scapulae, or as excessive protraction of the scapula. These changes in scapular mechanics have the capacity to decrease shoulder stability, and are associated with pain, limitation of range of movement, as well as functional performance.

The relationship between the scapula is not just involved in the shoulder but also the cervical-spinal biomechanics. The scapula serves as a point for the attachment of several muscles that connect the neck, thoracic spine and upper limbs. The muscles can also be overactive or even tired when scapular position is disrupted which causes more mechanical stress to the cervical spine.

In addition to biomechanical problems, workplace ergonomics is also related to the onset of musculoskeletal problems in IT professionals. Inappropriate design of workstations, incorrect height of the screens, lack of lumbar support and incorrect sitting posture can cause additional stress on the neck and shoulders. The ergonomic risk assessment tools typically used for assessment of the posture risks of computer work are Rapid Upper Limb Assessment (RULA) and rapido Office Strain Assessment (ROSA). The scores obtained in these assessments when high are a pointer of a higher probability of musculoskeletal disorders.

While there are some rehabilitation techniques recommended to correct the shoulder and neck dysfunction, there are also some recent studies that pursue the importance of scapular muscle training. Stabilization and strengthening exercises of the scapular muscles can be employed to realign scapular position, improve scapular motion and reduce the stress on the cervical spine. There are initial positive outcomes for lower trapezius-Serratus anterior and additional stabilizing muscle exercises when it comes to improving posture and reducing musculoskeletal symptoms.

A group of scapular muscle training programs, in which strengthening training, postural correction training and flexibility training are introduced, that is, the training is integrated. These programs tend to conform to the principle of FITT that takes into account the frequency, intensity, type and duration of exercises. Common therapeutic exercises prescribed in such programs include resistance band exercises, ITY exercises and scapular stabilization exercises. These interventions can improve upper body performance, and thereby help to restore neuromuscular coordination and muscular balance to enhance overall and scapular symmetry.

While musculoskeletal problems among office workers have grown wider and wider known by the office workers, most of the previous studies have concentrated on athletes, or people who have suffered from shoulder injuries.

This is why there is a need to investigate the existence of structured rehabilitation interventions to both biomechanical dysfunction and occupational ergonomic risks.

The purpose of the current research is to examine how an Integrated Scapular Muscle Training Program can be effective in increasing the scapular asymmetry, correcting the rounded shoulder posture, improving cervical range of motion, and ergonomic ability in IT professionals diagnosed with scapular dyskinesis. The findings from this research can be applied when implementing preventive and rehabilitative measures that will be able to help reduce the musculoskeletal problems and improve the overall occupational health of IT professionals.

## 1.2. Need for the Study

Occasionally, within the past few years, the musculoskeletal disorder that is related to the workplace has been on the rise tremendously due to the swift increase in computer-based jobs, especially in those people working in the information technology (IT) category. IT specialists are required to work on uncomfortable chairs, and often sit for six or eight hours (or more) a day at the computers. Typical work activities involve repetitive use of keyboard and mouse, little physical activity and prolonged exposure to computer screens. The occupational demands pose a lot of tension to the musculoskeletal system mostly on neck, shoulder and upper back areas.

Prolonged sitting and poor change of posture usually lead. Such postural distortions eventually cause the spine and shoulder girdle natural configuration to shift. As the head moves forward with respect to the body, the load at the cervical spine level is very high. At the same time, the shoulders tend to move towards a prolonged position and cause changes in scapular alignment and increase the tension of neighbouring muscle and ligament. These biomechanical alterations may over time result into discomfort, pain, loss of mobility and functional efficiency.

Scapular dyskinesis is one of such significant conditions that can be related to these postural deviations.  People who have this condition may have an asymmetrical scapula, which could be winged and/or overprotruded. It is a common complication due to failure of the muscles stabilizing the scapula to balance each other. Tightness in upper trapezius, pectoralis minor and weakness in lower trapezius and serratus anterior may disrupt normal scapular mechanics. In case the coordination of these muscles is ineffective, the scapula does not help to provide the shoulder with a stable base.

Scapular Dyskinesia does not only alter the shoulder functioning, but also it can affect cervical spine biomechanics. Considering the fact that a number of cervical and thoracic muscles are attached to the scapula, an abnormal position of the scapula may result in the following tension of the region of the neck. This can lead to reduced ROM in the neck, mechanical neck pain and disability. For those who are already in the IT field and rely heavily on their computerbased jobs, this could be detrimental to their productivity, comfort and overall happiness.

Inappropriate work posture is also a factor contributing to MSDs in IT workers. Most workstations are not equipped in such a way that they accommodate good posture when it comes to spending a lot of time at the computer. Due to poor positioning of the screen, improperly adjusted chairs, lack of arm support and poor positioning of the desk, there could be biomechanical stress to the upper body.

Although these ergonomic adjustments and posture training are generally advised to reduce musculoskeletal risk they may be ineffective in the context of removing musculoskeletal imbalances. New rehabilitation strategies also focus on the fact that it is important to strengthen and activate scapular stability muscles in order to achieve normal shoulder mechanics. The purpose of the scapular muscle training programs is to enhance the coordination and strength of the key muscles including the trapezius and the serratus anterior which are vital in ensuring the scapular stability and appropriate functions of the upper limbs.

Past studies have shown that scapular stabilization exercises are able to enhance shoulder functionality, decrease pain and improve postural aspects. However, much of the existing literature focuses on athletes, patients with the shoulder impingement syndrome or orthopedic rehabilitation patients. The volume of research is relatively low for interventions specifically for the effectiveness of these interventions among IT professionals, which is one of the fastest growing occupational groups affected by the effects of prolonged sedentary working situations.

Moreover, there have been many studies focusing on personal outcomes, such as pain or shoulder range without considering the entire relationship between scapular function, cervical mobility and work ergonomics. An analysis methodology that concurrently assesses scapular alignment, posture correction, cervical range of motion and ergonomic risk could give a more precise insight into the usefulness of rehabilitation interventions in the workplace.

The increasing incidence of neck and shoulder complaints among computer-based workers is apparently calling for the development and evaluation of well-structured rehabilitation programs, which would cover biomechanical and ergonomic variables. A multi-muscle training program of scapula may help restore the muscle balance, improve scapular positioning, correct rounded shoulder posture and improve cervical mobility. Moreover, musculoskeletal performance can also become a benefit in enhancing ergonomic performance during work in a workstation.

Therefore, the purpose of the current research project is to assess the effectiveness of the Integrated Scapular Muscle Training Program on scapular asymmetry, the perception of round-shoulder posture, the increase in the range of motion of the cervical spine and the improvement of its ergonomic functioning in IT specialists diagnosed with scapular dyskinesis. The outcomes of this study can be of great evidence to support the physiotherapists, occupational health specialists and workplace wellness program to design effective preventive and rehabilitative measures to minimize musculoskeletal problems in computer-based work.

## 1.3Statement of the Problem

Work-related musculoskeletal disorders (WRMSDs) have emerged as a major health challenge among people who have been involved in computer-related jobs especially those worked in the information technology (IT) industry (Korhan, 2010). IT related work involves prolonged sitting in front of the computer where professionals are required to repeat work with typing, operating the mouse and viewing the screen constantly.

Such job requirements tend to lead to a lack of physical activity and prolonged positions in one position. These conditions may cause musculoskeletal discomfort and functional impairments as time goes by and subject the neck, shoulders and upper back to excessive mechanical loads.

The changed scapula position may have serious implications on the biomechanics of the shoulder and cervical spine. Given that a number of muscles attaching the neck and thoracic area are attached to the scapula, when the scapular activities are disturbed, it can result in the normal muscle attached to the cervical area becoming tense. This can lead to decreased cervical range of movement, muscle fatigue as well as development of neck pain. These biomechanical disruptions can also enhance the effectiveness of work and exposure of people to chronic musculoskeletal disorders in those who have spent much time on desk-based work.

Besides muscular imbalance and postural deviation, workplace ergonomics is a significant contributor of growth and advancement of these conditions. Most IT professionals are at work in the environment where workstations might not be able to support good posture. Mechanical stress on the upper body can be augmented by improper monitor height, misplaced chairs, insufficient arm support and protracted immobile sitting posture. There are a number of ergonomic evaluation tools that have been extensively used to assess the risk of musculoskeletal disorders among workers at the office, When these scores are high, the tests can be used to quantify the increasingly postural pressures and risk of neck and shoulder problems.

With the increasing number of musculoskeletal problems encountered by computer-based workers, and the absence of research at the occupational level into the problem, there is a need to look at the concept of holistic rehabilitation, both muscular and ergonomic. Scapular muscle training, strengthening exercises then combined with postural training and finally exercises with ergonomic awareness can help restore normal scapular movements, cervical mobility and biomechanical load on the scapula during the functions performed in the workplace.

Hence, the issue that was covered in the current research can be formulated in the following way:

To assess the effectiveness of an Integrated Scapular Muscle Training Program to decrease scapular asymmetry, a problem related to rounded shoulder position, increase ROM of the cervical region and improve ergonomic performance of information technology workers (IT) with scapular dyskinesis.

This paper aims at gaining evidence based understanding of the impact of structured scapular rehabilitation protocols in treating musculoskeletal dysfunction in IT professionals

## 1.4 Purpose of the Study

The major objective of the research is to explore how an Integrated Scapular Muscle Training Program can be effective in the reduction of scapular asymmetry, round shoulder posture, cervical range of motion and ergonomic ability in IT professionals diagnosed with scapular dyskinesis. With the proliferation of computer-related jobs in the workplace, the length of sitting time and/or the repetitive motion of the upper limbs and extended sitting position of jobs are affecting a growing number of users. These circumstances are likely to cause a musculoskeletal strain, specifically in the neck and shoulder neck, and negatively impact on the physical conditions and/or the performance level. One such group of occupational groups that are more susceptible to such musculoskeletal issues are IT professionals.

It's common for them to have several hours of computer-related tasks a day with limited or no physical movement or postural changes. This workout could eventually cause postural abnormalities such as forward head posture, and rounded shoulders. These are structural abnormalities that are commonly associated with the relationship of an abnormal scapular position and muscular imbalance of the shoulder girdle. If there is a failure to stabilise the scapular muscles then the normal mechanisms of the shoulder may be disturbed and can contribute to other problems such as scapular dyskinesis. The complex between shoulder and cervical spine can be affected by scapular dyskinesis to a great extent too.

The shoulder stability and a base to perform effective upper limb movement relies greatly on the scapula. An abnormal posture of the shoulders will tend to result in increasing mechanical stress on the adjacent muscles and joints, reduce the workability of the shoulder, and increase mechanical stress in the cervical region. These biomechanical pathologies can also lead to limitation in the cervical range of motion and increase the likelihood of cervical pain for people who work for long periods of time on a computer. Despite the fact that many rehabilitation interventions are available to address musculoskeletal function deficits with the shoulder and neck, the most recent studies highlight the need to focus on specific muscle strengthening and activation of muscles that stabilize the scapula.

The training of these muscles can be beneficial in returning to normal positioning of the scapula, improved coordination of the shoulder and cervical areas, and improved upper body performance. Resistance band strengthening exercises, scapular stabilization exercises and posture correction techniques have been proved to enhance muscle balance and posture. It has been suggested in the present study, that the training program for the scapular muscle should be done based on the principle of FITT, which is respectively frequency, intensity, time and type of physical activity.

Another important aspect of the program is enhancing important stabilizing muscles around the scapula, such as the trapezius muscle and the serratus anterior muscle and others which support shoulder stability and facilitate correct positioning. The training program should aim to increase the mobility of the cervical spine and decrease the biomechanical stress while performing the work day, due to an improvement in the posture.The scapular muscle training program suggested in the present study is structured on the principle of FITT that incorporates a proper frequency, intensity, time and type of physical activity.

The program also seeks to tighten crucial scapular stabilizing muscles like the trapezius and serratus anterior among other supporting muscles that help in ensuring that the shoulder is held in the right position. The training program should aim to increase the mobility of the cervical spine and decrease the biomechanical stress while performing the work day, due to an improvement in the posture.

In addition to measuring biomechanical outcomes this study will measure the ergonomic ability among the IT workers. Ergonomics plays a crucial role in safeguarding the health of the whole worker against musculoskeletal disorders (MSDs) in the workplace. Poor workstation design, poor sitting posture and excessive sitting time are the primary causes of the declination of the neck and shoulder strains. There are also a number of ergonomic assessments developed including Rapid Upper Limb Assessment (RULA) and Rapid Office Strain Assessment (ROSA) that can typically be used to assess the risk of posture related to computer-based job. This study will quantify the reduction in the ergonomic risk scores before and after the intervention as well as the improvement in the scapular stability and posture at the work surface to demonstrate the improvement, and see if this improvement in scapular stability and work surface posture is associated with a reduction in the ergonomic risk score.

Another important finding of the research is that they will help to develop evidence-based rehabilitation strategies for occupational groups. While most of the currently available literature focused on athletes or sports-related traumas in the shoulder, there are limited studies on the impact of a relevant scapular training program in the workplace, namely in IT professionals. The current study is set to address this population group and thus, provides a much needed gap in the existing studies.

Furthermore, physiotherapists, occupational health practitioners and wellness in the workplace can use the results of the study in practice. This information on association of scapular muscles training, postural treatment, cervical mobility and ergonomic performance can be utilized to design effective preventive and curative programmes to be provided to computer-based workers. Such interventions may improve musculoskeletal health but also improve work efficiency, reduce pain/discomfort related absenteeism and have long term implications on work well-being.

With this in mind, the purpose of the present paper is to systematically evaluate the effectiveness of an Integrated Scapular Muscle Training Program, both biomechanical and ergonomic parameters, in the group of workstation users who have scapular dyskinesis. The study will help to scientifically prove the value of structured rehabilitation programs as a way of diminishing the prevalence of work-related musculoskeletal issues and enhancing the overall occupational health by exploring the improvement in scapular symmetry, posture, cervical range of motion, and ergonomic ability.

## 1.5 Aim of the study

The purpose of the present study would be to assess the effect of an Integrated Scapular Muscle Training Program on scapular asymmetry, compensating the posture of a round shoulder, increasing the ROM of the cervical spine and improving ergonomic capacity in IT workers who present scapular dyskinesis. The research question that the study wants to address is: Will a systematic muscle strengthening and stabilization exercise program (emphasis on scapular muscles) lead to measurable changes in posture, musculoskeletal functioning and ergonomic functioning at work? People tend to sit for long periods of time in the highly sedentary workplace that we live in, particularly in the information technology (IT) industry.

Restrictions in the spine and shoulder girdle that occur when the spine becomes excessively stressed, such as using the computer continuously, repetitive use of the upper limbs and forward head posture. This may lead in the long run to postural disturbances, such as rounded shoulders, forward head position, and to impaired range of motion and muscular imbalance. Such changes have the ability to alter normal scapular mechanics thus leading to the emergence of scapular diskinesia. In case of the inability of the scapula to act as a stable base of shoulder movement, it can lead to the impairment of both shoulder joint biomechanics and cervical spine.

This disorder may be accompanied by weakness of the lower trapezius (lats) and serratus anterior muscles, and tightness of the pectoralis minor muscle, as well as the upper trapezius muscle. This muscular imbalance may lead to changes in the scapular movement patterns, asymmetry and scapular position. People who sit for long hours at a computer workstation are likely to suffer from scapular dyskinesis, with a prominent impact being rounded shoulders. The rounded shoulders put the scapula into a protracted and anterior tilted position, putting more strain on the muscles and joints around the scapula.

This unnatural position can also have an impact on the biomechanics of the cervical spine, a decrease in cervical range of motion and an increased predisposition to neck discomfort or pain will result. Rehabilitation plans should be considered and include three variables with such a complex interplay of scapular position and shoulder mechanics, and the importance of the cervical spine. Re-training and strengthening the muscles that stabilize the scapula can serve to correct the scapula position, enhance shoulder balance and decrease overloading the cervical spine.

A combination of strengthening and postural correction and/or exercises for neuromuscular control could be very useful for improve musculoskeletal health. The scapular muscle training program that was incorporated in this study is aimed at working on the main muscles that are involved in ensuring that the scapular positioning and stability is maintained.

The exercises are therapeutic exercises based on the principle of FITT that takes into account four factors: Frequency, intensity, duration and exercise type. The systematic training of the scapular stabilizing muscles is expected to increase the coordination of the muscles and normal scapulothoracic rhythm. The study will be conducted to also determine changes in ergonomic capability of the IT professionals, after the cervical mobility has been done, as well as to determine changes to the scapular alignment.

Ergonomic ability is the ability of a man to safely and effectively perform the work associated with the occupational position. Lack of ergonomics of workstations may make one susceptible to musculoskeletal strains particularly in the neck and shoulder areas. There are a number of assessment tools available that can help to determine the ergonomic risk in offices, such as Rapid Upper Limb Assessment (RULA) and Rapid Office Strain Assessment (ROSA).

This study aims to determine if the improvement in scapular stability and posture would contribute to the improvement of the ergonomics in the workplace, by studying the difference between the level of these ergonomic risks before and after the intervention. Moreover, effectiveness of a physical program is not a focus of research. It also aims to deliver substantiated information that can be included in physiotherapy, occupational health and exercise data and in the workplace wellness program that will aid in the creation of effective prevention and rehabilitative programs for those who may be engaged in Computer based jobs.

The implications of scapular muscle training on the biomechanics and ergonomic results could be implemented in reducing the amount of work-related musculoskeletal disorders (WMSDs) among IT professionals. Thus, the overall aim of the study is to analyze in a methodological way the improvements observed in postural position and scapular stability, cervical rotational mobility and ergonomic work in the IT workers who present scapular dyskinesis with an integrated scapular muscle training program. The outcomes of this research will be applied in developing a holistic rehabilitation strategy that will improve musculoskeletal conditions, comfort at the work place and the productivity of a specific job.

## 1.6 Objectives of the Study

The research questions of the current research are developed to examine the effectiveness of an Integrated Scapular Muscle Training Program in bettering the musculoskeletal and ergonomic results among IT professionals with scapular dyskinesis systematically. It is essential to assess the changes in postural deviations, muscular imbalance and cervical mobility due to computer work of a long duration, as computer usage is frequently related to them. The goals of the research will help determine the current biomechanical problems and assess the gains made following the intervention.

**This study has the following objectives:**

**General Objective**

The effect of an Integrated Scapular Muscle Training Program on scapular asymmetry, rounded shoulder posture, cervical range of motion and ergonomic ability was examined in IT workers with scapular dyskinesis.

**Specific Objectives**

- To determine scapular asymmetry among information technology professionals with the help of Lateral Scapular Slide Test (LSST).
- To determine the posture of rounded shoulders using Table to Acromion Distance.
- To measure cervical range of motion with the help of universal goniometer.
- To compare the ergonomic risk rates of IT professionals who had RULA and ROSA assessment tools.
- To carry out an Integrated Scapular Muscle Training Program to the IT professionals who have scapular dyskinesis.

▪ To find the difference (pre-intervention-post-intervention) in scapular asymmetry value of the participants.

▪ To compare pre-intervention and post-intervention shoulder posture of the participants that were rounded.

▪ To assess the pre intervention and post intervention cervical range of motion of the participants.

▪ To compare the pre-intervention and post-intervention of the ergonomic scores of the participants.

▪ To identify how effective the Integrated Scapular Muscle Training Program is on musculoskeletal and ergonomic outcomes in IT professionals.

According to these objectives, the research should comprehensively examine the effects of scapular muscle training with a weight on the postural position, musculoskeletal performance and ergonomic performance of participants working in computer-related workspace conditions. The findings of the research can be used in developing effective workplace rehabilitation and preventive measures to minimise the occurrence of neck and shoulder disorders among IT workers.

## 1.7 Hypothesis

A hypothesis is a tentative statement or prediction about the hypothesized relation between the variables of a study (Hoijtink, 2011). Gives some guidance for investigation and helps determine whether improvement or lack of improvement in the outcome of interest is due to the intervention proposed. In experimental research, hypotheses typically are formulated to help clarify if there is measurable improvement with a particular treatment/intervention compared to control. In our current study, the hypothesis is constructed to test the effectiveness of an Integrated Scapular Muscle Training Program to enhance the scapular symmetry, correct rounded posture of the shoulders, increase the range of motion of the cervical and increase the ergonomic ability in IT professionals diagnosed with scapular dyskinesis. The prime premise of this study was that a strengthening and retraining program of the scapular stabilizing muscles would restore the muscular balance, scapular positioning and biomechanical stresses during the workplace activities.

If the intervention is likely to be effective in addressing these factors, then the musculoskeletal and ergonomic outcomes should measurably impact the situation. In testing this assumption two types of hypotheses are formulated as follows, (null hypothesis and alternative hypothesis).

**Null Hypothesis ($H_0$)**

In this hypothesis, the intervention is assumed to have no significant effect on the variables that are being measured and the change witnessed in the outcome variables after the intervention is as a result of chance and not the exercise program.

The differences in scapular asymmetry, rounded shoulder posture, cervical range of motion and ergonomic ability will not be statistically significant between IT professionals with scapular dyskinesis after the Integrated Scapular Muscle Training Program.

**Alternative Hypothesis ($H_1$ )**

Statistically significant change in scapular asymmetry, rounded shoulder position, cervical range of motion and ergonomic capability between IT professionals with scapular dyskinesis who undergo the Integrated Scapular Muscle Training Program will be achieved.

The hypothesis is that the effects of the structured training program will be reflected in the measurable changes in scapular stability, postural alignment, cervical mobility and ergonomic performance when compared with the control group.

**Direction of the Hypothesis**

The current research uses directional hypothesis since it is assumed that the intervention will result in the enhancement of the measured outcomes. Specifically, it is assumed the members in the group who went through the Integrated Scapular Muscle Training Program will demonstrate:

- Less scapular asymmetry with the Lateral Scapular Slide Test.

The lowered position of the acromion in relation to the table, which was seen as a low distance between the acromion and the table.

- Greater cervical extension of the range of motion gauged using goniometry.

Improved ergonomic function (lower risk scores RULA and ROSA).

A test of these hypotheses will enable the researcher to establish the effectiveness of the integrated exercise program in both biomechanical and ergonomic effects among IT providers with scapular dyskinesis. The findings of the hypothesis testing will be scientific evidence of the role of scapular muscle training in prevention and management of work related musculoskeletal disorders in computer based workplaces.

## 1.8 Assumptions

Assumptions are statements that are believed true to conduct a research study but does not directly test or prove in the research. As assumed these can be research design basis and conclusions based on the results obtained from these can be made. Assumptions in an experimental study are usually associated with how the participants will act, the quality of measurement instruments and the predictability of the reaction to the intervention. The following assumptions were made in the present research work:

(1) The subjects were IT workers suffering from scapular dyskinesia,

(2) The procedure of carrying out the test was correctly followed and,

(3) The intervention program was effective in promoting scapular functioning and posture in an IT worker with scapular dyskinesia.

The first hypothesis of this research is: Computer users with long-term use of the computer tend to experience postural deviations and musculoskeletal balances mainly at the neck and shoulder region. Rounded shoulder position and scapular dyskinesis are assumed to be due to prolonged sitting, repetitive movements of upper limbs and a consistent forward head position.

The other significant assumption is that the participants involved in the study will possess quantifiable amounts of scapular asymmetry, rounded shoulders position and the loss of cervical range of motion prior to the intervention. A training course which lacks even any one of these things is not effective, since after taking it one can't see any significant enhancement. It's also assumed the tools or methods used to measure the study variables are valid and reliable.

The clinical assessment methods, such as Lateral Scapular Slide Test (LSST) are assumed to be accurate in determining scapular asymmetry. Likewise, table to acromion distance measurement is supposed to be a suitable way of assessing the rounded shoulder position. It is assumed that the cervical range of motion measurements with the help of a universal goniometer are reliable.

The other assumption of the current investigation is that ergonomic assessment scales like Rapid Upper Limb Assessment (RULA) and Rapid Office Strain Assessment (ROSA) can display accurate results in terms of assessing the magnitude of ergonomic risk involved with computer workstations.

These scales are very common in occupational health studies and are believed to be an indication of the amount of postural stress faced by IT professionals in the work process. The research also assumes that the Integrated Scapular Muscle Training Program will be done properly and on a regular basis by the participants in the experimental group.

The participants should adhere to the exercise programme given and they should be active participants during the intervention. In addition, it will be assumed that strengthening and stimulating of the trapezius and serratus anterior, the two muscles responsible for stabilizing the scapula will enhance the position and co-ordination of the scapula. The increase stability of the scapula is thought to positively affect the shoulder position and posture and cervical mobility.

The other one is the influence of the improvement in the scapula stability and posture on ergonomics of actions of workstations. Should the scapula be placed properly and the shoulder girdle, it becomes an assumption that mechanical stress on the neck, upper limbs while utilizing the computer can be diminished and the ergonomic capacity can be enhanced. Finally, it is assumed that the answers given by the subjects of the experimental and control groups will be the truth, and they will be co-operative throughout the data collection exercise.

The other assumption is that external factors, such as other injuries unrelated to the study or major changes in the daily activity will not affect the outcome of the study during the period of the intervention. The evaluation of the results of the program effectivness in improving the postural alignment, mobility of the cervical spine and ergonomic competence in brainstorming IT professionals is carried out on the basis of these assumptions. Also, it is assumed that all people who participate in the study is able to complete the exercises set and conduct them safely, without experiencing severe symptoms or side effects.

It is assumed homeworkers are healthy and are able to follow the directions for assessment procedures and intervention exercises. The time allowed for the intervention programme is also assumed to be long enough to show some measurable physiological and postural changes for IT workers with scapular dyskinesis. It is believed that the activation of muscles, the positioning of the scapula and the postural alignment that occurs during regular use of the Integrated Scapular Muscle Training Program changes throughout the period of intervention.

The present research also assumes that the environment in which the assessment takes place is in a fairly stable state for all participants throughout the assessment and intervention process. It assumes the same workstation layout and surrounding in the room, same time on the assessment and supervision on the exercises, etc., which reduces the number of variables. Also, it is assumed that the people in the control group will engage in their normal manner of work activities, but not in any structured rehabilitation or corrective exercise therapy during the study.

This assumption is important to draw the conclusion that it is the changes observed in the experimental group being primarily due to the Integrated Scapular Muscle Training Program. The other assumption is that the psychological factors of the participants (motivation, stress level, work stress) will not have a significant impact on their performance in the assessment and during the intervention program. Posture and muscle tension could be impacted by occupational stress, and the impacts of occupational stress are assumed to remain constant across the study period.

The study further says that exercises that activate muscles and postures around the scapulothoracic area may have a positive impact on the neuromuscular control and proprioception. This suggests that better neuromuscular coordination may play an important role in postural stability and functional movement patterns of IT workers. The assumption used in this study is that through intervention process and repeated assessments, the ergonomic awareness of the participants could be increased indirectly. You will assume that the intervention program will take effect as a result of increasing the awareness of the sitting position, work station habits and body mechanics.

The other assumption is that demographic variables (such as age, gender, years of occupational exposure) of the participants are not extreme enough to be likely to affect the effectiveness of the intervention. While there may be small differences between the individual, it is assumed that there are generally consistent effects on the chosen sample population. The current research also assumes that there is a sufficient amount of data to analyze and interpret the data.

The cases selected for a study are thought to be representative of the entire population of IT professionals with scapular dyskinesis and large enough to evaluate the efficacy of an intervention program. Finally, it is assumed the relationship between scapular stability, cervical mobility and ergonomic performance is clinically meaningful and measurable. With the biomechanical relationship of the cervical spine, shoulder girdle and upper extremity postures, it is assumed that improvement in one variable will positively influence the other variables associated with it.

## 1.9 Variables

In research methodology, variables are the measurable characteristics or factors that might vary or change in the course of a research. Variables help to analyse the correlation between various facets of a research problem and how one variable can affect another. In experimental research designs, variables are usually categorized as independent variables, dependent variables and in other cases, as control variables. These variables must be well known and clearly defined if for understanding the research design structure and interpreting the results of the research. The variables of this study are associated with the effectiveness of an Integrated Scapular Muscle Training Program to enhance the postural position, cervical mobility and ergonomic capacity of IT professionals that have scapular dyskinesis (Sawyer, 1995).

### Independent Variable

Independent variable – the condition influenced or manipulated by the researcher to see its effect on the other variable(s).

The intervention/treatment that is being investigated in the study. Independent variable I used for this study is Integrated Scapular Muscle Training Program. This program involves a systematic arrangement of therapeutic activities that help in strengthening and mobilizing the muscles that act to provide stability of the scapula. Resistance band strengthening exercises, scapular stabilization exercises and postural correction exercises will be used in the exercises to be incorporated into the training program.

The exercises will be applied using the principle of FITT, which refers to the frequency, intensity, time and type of exercise (Dergaa et al., 2023). There is an attempt of introducing an intervention in this study to look at the effect of scapular stabilizing muscle strengthening and retraining on IT professionals' scapular positioning, postural orientation, cervical mobility and ergonomic function.

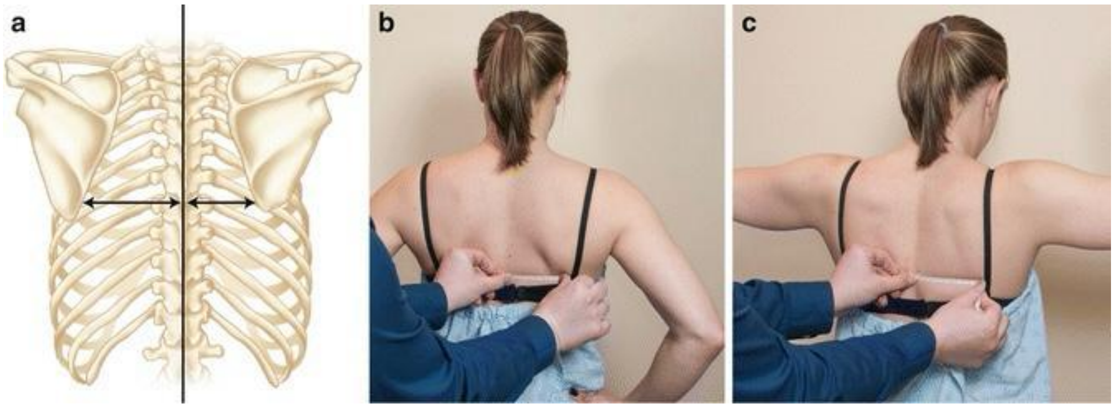
### Dependent Variables

Dependent variables refer to the results that are quantified in the research to know the impact of the independent variable. These variables are likely to vary due to the intervention that will be put in place during the research.

The number of dependent variables in the current study is as follows:

1. **Scapular Asymmetry**

If right and left scapula are not placed in the same manner, it is called Scapular asymmetry (R. M. Martin & Fish, 2007). Deviant scapular position can be caused by muscle imbalance or change in the shoulder girdle movement. Scapular asymmetry was measured in this study by using the Lateral Scapular Slide Test (LSST). The distance between the inferior scapula angle and the thoracic vertebra spinous process is measured. If the two sides do not match up in this measurement it is known as scapular dyskinesis.




2. **Rounded Shoulder Posture**

Arounded shoulder posture is where the shoulders are pushed forward as a result of tightening of anterior muscles of the shoulder as well as the weakness of the posterior stabilizing muscles. This stance can contribute to abnormal positioning of the shoulders, and may add strain to the neck and upper back. In the present paper the skill position of the rounded shoulder is defined by Table to Acromion Distance (TAD) determined by measuring the distance from the Acromion Process of the shoulder to the Table whilst the participant lies in a Supine position.

**3. Cervical Range of Motion (ROM)**

Cervical range of motion can be defined as the extent to which the cervical spine has to move. Healthy cervical motions will be required to carry out normal activities and head and neck alignment. Cervical movement can be limited in patients with scapular dyskinesia and poor posture by muscle imbalance and mechanical tension. Cervical ROM is determined in this research with the application of a universal goniometer and possible movements are assessed including cervical flexion, extension, lateral flexion, and rotation.

**4. Ergonomic Ability**

Ergonomic ability is one's capacity to maintain good posture during work and to minimize biomechanical stress when engaged in completing work. Proprioception can increase the risk of musculoskeletal problems in the neck and shoulders by poor ergonomic conditions. Ergonomic ability is measured in this study by use of standardized measures like Rapid Upper Limb Assessment (RULA) and Rapid Office Strain Assessment (ROSA). To verify the level(s) of ergonomic risk associated with activities performed on the computer workstation.Control Variables

Control variables are the factors that are held constant during the study to avoid their contribution to the study results. Being in control of these variables assists in making sure that changes in the dependant variables would have been as a result of the intervention as opposed to other external influences.

The working conditions, age range of the participants, the duration of the computer usage, and similar occupation properties among the participants are the possible control variables in the current research. The study will be able to effectively test the impact of the integrated scapular muscle training program by its consistency.

## 1.10 Theoretical Framework

A theoretical framework provides the conceptual foundation for a research study. It explains the theoretical concepts and scientific principles that support the relationship between the variables being investigated. The theoretical framework helps in understanding how the intervention is expected to influence the outcomes and provides a structured approach for interpreting the results of the study.

The present study is based on the biomechanical and rehabilitation principles related to scapular stability, muscular balance, and postural alignment. The framework integrates concepts from scapular stabilization theory, postural correction theory, and ergonomic principles to explain how an Integrated Scapular Muscle Training Program may improve musculoskeletal function and workplace ergonomics among IT professionals with scapular dyskinesis.

## Scapular Stabilization Theory

The scapula is an important part of the mechanism of the shoulder and upper limb movement. Scapular Stabilization dictates that the scapula be the fixed point from which the humerus moves during shoulder activity. Several muscles around the scapula need to work together to allow the best range of shoulder function.

These muscles are trapezius, serratus anterior, rhomboids and levator scapulae. If these muscles function appropriately together, then they will ensure proper scapular positioning and ease of scapulohumeral rhythm. But when any muscular imbalance happens because of poor posture or repetitive motions for long periods of time, the natural movement pattern of the scapula may be disrupted.

Decreased function of the lower trapezius and serratus anterior muscles and lengthened pectoralis minor and upper trapezius muscle can cause abnormal scapular motion, or scapular dyskinesis. From a theoretical perspective, scapular stabilization will follow the strengthening and retraining of these muscles and improve the motion of the shoulder. The better the scapular stabilizers coordinate, the more efficient the shoulder complex will be; decrease the amount of mechanical stress on surrounding structures.

## Postural Correction Theory

An improper body alignment can result in imbalance of the muscles and biomechanical dysfunction, as explained in the postural correction theory (Firouzjah et al., 2023). Proper postures may develop and become poor over time in the person who has to sit for many hours doing computer work.

Forward head and rounded shoulder posture are common deviations of posture. These deviations result in an abnormal alignment of the spine and shoulder girdle. The rounded shoulder posture causes anterior tilting of the scapula and brings the scapula forwards (protraction), disturbing the normal relationship between the scapula and thoracic spine.

The pectoralis minor and the top part of the trapezius muscle becomes tight and shortened, the lower part of the trapezius muscle and the serratus anterior muscle become weak as the shoulder moves forwards. This imbalance is responsible for abnormal positioning of the scapula, leading to decreased stability of the shoulder.

Postural correction strategies include strengthening weak muscles, stretching tight muscles and re-aligning the body segments. This integrated exercise program is designed to help balance these muscular imbalances by strengthening scapular stabilizing muscles and enhancing neuromuscular control of the shoulder complex.

## Cervical–Scapular Biomechanical Relationship

The cervical spine and scapular region are closely interconnected through muscular and biomechanical relationships (Alizadeh, 2019b). Several muscles that control neck movements are attached to the scapula and the upper thoracic region. When scapular alignment is altered, the mechanical load on the cervical spine may increase.

For example, forward head posture and rounded shoulder posture can increase the activation of cervical extensor muscles and place additional strain on the neck. This may lead to reduced cervical range of motion, muscle fatigue, and neck discomfort. Restoring proper scapular positioning may help reduce excessive strain on the cervical spine and improve cervical mobility.

Therefore, improving scapular stability through targeted exercise interventions may contribute not only to improved shoulder mechanics but also to improved cervical spine function.

## Ergonomic Theory in Occupational Health

Ergonomics theory pools on the relationship between people and their work. It seeks to create work elements and workplaces that impose a minimum of physical stress and optimize work efficiency.

For IT and other computer-based jobs, the prolonged sitting and improper workstation design may greatly contribute to musculoskeletal disorders. Using ergonomic assessment tools, like the Rapid Upper Limb Assessment (RULA), the amount of postural risk associated with an activity at a workplace is determined.

They evaluate variables like the body positioning, repetitive motion and workstation design to identify the risk of developing musculoskeletal strain.

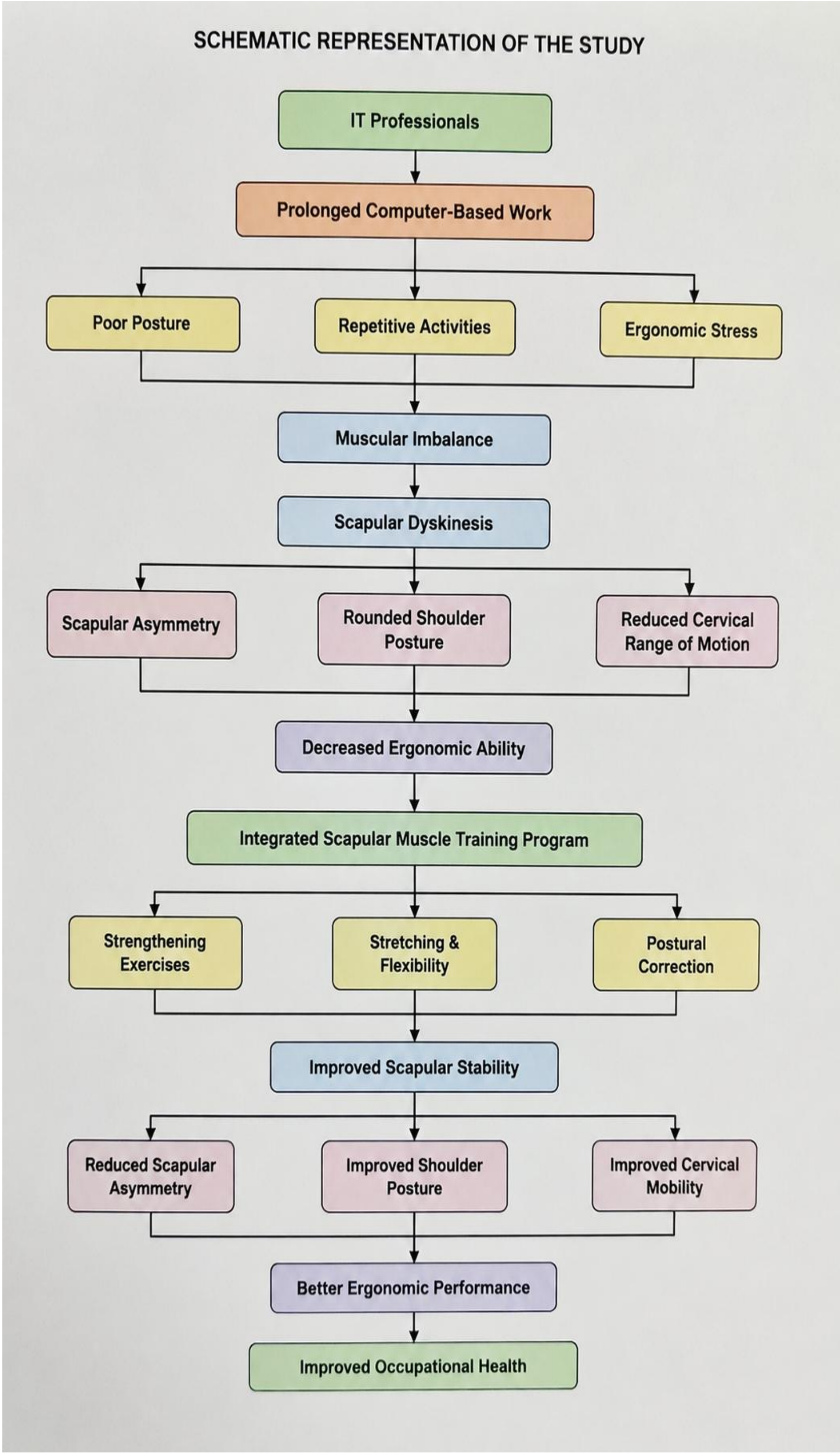
Ergonomics suggests that enhancing posture and muscle stability can lower biomechanical stresses during the work activity. Improving the strength of the scapular stabilizing muscles could help people maintain a better working posture and minimize the risk of an ergonomic muscle injury when working in front of a computer.

## Integration of Theoretical Concepts

The theoretical framework of the present study integrates these biomechanical and ergonomic concepts. The framework proposes that prolonged computer use among IT professionals leads to postural deviations, muscular imbalance, and scapular dyskinesis. These conditions may contribute to reduced cervical mobility and increased ergonomic risk during workstation activities.

The Integrated Scapular Muscle Training Program is expected to strengthen scapular stabilizing muscles, restore muscular balance, and improve postural alignment. Improved scapular positioning may reduce mechanical stress on the cervical spine and enhance cervical range of motion. Additionally, improved posture and muscular stability may contribute to better ergonomic performance during computer-based work.

Thus, the theoretical framework supports the assumption that targeted scapular muscle training can influence both biomechanical and ergonomic outcomes among IT professionals with scapular dyskinesis. The framework provides a conceptual basis for evaluating the effectiveness of the intervention used in the present study.


SCHEMATIC REPRESENTATION OF THE STUDY
IT Professionals
Prolonged Computer-Based Work
Poor Posture
Repetitive Activities
Ergonomic Stress
Muscular Imbalance
Scapular Dyskinesis
Scapular Asymmetry
Rounded Shoulder Posture
Reduced Cervical Range of Motion
Decreased Ergonomic Ability
Integrated Scapular Muscle Training Program
Strengthening Exercises
Stretching & Flexibility
Postural Correction
Improved Scapular Stability
Reduced Scapular Asymmetry
Improved Shoulder Posture
Improved Cervical Mobility
Better Ergonomic Performance
Improved Occupational Health

## 1.11 Delimitations of the Study

Delimitations are the boundaries and/or limitations that are consciously established by the researcher in the design of the study.

These borders will be helpful in informing boundary of the research as well as any context in which the research will be carried out. Delimitations do not imply weaknesses of the study but rather specify the choices made by the researcher for limiting the study to a specific area of variables, sample of population, and context of research.

Due to the nature of the present study, some delimitations have been set out to investigate the effect of an Integrated Scapular Muscle Training Program for IT Professionals suffering from scapular dyskinesis.

First, the study is limited to those who work in IT, typically in front of a computer for longer periods. The subjects in the study consist of individuals working in the IT sector and having high computer workload. This delimitation enables the study to focus on the population which is more susceptible to musculoskeletal strain caused by repetitive use of the upper limbs and long sitting positions, and postural deviations.

Secondly, the study only includes participants that demonstrate scapular dyskinesis and rounded shoulder posture. No research is done on people without these postural deviations. The concept of delimitation allows the study to specifically focus the effect of the intervention specifically on those who already have measurable postural and/or scapular abnormality.

Third, the study focuses on certain biomechanical and ergonomic parameters like scapular asymmetry, rounded shoulder posture and cervical range of motion, ergonomic ability. In the context of this study, other factors related to MBD, such as, but not limited to, pain levels, muscle strength and psychological (mental) factors will not be addressed. Restriction of variables in the research design helps to keep the study clear and manageable.

Fourth, the study examines the ergonomic ability using a single set of standardized assessment tools: the Rapid Upper Limb Assessment (RULA) and Rapid Office Strain Assessment (ROSA). This research does not use the other ergonomic assessment methods. This delimitation assists the participants in understanding the ergonomic risk in the workplace in a similar way. Fifth, the intervention employed in this research was only an Integrated Scapular Muscle Training Program in a structured program.Fifth, this study's intervention was a structured Integrated Scapular Muscle Training Program for the strengthening of scapular stabilizing muscles.

The program is made up of exercises that are performed according to the FITT principle, such as scapular stabilization exercises and resistance training with resistance bands. Other rehabilitation techniques such as manual therapy, the use of electrotherapy and ergonomic work station changes were not included in the intervention.

Sixth, the study is conducted over a specified intervention and during the study the subjects of the experimental group perform the specified exercise program. Limits of training programme is the specified study period, no follow-up after training the intervention. Depending on the design of the research and practicality, the study will have a set sample size and age range of participants. The subjects whose age is not within the age limit or have medical condition which might affect the exercise program are excluded from the study.

Finally, research is conducted in specific workplace/organizational settings in which the IT practitioner is working. The findings of the study are therefore only applicable to those working in similar jobs, and may not be applicable to those in different types of jobs. The delimitations aid in setting boundaries for the present research work and help to ensure that it stays focused on the effectiveness of the Integrated Scapular Muscle Training Program in improving scapular asymmetry, rounded shoulder posture, cervical ROM and ergonomic ability among IT professionals with scapular dyskinesis.

## 1.12 Significance of the Study

It's an important study since it is tackling one of the emerging occupational health problems of importance in IT practitioners, namely work related musculoskeletal disorders due to extended hours of sitting in front of the computer along with lack of correct sitting posture. In an age where technology is increasingly critical, and increasingly finding jobs where the computer plays a key role, these roles require long periods of sitting and repetitive use of the upper body. In many instances these requests will cause dysfunction such as shifts in position, muscular imbalances, neck pain, shoulder pain and reduced function.

Thus, it is increasingly important to have effective preventive and rehabilitative interventions that can be used to treat the biomechanical and ergonomic issues. Current study is significant as the impact of Integrated Scapular Muscle Training Program on improving the scapular asymmetry, rounded shoulder posture, cervical range of motion and ergonomic ability among IT workers with scapular dyskinesis is investigated.

The findings of this study can contribute to expanding the occupational physiotherapy, ergonomic rehabilitation and musculoskeletal health knowledge. The study will have benefits for physiotherapists and rehabilitation professionals. It could provide scientific evidence of the effectiveness of scapular stabilization exercises and postural correction programs in the occupational population.

The findings might prove beneficial to formulate an organized program for "postural dysfunction and scapular abnormalities" for computer-based workers. The practitioner in the areas of occupational health and workplace wellness program could also benefit from the findings of the research. Understanding the connection between scapular instability and cervical mobility and ergonomic outcomes may allow organizations to design programs to reduce the occurrence of MSD in their employees.

Effective rehabilitation and ergonomic awareness courses can help create a more comfortable workplace, minimize fatigue and enhance workplace efficiency. Another one of the other major implications of the research is when it comes to preventing chronic musculoskeletal problems. If chronic neck and shoulder disorders can be prevented from becoming identified and corrected early, IT professionals may benefit from:

Rounded shoulder posture and scapular dyskinesia. Better posture and muscle balance may minimize mechanical stress on the spine of the neck and shoulder girdle when using a computer. Besides the ergonomic point of view the study is notable, too.

The results of this study may also prove informative in the question on work postural risk when assessed by standard assessment tools (RULA, ROSA) among IT professional with respect to their ergonomic ability. Results can contribute to the need for combining exercise based rehabilitation with ergonomic education for better occupational health results. Moreover, the results of the present study could be useful in future studies on the subject of occupational rehabilitation and musculoskeletal physiotherapy. Due to the small number of studies targeting scapular muscle training programs in IT professionals, however, the present study can be considered a reference in future studies with a greater number of participants or with other professional groups.

The outcomes of the research can also benefit the IT professionals, by informing them about the importance of posture, the importance of using ergonomic techniques and the importance of exercising when working in front of a computer. This gained knowledge of exercising preventatively may encourage individuals to do more healthy work habits and reduce the risk for musculoskeletal discomfort.

It is expected from the above that the present study will contribute valuable concepts in the fields related to physiotherapy, occupational health, ergonomics, workplace rehabilitation and research on musculoskeletal system to the extent that it throws light upon the effectiveness of an Integrated Scapular Muscle Training Program in IT professionals with scapular dyskinesis.

## 1.13 Operational Definitions

Operational definitions provide definition to terms and variables that are important to the study as they are measured in or applied to the study. These definitions help to clarify and have a consistency in the understanding of the concepts included in the research.

**Integrated Scapular Muscle Training Program**

The Integrated Scapular Muscle Training Program (ISMTP) is a structured exercise program aimed at enhancing scapular stability, muscular balance, posture and upper body function in the present study. The exercises involve scapular stabilization, resistance training, postural training, stretching and neuromuscular coordination training according to the FITT principle.

**Scapular Dyskinesis**

Scapular dyskinesis is a scapular (shoulder blade) dysfunction that occurs during movement. Scapular dyskinesis in this study encompasses any clinical assessment finding of visible scapular asymmetry, winging or excess scapular protraction.

**Scapular Asymmetry**

Asymmetry of scapulae is the unequal placement of the right and left scapulae. Lateral Scapular Slide Test (LSST) is used for this study to assess scapular asymmetry based on the difference in scapular distance measurements, which would reflect scapular positioning.

**Rounded Shoulder Posture**

Rounded shoulder posture is one of the postural deviations that occurs when the shoulders are in front of the body because of muscular imbalance and poor posture. In this present study, the measurement method of Table-to-Acromion Distance (TAC) is used to measure rounded shoulder posture.

The range of motion in your neck.The movement of your neck.

Cervical range of motion is the amount of movement that the cervical spine has along various planes: Flexion, extension, lateral flexion, and rotation. A universal goniometer is used to measure cervical range of motion in this study.

**Ergonomic Ability**

Ergonomic ability is the ability of a person to have a proper posture and to reduce biomechanical stresses during the execution of the job. The ergonomic ability in this present research is determined by using the Rapid Upper Limb Assessment (RULA) and Rapid Office Strain Assessment (ROSA) scores.

**IT Professionals**

Workers in the information technology industry whose job functions require extended use of computers for typing, mouse usage, programming, data management and computer-related tasks.

**Musculoskeletal Disorders**

MSDs are conditions of the musculoskeletal system that affect muscles, joints, tendons, and related structures, which can involve painful and/or uncomfortable conditions, or can result in functional limitations and/or reduced mobility. The most prevalent area of body complaints in the present study is in the neck, shoulder, and upper back region as a result of long periods of computer use.

## 1.14 Summary of the Chapter

The background and justifications of the study on the increasing problem of musculoskeletal disorders associated with working in the IT industry have been presented in the previous chapter. A few of the most significant contributing factors to scapular dyskinesis and rounded shoulder posture and cervical dysfunction included prolonged computer use, repetitive use of upper limbs, poor posture and no ergonomics.

This chapter covered the importance of the stability of the scapula to normal shoulder mechanics, and the relationship to function of cervical spine. It added that the muscle imbalance that occurs in this postural alignment, and the adoption of this postural schema for extended periods of time, may impact how the scapula is aligned and result in biomechanical stresses on the cervical area. The ergonomic risk factors for OMSD also were described. This need raised the importance for further studies where effectiveness of scapular muscle training program could be determined particularly in IT professionals.

Problem statement, purpose of the study, objective, hypotheses, assumption, variables, theory, delimitation and significance of the study were presented and operational definition was presented. The study relied on the theoretical underpinnings of scapular stabilization theory, postural correction theory, cervical-scapular biomechanical relationships and ergonomic principles. These concepts also guided the scientific aspects of this study and how an Integrated Scapular Muscle Training Program could influence posture, cervical mobility, scapular positioning and ergonomic performance in IT professionals who suffer from scapular dyskinesis.

Overall, the chapter laid emphasis on the conceptual and scientific groundwork for the subsequent research and provided an unambiguous direction to research the effectiveness of the intervention programme on the biomechanical and ergonomic results in IT workers

# CHAPTER 2

# REVIEW OF LITRATURE

## 2.1 Occupational Computer Use and Upper Quadrant Musculoskeletal Disorders

In addition to the above, educating oneself about the upper quadrant musculoskeletal disorders and understanding that these disorders are acquired over time and occur as a series of physiological and biomechanical chance is crucial. There are reports of transient muscle fatigue that may cause a mild discomfort to people. If this is not followed by adequate recovery from the risk factors, however, then it can lead to states of chronic pain, which are characterized by chronic inflammation, improper neuromuscular control, and adaptations to the soft tissues.

These disorders are essentially developed due to the concept of load imbalance from a biomechanical perspective. The musculoskeletal system is seen to be best suited for environments that are dynamic, with motion and changing positions. Working on the computer, however, exerts static loading conditions, in which some groups of muscles are kept in constant activity and other are underused. As an example, the upper trapezius and cervical extensors usually become overstimulated, and deep cervical flexors and lower trapezius are usually inactive. This is an imbalance that disrupts the force transmission and therefore leads to sub-optimal movement patterns.

The other key concept that is essential is one of altered motor control. Repeated movements combined with a poor posture may cause a change in the recruitment of muscles during movement. Research has demonstrated that patients in pain with the neck and shoulder have slow-onset of the stabilising muscles and use more superficial muscles. This disrupted motor pattern aggravates the joint, and perpetuates the pain and dysfunction cycle.

These are also the muscles that can be used to classify the musculoskeletal disorders of the upper quadrant. These include:

Muscular diseases, such as the syndrome of muscle fatigue and myalgia.

Tendinous disorders (Tendinitis and Tendinosis).

- Disorders of the joints like cervical facet joint.
- Nerve related diseases such as cervical radiculopathy and thoracic outlet syndrome.

Muscle, skeleton and posture syndromes are the most common and are thosethat occur in the computer user such as the trapezius syndrome, the levator scapulae and the pectoral syndrome. These changes in soft tissue can also result in reduced mobility in the joint and secondary joint dysfunction over time. The scapular mechanics is of particular importance in the case of the upper quadrant disorders. Scapula is a dynamic stabiliser and plays an important role in the transfer of forces from the upper limb to the axial skeleton.

Muscle imbalance and/or poor posture alters the scapular position, which has implications for the entire kinetic chain. Can result in abnormal loading of shoulder joint, excessive loading of upper structure of the neck and inefficient use of upper limb.

Another factor is a lack of active muscle movement in the low levels – as is typical of working with the computer. The computer activities are low intensity and are continuous, unlike the high intensity activities in which individuals can rest and recuperate. Such exercise has been reported to be more exhaustive with time as it does not allow sufficient rest and relaxation of muscles. Low force activities may therefore be very uncomfortable when they are sustained for long periods of time.

Organizational factors and environmental factors are also important for the musculoskeletal disorders. Delays in taking adequate breaks, excessive workload demands and ergonomic ignorance are some of the factors that result in continued exposure to risk factors. The majority of the time, employees are not instructed on how to position their work stations properly; thus, the bad habits are formed unconsciously.

Also, genderization in the incidence of upper quadrant disorders has been introduced as some researchers believe that women have a higher incidence of upper quadrant disorders compared to men. These differences are due to differences in muscle strength anthropometric factors and exposure in the workplace. Furthermore, individuals' pain perception and coping mechanisms are also factors in symptom experience and reporting.

The chronicity of these disorders is another problem. Unchecked, acute musculoskeletal pains may eventually change into chronic pain syndromes. The chronic conditions are usually accompanied by a ‘central sensitization', where the nervous system becomes oversensitive to pain. This results in a pain that takes up its time ceaselessly even if the main tissue damage is not touched in the management. These recent studies further demonstrated that the biopsychosocial model is of vital importance in developing the work-related musculoskeletal disorders (WRMD).

This model proposes that biological (including postures and muscular imbalance), psychological (stress and anxiety) and social (job satisfaction and work environment) factors all interact to influence the onset and development of these disorders. A holistic perspective that is important when generating effective intervention strategies. The latest style of preventative practice is a focus on detecting risk factors early, or preventing risk factors in the workplace.

This involves ergonomic redesign, flexible work stations and promoting an active break as well as introducing work place exercise programmes. Amongst them, exercise-based interventions that aim at correcting postures and stabilising the scapula have demonstrated promising outcomes as to the reduction of symptoms and improvement in functional outcomes.

Moreover, there are new technological solutions that are under development, like wearable sensors, posture-monitoring devices, which can offer real-time posture and movement feedback. These can be leveraged to build awareness and drive a change in computer behaviours. To summarise UQ-MSDs are complex, multifactorial, with biomechanical, physiological and psychosocial factors related to computer work.

They are affected by work-related motor control errors and ergonomics, repetitive movements, and prolonged static loading. The study of all these mechanisms requires a comprehensive understanding of these mechanisms in order to develop preventive and rehabilitative strategies that could be targeted at specific groups, particularly the high-risk group, such as IT professionals.

## 2.2 Scapular Dyskinesis and Muscle Imbalance

Scapular dyskinesis is the non physiologic movement of scapula motion. It is also a very important structure in the movement of the upper limbs as it provides a stable foundation for the movement of the humerus and it allows to generate and transmit forces from the arm to the trunk and vice versa. Even slight disturbances in scapular positioning and/or movement can have dramatic effects on the mechanics of the shoulder, the function of the cervical spine and overall upper quadrant function.

Normally the scapula will have the coordinated movement of humerus, called scapulohumeral rhythm. This activity is held together by a balance between a number of muscles, mostly the trapezius (upper, middle and lower fibers), the serratus anterior, rhomboids and levator scapulae.

These muscles all work together to control scapular upward rotation, posterior tilt and external rotation when lifting arms. When this coordination is disturbed, there are abnormal scapular motion patterns that arise and result in scapular dyskinesis. Scapular dyskinesis has been thought to be one of the most important factors contributing to muscle imbalance. In patients, who had undergone continuous computer activities in particular computer experts, the following are repeated motions and prolonged poor posture, which cause anticipatory trends of muscular disequilibrium.

Overactivity and tightness is usually seen in the upper trapezius, levator scapulae and pectoralis minor, whereas the lower trapezius and the serratus anterior are weak and inhibited. While this imbalance alters the rest posture of the scapula and disrupts the scapula dynamic control.

One of the most common crossed syndromes which can be associated with scapular dyskinesia is the upper crossed syndrome. Anterior closure of chest muscles and upper cervical extensors and posterior weakness of deep cervical flexors and scapular stabilizers- this presentation.

This results in scapula adopting a longstanding, antero-inferior sloped and internally rotated position. This abnormal position will decrease the subacromial space and the chances of impingement of the shoulder and pain.

Dyskinesia of the shoulder blade can be observed in many different ways; depending on the pattern, it may be termed one of several scapular dyskinesias. These include:

Type I: Elevation of the inferior angle (of anterior tilting)

Type-II: Medial Border Prominence (Internal Rotation).

Type III: Scapula hyper translation or early elevation of the scapula.

Type IV: Symmetrical movement in the normal type.

Such classifications provides doctors certain knowledge of muscle the dysfunction and can then create a rehab treatment plan. Scapular dyskinesis has biomechanical implications on the static and dynamic stability of the shoulder complex. T

he scapula gives a base of glenohumeral joint motion and its mal-positioning is able to change joint alignment resulting in an inefficient transmission of force. This will stress the rotator cuff muscles and the structures surrounding them which can lead to pain, fatigue and decreased functional capacity.

A scapular stability is especially important in relation to the role that the serratus anterior performs. Failure to rotate the scapula upwards and tilt backwards enough due to weakness or lateness of this muscle. Weakness of the lower trapezius on the opposite side also helps to perpetuate these abnormal movement patterns, as weak lower trapezius contributes to poor scapular control and over recruitment of the upper trapezius.

This instability is compounded by another vicious cycle: When the mechanics go wrong, then the muscles will go wrong as well. Cervical spine biomechanics is also highly related to scapular dyskinesia in addition to shoulder dysfunction. The scapula acts as a point of attachment of a number of muscles that affect the movement of the neck such as upper trapezius and levator scapulae. These muscles can overreact when the position of the scapulas is changed resulting in a greater tension in the cervical area.

This can make range of motion of the neck compromised, cause neck pain and promote postural fatigue, especially for those who are seated for extended periods of time. Another factor of scapular dyskinesis development is neuromuscular control. To achieve correct scapular movement, it is necessary to have accurate timing and coordination of stabilizing and mobilizing muscle.

Stage of muscle elongation can lead to delayed stabiliser activation in the individual e.g. serratus anterior muscle and/or overactivation / early activation of compensatory muscles e.g. upper trapezius without actual muscle imbalance. This distorts the pattern of recruitment thereby decreasing the efficiency of movements and raising the chances of injury. Fatigue also makes the scapular dysfunction worse.

During long duration activities (e.g., working at the computer) the muscles responsible for posture are continuously engaged and thus become fatigued. Once muscles fatigue, they will cannot support the scapula correctly and overtime, posture and movement quality will decline. Scapular dyskinesis has been clinically shown to be extremely prevalent in persons with uncomfortable shoulders and also seen in persons without discomfort and poor posture. The incidence is quite high in the workplace especially among IT professionals as they are exposed to occupational risk factors like sitting a lot, doing repetitive work and poor ergonomics.

Scapular dyskinesis typically is evaluated with observational and clinical tests including Scapular Dyskinesis Test or Lateral Scapular Slide Test (LSST). These tests can be useful to help identify asymmetry and abnormal gait patterns and muscle imbalances. These impairments are crucial in identifying the strategy to use in formulating intervention strategies. Therapy interventions aimed at the treatment of scapular dyskinesis are mainly aimed at rectifying muscle imbalance and returning the normal movement patterns. Activities to improve serratus anterior and lower trapezius are typically used to improve stability of the scapula.

Tight muscles to stretch out include pectoralis minor, and upper trapezius muscles. Rehabilitation training also should involve correcting the posture and neuromuscular re-education training. Preliminary evidence has shown the effectiveness of scapular muscle training in integrated muscle training programs for improved scapular alignment, pain reduction and functional performance.

A combination of strengthening exercises and flexibilities motor control based exercise treatments that work towards the structural and functional aspects of the condition. The interventions are especially applicable when working with IT practitioners and relevant to the issues that can impair functioning in the occupational posture and activity area of occupational performance.

In conclusion, scapular dyskinesis is a multifactorial disorder that is primarily due to the muscle imbalance, the neuromuscular control and poor posture. It has important implications for the function of the shoulders and the cervical spine and occurs in high numbers amongst the population of those who undertake long term interaction with a computer. Understanding the mechanisms of scapular dyskinesis is key for the development of specific rehabilitation interventions that would lead to muscle balance, posture and musculoskeletal health.

## 2.3Rounded Shoulder Posture/Pectoralis minor tightness

One of the most prevalent postural deviations that are seen among people involved in more computer-based tasks, especially those working in the IT field are the rounded shoulder posture. Characterized by forward rotation of the shoulders, protraction and internal rotation of the upper limb. It may be described as being a postural imbalance that is tight yet pectoralis minor is tight and posterior scapular stabilizers are weak and hence presents with marked changes in upper quadrant biomechanics.

Pectoralis minor is a small but important muscle that originates on the anterior sides of ribs 3 – 5 and is inserted at the coracoid process of the scapula. Primarily it moves in directions of scapular protraction, anterior rotation and down rotation. Under normal circumstances, Pectoralis Minor acts in conjunction with other muscles about the scapula to provide optimum stability of the scapula during upper limb motion. However, if this muscle is short or tight, it will constantly pull the scapula in an anterior and inferior (down) direction and change the position of the scapula.

Pectoralis minor tightness is an inherent characteristic of people who have maintained the sitting postures with forward head and rounded shoulder postures. In these positions, the muscle will be kept in a shortened position over long periods of time which causes it to adaptively shorten as time progresses. The structural change decreases the suppleness of the muscle and diminishes its capacity to restore to its usual rest position, which makes it part of continued deviation of position.

This tightness of the pectoralis minor is not something to be analysed lightly as this has biomechanical significance. In case of scapula being pulled into anterior tilt and protraction the capacity of scapula to make upward rotation and backward tilt during elevating the arm is impaired. Scapular changes cause the subacromial space to be smaller, and can increase the risk of impingement of the rotator cuff tendons and subacromial structures. In the long run this may cause pain, inflammation and loss of shoulder functionality.

A tight pectoralis minor will not only create a rounded shoulder position it will also be a symptom of the pattern of muscle imbalance. The tendency of the imbalance is tight anterior muscles (hyperactive—the anterior scalene muscles, pectoral muscles major and minor) and posterior muscles that are weak and inhibited (sub moyen trapezius muscles, middle and lower trapezius muscles, rhomboids).

This consequently creates a dysfunction of the force couple that needs to occur in order to maintain an appropriate scapular position and motion. Upper crossed syndrome is a useful theory to explain this syndrome.

This syndrome features upper trapezius and pectoral muscles that are tight and deep cervical flexors and scapular stabilizers that are weak. Both are prevalent among computer users and a common look is forward head posture and rounded off shoulders. The presence of this syndrome, is once again a sign of the role of muscular imbalance in the development of the dysfunction in posture. Not only is the problem of the rounded shoulder posture kinesiologically an influence on the static attitude but it is also an influence on the dynamic patterns of movements.

Throughout the shoulder elevation, the scapula does not rotate sufficiently to face upwards instead the scapula is held protracted and tilted anteriorly. This results in inadequate movement, loss of energy and mechanical overworking of the shoulder joint. Also, the scapular kinematics may be changed resulting in the cervical compensatory motions, which can be the cause of neck pain and impaired mobility.

Neuromuscular control implications also exist with the tightness of the pectoralis minor. This may affect the normal way of muscle activation as shrunken muscles are at a higher resting tone and don't extend as much. At the same time, the muscles that are lengthened such as the lower trapezius may be inhibited (meaning they are weaker) and thus unable to pull the scapula into a good stabilization position.

This asymmetry in muscle contraction helps to create poor coordination and develop dysfunctional movements even more. The other factor that should be taken into consideration is the effect of sitting on thoracic spine position. Rounded shoulder position usually is accompanied by thoracic kyphosis, which further compromises the shoulder position.

The more the thoracic spine is flexed the more the scapula is pushed into a protracted, anterior tilted pose. This is a good illustration of the dependency of the thoracic spine position and the scapular position, and its significance in the evaluation and treatment of postural disturbances in the kinetic chain.

The table-to-acromion distance measurement or the pectoralis minor length test is the most commonly used method of clinical assessment of pectoralis minor tightness. Test subject is in supine position and vertical distance from back of the acromion to the supporting surface is measured in this test. The anterior shoulder structures will be shorter the further away, and is often associated with rounded shoulder posture.

It is established that the occurrence of rounded shoulder position is very high among people with sedentary ways of life especially those who are employed in desk jobs. The number of hours that someone spends using a computer has been correlated well with the occurrence of postural abnormalities such as forward head posture, and rounded shoulders.

Such postural alterations are usually accompanied by such symptoms as neck pain, shoulder pain and loss of functional capacity. Correctional intervention strategies include tightness of pectoralis minor and rounded shoulder position, aiming for a restoring muscle balance and postural alignment.

The stretching exercises that are focused on the pectoralis minor and major are usually aimed at lengthening the muscles and decreasing the anterior pull of the scapula. Meanwhile, exercises that will encourage the posterior scapular stabilizers, the lower trapezius and rhomboids are needed to return the proper position of the scapula.

Ergonomic changes and postural correction exercises are also of great importance to manage this condition. Education of people on the proper sitting posture, rearrangements of the work stations, and periodical incorporation of movement breaks would be useful in alleviating constant pressure on the musculoskeletal system.

Also, neuromuscular re-education is done to improve the movement coordination of scapular muscles and activation patterns. Recent studies also lay stress on the significance of integrated exercise programs that involve combination of the stretching, strengthening and motor control training.

These programs have shown to be effective in the area of improved posture, reduced pain and enhanced function. This type of intervention is more relevant for specific occupational groups such as occupational therapists, IT workers and others that target the cause of the postural dysfunction directly.

To sum up, one of the major issues that promote the emergence of the rounded shoulder position is caused by pectoralis minor tightness particularly for the people who have been exposed to excessive computer use. This muscle imbalance and resultant scapular change of mechanics is an important factor to the shoulder and cervical spine.

Specific rehabilitation measures are needed to improve the posture, reduce musculoskeletal stress and overall occupational health in order to address these issues. Scapular Positioning and Cervical Biomechanics

## 2.4The location of the scapula and cervical biomechanics

Thisare an important subject of upper quadrant function. Although scapula and cervical spine are not separate entities, there are a multitude of muscles, ligaments and neural mechanisms inter-depedent between the two.

The movement of the scapula or displacement of the scapula is directly related to the cervical mechanics that would lead to pain, restriction of movement and loss of function. A number of muscles attach the upper limb to the axial skeleton and the scapula is an important point of attachment.

Of these, the upper trapezius, the levator scapulae and rhomboids are extremely helpful in completing the linkage between scapular motion and the cervical spine. They are muscles located between the cervical vertebrae and the scapula and as they are connected between neck and shoulder they are considered as functional bridge.

Therefore, this may change the length-tension curve of these muscles and lead to changes in the position of the scapula, its stability and movement at the cervical level. A theorised normal scapular position is considered to be a slight retraction, posterior rotation and upward rotation of the scapula during arm elevation.

This will give an adequate distribution of loads across the shoulder complex and minimise the load on the cervical spine.

However, the scapula is protracted, downwardly rotated and anteriorly tilted in poor posture patients, particularly those who use a computer regularly. This abnormal posture has the effect of disrupting the normal biomechanics and putting stress on the cervical structures. When the head is forward and is often associated with scapular protraction, there is a high mechanical load on the cervical spine.

The centre of gravity also shifts forward with forward motion of the head and the muscles that are required to maintain the head position become more active. This causes protracted shortening of the muscles like the upper trapezius and levator scapulae which causes muscle fatigue, tightness and pain.

These combined with the distorted scapular positions create a vicious cycle of dysfunction which continues to create neck & shoulder problems. There is also another type of dyskinesia: scapular dyskinesia, which will also cause greater biomechanical stress in the cervical spine. Scapula does not have a stable base to shoulder movement, which has resulted in the development of some compensatory processes in the cervical spine in order to function. To apply case when adequate upward rotation of scapular is not available and the body compensates with increased extension or lateral flexion of the cervical spine as the body attempts the necessary movement (e.g., arm elevation).

These compensations place greater stress on the cervical joints and soft tissues causing pain and decrease in motion. Special interest regarding the concept of regional interdependence is the scapula-cervical relationship. The idea is that a malfunction in a particular part of the body may help in the symptoms of another part although these parts are not necessarily close to each other. In this region, the cervical dysfunction could be responsible for scapular malalignment and vice versa.

This two way connection implies the importance of treating and assessing both the areas simultaneously.

The postural control needs to be coordinated at the neuro muscular level, such as the cervical muscles and the scapular stabilizers. A lack of activation of stabilizing muscles (such as lower trapezius, serratus anterior, with excessive activation of upper trapezius) is a common occurrence in those who have scapular dysfunction. Such imbalance distorts the movement patterns and causes more stability to be dependent on cervical musculature which results in too much strain and fatigue.

The most important role in this interaction is played by muscle length-tension imbalance. A weak lower trapezius muscle might have a balance relationship with the tight muscles, such as the pectoralis minor and/or levator scapulae, which pull the scapula into a protracted and elevated position. This makes the cervical muscles stabilize and compensate to lift and keep the head and shoulders in place in addition to the mechanical load.

Another key is that the position of thoracic spine can influence the biomechanics of the scapula and cervical spine. Scapula position – increase thoracic kyphosis – very common in sitters; mobility with scapula is decreased. This change in chest curve will alter the scapula's position to be more protracted with a change in cervical position that will cause neck muscles to be strained.

The thoracic spine, scapula and the cervical spine, then, constitute a kinetic chain. Even a combination of prolonged static loads, seen in computer work for example, is a factor in this dysfunction. The prolonged positions involve maintenance of low intensity muscle activity especially on the cervical and scapular stabilizing muscles. It eventually leads to tiredness of the muscles and a lack of “good alignment” ability.

Similarly, when fatigue is present, the compensatory posture, such as a bent forward head posture, and shoulder protraction posture will attempt to adapt to fatigue, but will increase the biomechanical stress. There has been a good correlation between scapular positioning and neck pain in the clinical trial.

An exaggerated protraction of the scapula, a decrease in upward rotation and a distortion of the muscle activity pattern are commonly found in people who have neck pain. Additionally, loss of ROM at the C-spine has been correlated with poor scapular movements, suggesting poor scapular movement as one of the sources for the loss of C-spine ROM. The scapula-cervical relationship is evaluated in the position of stillness and the motion of the scapula and cervix. Impairment identification is usually done with observational analysis, range of motion testing and muscle strength testing.

However, it is helpful to plan and diagnose treatments by the goniometry of cervical motion and clinical examination of scapular location. Interventions which targeted this relationship were muscle balance, neuro-muscular control and posture correction. For strengthening scapular stabilizers, particularly lower trapezius and serratus anterior, the exercises are needed for improving the position of the scapula.

The tight muscles, including the upper trapezius, levator scapulae and pectoralis minor, are stretched at the same time to decrease the abnormal forces on the scapula. Ergonomic interventions and postural correction exercises play an important role as well in the management.

Mechanical stress on the cervical and scapular areas can be greatly minimised by workstation set-up, encouraging appropriate sitting position, and introducing frequent movement breaks. The neuromuscular re-education strategies are used to improve coordination of scapula and cervical spine to allow for pain free and efficient movement. Some recent research has indicated that combined rehabilitation programs (simultaneous treatment of scapular and cervical dysfunction) are better.

It has been proven that these programs are beneficial for enhancing posture, cervical range of motion, pain, and function. Many of these occupations, for which dysfunction is directly targeted, are particularly benefiting from these interventions.

**A short summary:**

The scapular position plays an important role in the optimality of cervical biomechanics. In most cases, the change of scapular position due to the muscle imbalance and bad posture, can markedly increase the mechanical load on the cervical spine.

Introducing Pillar 1, Pillar 2, and Pillar 3 within a single website unit emphasizes the need for a holistic and comprehensive approach that considers the combined effects of all the pillars, which are particularly important in terms of restoring muscle balance, optimizing posture and enhancing the neuromuscular control that results in overall health and function of the musculoskeletal system.

## 2.5 Ergonomic Risk Assessment (Systems) in Office Workers (RULA and ROSA)

Over the years, there had been a growing trend of work-related musculoskeletal disorders (WRMSDs) in desk-based workers, giving importance to the need for ergonomics assessment for workplace health and safety.

Office based occupations especially those in the information technology (IT) segment require a lot of sitting time, repetitive upper limb movements, and held postures which are drivers in the development of ascending patterns of biomechanical strain.

Ergonomic risk assessment tools should be used as it helps identify the presence of hazards, it provides quantitative estimates of the risks to postures and it prevents interventions.

There are several definitions for ergonomics involving one human who studies another human and the interaction between him and his work environment and optimizes well-being of this one human being, including his performance to each other human or the whole system. For computer based work, ergonomics involves the workstation setup and design of work stations to promote neutral posture to minimise muscle and joint tensions, thereby reducing musculoskeletal injury.

Some of the more popular ergonomics assessment methods for detecting postural risk to office workers are the Rapid Upper Limb Assessment (RULA) and the Rapid Office Strain Assessment (ROSA). These two are observational techniques and are fast, easy, hazard evaluation techniques that do not involve high-tech equipment.Rapid Upper Limb Assessment (RULA)

RULA is a systematic tool that has been developed to evaluate the risk factors associated with upper limb musculoskeletal disorders in individuals (Dockrell et al., 2021). Especially for analysis of neck, trunk and upper extremities postures during inactive or repetitive activities such as computer work  it could be argued that this is particularly applicable.

The RULA test Classifies the body into two broad categories:

• GROUP A: WRIST, LOWER ARM AND UPPER ARM.

1– Group B: Neck → Trunk and Legs

Body Parts: The Body Parts are rated by there positions, movement of the body parts and deviation of them from their neutral position. Static or repetitively means apart from the usage of the muscles one distinguishes static muscles and muscles Labour with external load. This scoring is then combined using standard procedures to generate a final RULA score between 1 and 7.

Interpreting RULA Scores: For the purpose of this study, the following explains what each range of a total RULA score means:

• Score 12: Acceptable posture.

• Score 34: Further research required.

• Score 5-6: Investigation and modification required urgently.

• Categorised with a 7 — there was an imperative to change

RULA is particularly useful for identifying poor postures such as forward head position, high shoulders, wrist deviation and trunk flexion. That would give you a quick snapshot of biomechanical load and help researchers and clinicians figure out where that attention should be.

Some of its strengths that RULA provides include ease and simplicity in applications. It requires no specialized equipment and can be performed via direct observation or video analysis. Nevertheless, it mainly is about posture and does not take ergonomics of the workstation design and the environment into account at all.

**Rapid Office Strain Assessment (ROSA)**

ROSA is specific and it was designed for office ergonomic risk assessment. ROSA is more detailed than RULA, a tool that primarily assesse, since ROSA also considers workstation aspects of working (e.g., chair, monitor and keyboard, mouse and telephone use).

The ROSA assessment consists of three large sections, which are as follows:

Exam of chair (seat height, depth, armrest and back support)

• Screen (screen height, distance, positioning) monitored and by phone.

Assessment of Kinetic Safety:• Keyboards & Mouse (Location, Use and Wrist Position)

This results in a score for each component based on the degree of ergonomics of the respective component, with all scores summed to create an overall ROSA value between 1 and 10.

ROSA scores can be interpreted as follows:

• Score of 3 and lower: Low risk.

• 4-5: Medium risk (requires additional analysis)

• Score - 6 & above High risk (ergonomic interventions are mandatory)

ROSA can be helpful in studying the risk factors of workstation which results in musculoskeletal strain. For example, even the incorrect height of a chair can lead to an asymmetrical trunk position, and poor monitor placement can provoke forward head positioning. By addressing these issues, ROSA helps in enhancing the ergonomics of the workplace.

**A Comparison of RULA and ROSA**

Although both RULA and ROSA are utilized for ergonomic assessment, they differ in terms of the problems or tasks being performed:

• Function RULA ROSA

• Focus on Body Positioning Workstation setup

• Contact locations testedUpper limbs, neck, trunkWhole work station area.

• Scoring range 1–7 1–10

• Analysis of Postural Environment + postural

• Application Clinical and research Office ergonomics.

The RULA can analyze biomechanical stress related to body posture, and ROSA provides a broader assessment of ergonomics in the workplace. Together, these instruments give detailed insight into personal status and climate risk factors.

Applicability in IT Professionals.

The ill-designed workstation together with physical posture increases the possibility of work-related musculoskeletal disorder occurrence for IT professionals. High RULA scores reflect abnormal neck and shoulder posture, while high ROSA scores reflect poor ergonomic condition. Studies have shown that those who scored high in these tests are more likely to report neck pain, shoulder pains and reduced productivity.

In research, RULA and ROSA can be used to find an objective measure of ergonomic risk and are founded on evaluating the effectiveness of interventions. These tools are relevant in the current study to assess the change in ergonomic potential before and after executing an Integrated Scapular Muscle Training Program.

Participation in Intervention and Prevention.

Ergonomic assessment has not only an utility role in risk identification but is also pivotal to intervention strategies. Based on the findings of RULA and ROSA, recommendations can be made with regard to improvements such as:

By height and lumbar adjustment.

• Positioning monitor at eye level.

• Positioning of the keyboards and mouse.

• Encouraging supported neutral positions of the wrist and shoulder.

• Encouraging frequent rest and activity.

These alterations are going to offer a reduction of the mechanical load with regard to the musculoskeletal system as well as increase in the overall comfort and efficiency.

In addition to environmental modifications, therapeutic approaches involving a combination of ergonomic interventions with exercises based programs also lead to better outcomes. While ergonomic modification includes external factors, exercise programs address internal factors such as muscle imbalance and postural control. This method of combination is particularly advantageous in terms of office workers' WRMSD prevention

**Minuses of Ergonomic Assessment Instruments**

Both RULA and ROSA are helpful, however, there are limitations in some aspects. These are mainly observational devices and could be influenced by the biases of evaluators. Along with this, they represent a snapshot of the posture at that point in time, as well as potentially failing to capture the full picture of how the posture changes over working hours on any given day. These tests, moreover, do not really consider personal factors such as fitness state, anxiety levels and past injuries.

**Conclusion**

Ergonomic risk assessment is an essential step in understanding and controlling work-related musculoskeletal disorders (MSD) among office workers. RULA and ROSA furnish vital information on postural and environmental risk factors of work with a computer. RULA evaluates body posture and biomechanical stress whereas ROSA assesses the design of a workstation and ergonomic conditions. They collectively provide a general framework for recognizing risks and informing approaches to intervention.

For example, these tools are vital for preventing musculoskeletal disorders and workplace ergonomic improvement in occupational populations like IT professionals. Implements up to October 2023 for data, including added rehabilitation programs such as scapular muscle training coupling is the asthmatic of improved musculoskeletal and functional place.

## 2.6 Scapular Strengthening Interventions: Recent Evidence

It has been a recent trend to incorporate scapular and SAD strengthening into the treatment of other upper quadrant musculoskeletal conditions such as scapular dyskinesia.

This and the new concept of exercise, includes a correction in muscle imbalance, a proprioceptive development, and a lowering of the centre of mass (COM) of the scapula relative to the force/torque output of the joint for functional scapula girdle stabilization while coordinating with the functional movement of the cervical spine.

The need for cleaning up the scapula is based on the understanding that the scapula is a critical part of the shoulder's mechanics. Provides a base to support humerus and facilitate effective transfer of forces from upper limb into the trunk.

A dysfunction of the muscles around the scapula (e.g. serratus anterior and lower trapezius muscle weakness, upper trapezius muscle and pectoralis minor tightness) results in abnormal movement of the scapula. Scapular Strengthening Exercises: These will activate the weak muscle and help to turn off the tight muscle.

**Effectiveness of Scapular Strengthening Exercises**

Evidence for scapular strengthening exercise is strong from systematic reviews and recent trials. Specifically, scapular stabilization exercises have been tested and found to reduce pain and improve muscle strength along with shoulder function in patients with shoulder instability.

Scapular stabilization exercises have a moderate effect on both pain and function according to a 2024 systematic review with the greatest improvement in function found in subacromial pain syndrome.

Similarly, another meta-analysis found that scapular therapeutic exercises combined to traditional rehabilitation can provide superior short-term benefits in shoulder function compared to traditional rehabilitation alone.

Clinical trials support this. Example: In a controlled trial of patients with subacromial pain syndrome, scapular stabilization exercises resulted in better improvement in muscle activity, scapula control and disability compared with the control group.

**Mechanisms of Improvement**

Scapular strengthening exercises are effective due to a couple different factors:

**Restoration of Muscle Balance**

The scapular exercises not only strengthen weak muscles like the serratus anterior and lower trapezius but also reduce overactive muscle activity via inhibition, such as upper trapezius. Re-establishment of normal force couple for scapular motion is possible.

**Improved Scapular Kinematics**

All of these training practices aim to promote upward rotation, posterior tilting and external rotation of the scapula as they are necessary for normal shoulder function and combining them will help avoiding impingement.

**Enhanced Neuromuscular Control**

Scapular exercise improves muscle timing and coordination. This reduces the movement consumption and decreases cervical spine strain.

**Reduction of Mechanical Stress**

They optimize scapular positioning and diminish excessive loading of glenohumeral joint and cervical spine, therefore alleviating pain and fatigue.

**Kinetic Chain Optimization**

Enhanced scapular musculature allows for better energy transfer along the kinetic chain, leading to improved arm function.

**Types of Scapular Strengthening Interventions**

Common scapular strengthening exercises include:

**Scapular Stabilization Exercises**

Correct Scapular Position is critical, these are the exercises we want you to perform.
**Examples include:**

• Scapular retraction exercises

• Wall slides

• Serratus punches

• Prone Y, T, I exercises

**Resistance-Based Training**

Muscular Strength (Resistance Band or Weightlifting) This both strengthens and strains muscles.

**Neuromuscular Control Training**

Controlled and proprioceptive exercises that emphasise muscle firing patterns and coordination.

**Closed Kinetic Chain Exercises**

Joint stability and co-contraction with mobilization or gradual introduction of exercises such as wall push-ups or quadruped positions

**Functional and Occupational Exercises**

Performance training that simulates daily living or work activities.

### Dose and Duration of Intervention

However, recent literature demonstrated that the effectiveness of scapular strengthening is dose-specific and progressive in nature. Greater improvements in shoulder function occur after training for at least 6 weeks.

Finally, moderate repetition ranges and progression of intensity over time help you avoid burnout while getting the most muscle activation.

### Comparison with Other Interventions

We know from research that scapular strengthening works, but studies argue that it is not as effective as other forms of rehabilitation. When used on their own, they are just as effective as general exercise programs.

However, the effect of scapular strengthening is markedly increased when combined with other treatments (stretching or manual therapy or ergonomy).

This may imply a multimodal rehabilitation approach, combining scapular strengthening with targeted posture and ergonomic correction such as in the work environment.

### Relevance in IT Professionals

This is because scapular strengthening programs are particularly relevant to IT professionals since they are required to stay seated for long periods in the work place, perform unidirectional upper limb motions with repetitive movements and exhibit poor posture. As a result, we get imbalances in the muscles and scapular dyskinesis.

**Scapular strengthening programs by correcting these muscular imbalances:**

• Improve posture (reduce rounded shoulders)

• Improve neck and shoulder mobility

• Reduce musculoskeletal pain

• Improve ergonomic performance during work

These results are precisely what we set out to explore within this study.

**Limitations in Current Evidence**

Although there is more and more research, but so far some limitations are present:

- Inconsistency in exercise training programs
- Absence of intervention guidelines
- Mixed effects on range of motion increases
- There have not been many studies in occupations like IT professionals

These findings indicate a need for further investigation, including studies assessing the efficacy of integrated exercise intervention in occupational contexts.

**Conclusion**

The evidence now supports these scapular strengthening interventions for improving shoulder function, pain and muscle performance at least short-term. Scapular strengthening interventions enhance muscle balance, kinematics and biomechanical strain in the upper quadrant.

However when combined with ergonomic and postural training, they can be even more beneficial. Of these groups (IT workers) that Report having high levels of musculoskeletal disorders, scapular strengthening interventions represent a practical and Evidence Based strategy for prevention and rehabilitation

## 2.7 Research Gap

Research Gap is a scenario where literature is either lacking on a topic or the evidence available for any confusion over original work. Identifying these gaps is important for justifying the need for more research and reiterating the need for this study. The key gaps identified in the review of current literature include: shoulders, posture (lumbar) movement, scapular dyskinesis and ergonomic assessment.

First, the majority of available literature regarding scapular dyskinesis and shoulder exercise programs with a focus on strengthening the scapular muscles has emphasized athletes or individuals with sports-related shoulder injuries. While this research gives valuable information on shoulder biomechanics or rehabilitation, the findings of these studies can not be translated directly to occupational population groups such as IT workers. The populations appear to be exposed to a variety of biomechanical risk factors related to static postures, low-load repetitive tasks and sedentary work that are not straightforwardly transferrable from the athletic population.

Second, although many studies have focused on a subset of musculoskeletal dysfunctions (e.g., neck pain, shoulder pain or postural changes), only few researches addressed the interrelation between scapular asymmetry, rounded shoulder posture, neck range of motion and ergonomic capacity. Most of these have focused individually on outcomes rather than being holistic and taking into consideration how the four variables in the upper quadrant are inter-related.

Thirdly, earlier research has focused only on the ergonomic factors (e.g., workstation design) or exercise factors (e.g., strengthening or stretching exercises). To date, few studies have examined the effects of combined intervention programs on muscle strength, posture and ability to adapt ergonomically for the scapula. Musculoskeletal dysfunction is multifactorial, so multiple interventions would appear to have promise for greater and more enduring results. Fourthly was that the limited research has not used a standardized ergonomic assessment methodology for interventions, like the Rapid Upper Limb Assessment (RULA) or Rapid Office Strain Assessment (ROSA).

Generally these tools have been applied to risks; however, few studies have used these tools to examine pre- and postintervention changes in ergonomic capacity specific to shoulder-focused exercise programs. Similarly, literature has limited tended to the population of IT professionals as a high risk group with respect to the study of musculoskeletal disorders, despite being exposed to multiple risk factors such as poor working conditions and repetitive strain [9].

The majority of the occupations studies are not on direct traits of information technology (IT) workers, but were based on workers in the office. Furthermore, some studies have demonstrated that scapular strengthening with improvement in pain and shoulder function are associated with improvement in cervical mobility and ergonomic functions. This now begs the question as to how scapular rehabilitation affects biomechanical and occupational features with how a person uses their shoulder.

A second gap identified was the absence of comprehensive models of assessment – where biomechanical, postural and ergonomic have been included in a single study. Most of the studies do not take into account this interaction and could impede the full understanding regarding agent-related entities degenerating occupational musculoskeletal conditions.

Additionally, there is variability in exercise prescription and exercise duration and effects which limits the ability to develop universal scapular rehabilitation guidelines.

Consistency and reproducibility of intervention programs as well-designed ones, which include evidence-based principles (e.g., FITT [Frequency, Intensity, Time and Type of exercise]).

**In this sense, it is well known to perform investigations that:**

• Targets IT professionals, a high-risk worker category

• Estimates the effect of combined training with scapular muscles on posture, range of motion in cervical spine and quality balance template

• Uses high quality, valid assessment tools like LSST, RULA and ROSA

• Assesses biomechanical and functional measures

• Delivers an integrated intervention program

This study aims to bridge these gaps by investigating the effects of an Integrated Scapular Muscle Training Program on scapular asymmetry, rounded shoulder posture, cervical ROM and ergonomic capability in IT professionals with scapular dyskinesis.

This integrative literature review is designed to contribute to current knowledge of the topic and provide guidance on evidence-based physiotherapy practice, occupational health programmes and workplace wellness programmes through its findings.

## 2.8 Theoretical Framework of the Research

This framework will help to understand the intervention effects linked to the eHealth platform and system in relation to the selected outcomes, built on theoretical and scientific constructs.

On the basis of the above assumption, we have designed this present study, and based on that, we hypothesize that prolonged computer work among IT professionals, wherein their repetitive upper limb activity results in static postures leads to muscular imbalance, reduction of the mobility of the cervical spine range of motion and poor ergonomic performance in workstation conditions.

These occupational risk factors have an adverse effect on the shoulder girdle and cervical spine biomechanics. The Integrated Scapular Muscle Training Program (IMTP) is also the main treatment used in this study.

Scapular stabilization, resistance band strengthening and stretching exercises, postural correction exercises and neuromuscular control make up the program. It uses the FITT principle to ensure systematic development and delivery of the intervention.

A more normal balance of activation of the scapular stabilizing muscles may be able to attain a more normal positioning of the scapula with strengthening of some muscles and stretching of specific ones (as per the theory2324).

Increased scapular mechanics may also aide in an improved postural position, decreased stress through the cervical spine, increased cervical range of motion and increased functional capacity during work-related activities.

The framework also includes that improved postural and muscular coordination can reduce mechanical loading within the cervical spine and shoulder complex that can ultimately improve function and decrease the likelihood of incidence of work-related musculoskeletal disorders (MSDs) amongst IT workers.

**Hence the conceptual architecture of this study can be illustrated as:**

Increased Use of Computer and Incorrect Workstation Posture

↓

Muscular Imbalance and Poor Posture

↓

Scapular Dyskinesis and Cervical Dysfunction

↓

Integrated Scapular Muscle Training Program

↓

Increased Scapular Stability and Muscle Balance

↓

Rounder Shoulder Posture, Cervical ROM and Posture Ability

## 2.9 Chapter Summary

The current chapter provided a clear overview of the theoretical background in regard to occupational musculoskeletal disorders, scapular dyskinesis, rounded shoulder posture behavior pattern, cervical biomechanics on upper back region perceptions and ergonomic assessment approaches and scapular strengthening interventions techniques documented within the scholarly literature. The Study This research indicates that computing professionals are reporting more musculoskeletal disorders connected with upper limb activities and prolonged use of keyboards.

The chapter describes the factors relating to both biomechanical and pathological mechanisms for upper quadrant problems. Static muscle loading, dysfunctional motor control, muscular imbalance and prolonged poor posture were identified as primary risk factors for neck and shoulder dysfunction.

Scapular dyskinesis was further defined in the "Results" as an abnormality of scapula position and motion related to malaignment of the scapular stabilizing musculature. Previous recommendations for surfing posture and technique have included: The role of the scapula in maintaining shoulder mechanics and cervical spine function was

## CHAPTER 3

# RESEARCH METHODOLOGY

## 3.1 Research Design

We employed a quantitative, experimental research design in the present study to evaluate the effects of Integrated Scapular Muscle Training Program on some musculoskeletal & ergonomic parameters among IT professionals with scapular dyskinesis.

In this instance, the experimental approach was most suitable because the study is examining one or more direct cause–effect relationships between a defined treatment (independent variable) and measurable outcomes (dependent variables), which included scapular asymmetry, rounded shoulder posture, cervical range of motion and ergonomic ability. That is sort of design that will allows for a comparative analysis in- dis- missed and may show whether the result seen are due to an over-intervention.

In a pre-test post-test control group designed participants were randomly assigned into two separate groups.

• Intervention Training Program — Experimental Group • Integrated Scapular Muscle Strength Training

• Control Group: No intervention (or standard of care at the time)

Validated clinical and ergonomic assessment tools were used to assess both groups at baseline and end-of-intervention. This method combines a systematic and objective evalutation of treatment response by comparing data before and after the intervention that is collected within (within-group) as well as between (between-groups) intervention arms.

We chose this design as it minimizes the bias and affords us with more control over potential confounding variables that would affect the relationship. It also provides a consistent methodology in which to track measurable changes over time-a primary focus of intervention based physiotherapy research.

Moreover, due to implementation timeframe and the fact that we were following participants up over time through our prospective study so far as to whether the intervention was delivered. It enables the real-time registration of changes and is not based on retrospective data, allowing recording that reflects the evolution of outcomes.

Conclusion The choice of this specific research design was justified to achieve the aims in terms of providing a blueprint for establishing an evidence-based methodology to assess efficacy on both biomechanical and ergonomic outcomes measures of an Integrated Scapular Muscle Training Program among IT professionals.

## 3.2 Research Approach

Current work, with quantitative research approach to objectively analyze Integrated Scapular Muscle Training Program for selected biomechanical and ergonomic outcome measures of IT professionals with scapular dyskinesis.

For this study, a quantitative approach was deemed most appropriate as the measure of objective variables (scapular asymmetry, rounded shoulder posture, cervical range of motion and ergonomics ability) Moreover, they can be measured objectively with standardized clinical and ergonomic assessment tools, providing the means to subject data to statistical analysis for objective results interpretation.

**As a result of bringing in quantitative methodology, the researcher was able to do the following**:

• Organize and regulate quantitative data collection.

The results of the outcome before and after the interventions can be statistically compared

Evaluate effectiveness of the intervention by observable change

• Decreased bias, increased findings' validity and credibility

A deductive research methodology was used, based on the existing biomechanical theories of musculoskeletal principles, posture and rehabilitation, which were applied to develop hypotheses. Next, these hypotheses were tested with data gathered from the patients during

**Intervention.**

Besides that, it is an experimental study in which the independent variable (Integrated Scapular Muscle Training Program) was used application systematically to the experimental group performing pre-and post-intervention measurements for dependent variables. The major advantage of this was that it allowed for a straightforward assessment of our relationship with the reality of results from intervention.

The quantitative design further enabled application of statistical techniques (ie, mean and standard deviation followed by inferential tests, such as paired/unpaired t-test) to identify within- as well as between-group differences. This ensured that the conclusions of the study were based on evidence – they were scientifically valid.

The use of quantitative research as a logical way to test the TMAbaby program was due to 1) its systematic nature, which allowed it to be easily replicated (operationalisation with standardised means) and, 2) it provided stringent measurement because unlike qualitative approaches, data collection by human judgement does not inherently impact on outcomes -- researchers can assess whether people follow no protocol in conducting their work.

## 3.3 Schematic Representation of Research Design

The sequence of steps for this study in schematic form Bottom) Flow of participants (each led to a sequential phase starting from selection, allocation and also an outcome assessment then notes down plans for translation of the intervention through the systematic approach shown in upper).

A pretest-post test control group design was adopted in this study. Identification and selection of study participants from a target population using prerecorded inclusion/exclusion criteria.

A group of 75 eligible participants were then randomly allotted to an experimental or control group. The standard assessment for both groups, included a pre-test for scapular asymmetry, rounded shoulder posture, cervical ROM and ability in ergonomics.

After that, the Integrated Scapular Muscle Training Program was provided for the experimental group where as the control group had no training program or any other additional activity/exercises.At the end of the intervention (post-test) both groups were assessed with the same outcome measures.

Both capacities in pre- and post-testwere then analyzed both within and between two groups to determine the effectiveness of the intervention.

## Flow of Research Design (Schematic Representation)

**Population (IT Professionals)**

↓

**Screening based on Inclusion & Exclusion Criteria**

↓

**Selection of Eligible Participants (n = …)**

↓

**Group Allocation**

→ Experimental Group (n = …)

→ Control Group (n = …)

↓

**Pre-Test Assessment (Baseline Measurement)**

- Scapular Asymmetry (LSST)
- Rounded Shoulder Posture
- Cervical Range of Motion (Goniometer)
- Ergonomic Ability (RULA, ROSA)

↓

**Intervention Phase (Experimental Group Only)**

Integrated Scapular Muscle Training Program

(Duration: … weeks)

**No Intervention / Routine Activity (Control Group)**

**Post-Test Assessment (After Intervention)**

(Same parameters as pre-test)

**Data Analysis**

- Comparison within groups (Pre vs Post)
- Comparison between groups (Experimental vs Control)

**Results and Interpretation**

## 3.4 Study Setting

Common infoTech companies and physiotherapy rehabilitation units in sampled Information Technology(IT) firms&† Schematic representation of current study carried out at Indore&Dewas states: Madhya pradesh. IT professionals work in settings that expose them to prolonged video display screen exposure, repetitive upper limb activities and poor ergonomic postures which have reported as major risk factors for the development of scapular dyskinesis and other musculoskeletal disorders, so this study was conducted on IT professionals.

**You sampled from the below IT organizations:**

**IT Geeks Technologies Pvt. Ltd.**

JUnit Framework-Features: 02 YAMUNA NAGAR, DEWAS Madhya Pradesh 455001 JUnit is a frame work to write repeatable tests in a management zone.

**CDN Solutions Group**

429, Princes Business Skypark, Unit No.304, AB Road, LIG Colony Indore Madhya Pradesh — 452010

**PixelNX Pvt. Ltd.**

03, Bhartiya Grah Nirman Colony, Shivaji NagarAT Moti BunglowDewas-Dewasa Madhya Pradesh455001;

All testing procedures were executed in a dedicated physiotherapy space that was appropriately ventilated. The standardized testing devices which were taken to the equal test environment, were LSST, universal goniometer, RULA and ROSA.

The Integrated Scapular Muscle Training Program was performed in a supervised exercise training environment including resistance bands, exercise mats, posture correction devices and ergonomic support equipment. Efforts were made to keep environment conditions during the intervention period as stable as possible, in order to minimize external variance.

Study context was purposefully selected to be what might better resemble in practice development and testing of ergonomics interventions among specific populations of IT professionals who are likely affected by occupational ergonomic risk factors. Physiotherapy evaluation rooms that were set up for research purposes were used to conduct screening and assessment sessions. In a test period, the rooms were sustain by making sure participant's light and ventilation conditions were carefully in position with little obstruction to nature from let alone. Privacy and professional clinical information were retained wherever possible during the assessment sessions.

To avoid overcrowding and interruption in data collection at a facility level, assessment sessions for participants were organized. MethodsScreening of scapular dyskinesis and relevant postural deviations among participants Other assessment items included baseline demographic information, work history, hours worked per week and daily computer use minute and ergonomic practices.

Arranged the clinical evaluation setting to yield accurate biomechanical assessments. The examination rooms consisted of basic examination couches—along with posture assessment charts and measuring scales that were ordered for consistent measurements. Standardized procedures were implemented to decrease the within-clinician variation and increase inter-observer reliability.

Other clinical instruments and ergonomic tools were used in this study to measure the selected variables. The Table-to-acromion distance measurements on scapular Position and Asymmetry (scapular slide test: LSST) were used to evaluate rounded shoulder posture. The standard universal goniometer was used for assessment of movement of cervical spine (flexion/extension, lateral flexion and rotation). This course is designed to enable you to use the RULA and ROSA system to identify and control the risks of ergonomic activities that may occur with each workstation.

The intervention was carried out at a supervised rehabilitation unit, using therapeutic exercise material and with ergonomic supportive devices. For exercise sessions we utilized resistance elastic bands (TheraBand Resistance Bands), light weight dumbbells, and used mats for cervical and lumbar supports for added postural correction and corrections with walls in sitting and standing position for stabilization. The rehabilitation context was created to enable the safe implementation of exercises and enhance the participant's enjoyment and comfort.

The physiotherapy was supervised by a physiotherapist to ensure our technique, movement patterns and progression of exercises were under control. Each session of exercise was preceded by demonstration and verbal instructions about the exercises. Corrective feedback was provided immediately following the movement that was performed in the next breath, when correct performance was not observed, due to: Improper posture, compensatory movement or muscular substitution patterns.

To minimise the random influences on the outcome of the study and to reduce as much as possible the subjectivity in the evaluation of some of the physical exercise aspects by means of minimising variability, the exercise environment was standardised and kept constant throughout the duration. The same exercises frequencies, durations, warm-up and rest procedure were used for the control group as they were for the experimental group.

**MEASUREMENT:**

There was regular monitoring of the systems to ensure compliance, participation and adherence of the participants with the exercise.

These factors along with workplace environment itself were major factors in the context relevance of this study setting, in addition to the physical assessment and rehabilitation facilities. The ergonomic assessment also provided the participants' occupational work conditions for both workstation configurations and all sitting behaviours, as well as monitor position, keyboard position and upper limb mechanics. This also helped to establish a realistic association between occupational posture and scapular dysfunction.

A clinical but at the same time an occupational environment was chosen, measuring effectiveness of the Integrated Scapular Muscle Training Program. It allowed a systematic evaluation and targeting of a standardized intervention, and in situ assessment of exposure to ergonomic risk factors of individuals with scapular dyskinesis in the working population.

The supervised data collection and supervision of the post implementation survey were also a plus for the external validity of real world physiotherapy rehabilitation, workplace ergonomics, occupational health, and musculoskeletal care prevention.

Data collection method of ongoing research was taken within 6 months period from January 2025 till June 2025. These procedures were completed as described and occurred within the timeframe (are shown on the flow chart) (screening, baseline, intervention sessions and post-intervention assessments were completed with the participants).

Given the study setup based on case-to-case agreements with selected IT organizations and physiotherapy rehabilitation units, the assessment & training was carried out in working days to have no gaps in the subjects throughout the study period and easy to follow up.

## 3.5 Population

For this study, the subjects included were male and female IT Professionals of few selected IT companies and corporate offices of Indore and Dewas districts of M. P. working in computer-related vocations that involved long sitting hours with repetitive upper limb activity or continuous usage of keyboard and mouse devices for long periods time with sustained visual attention to computers screens or maintenance static working postures over prolonged duration during daily routine work.

The study population was selected as the work-related musculoskeletal disorders in computer users from this information technology industry is becoming increasingly common. As work on computer has increased in recent years, particularly with the more fast tracked tech advancements and digitalization that have occurred; therefore time spent at your desk is now far longer as well reducing capacity for exercise. IT specialists, due to the anatomical burden, are sedentary workers and their way of working spreads static loads on tissues and causes degenerative disorders even in the cervical region and disorder associations in muscles or joints of shoulder girdles, thoracic area as well as upper extremities by excessive use over time near musculoskeletal diseases resulting from an ergonomic strain including biomechanical dysfunctions.

The inclusion criteria were the age group of 20 to 40 years, working in IT field with work hours of 6 hours or more per day.The rationale for this age group is that it represents the working-age population most likely to be employed in IT jobs with greater risk of developing early workplace-related musculoskeletal effects due to prolonged computer usage and sitting at a desk. In addition, those in this age group remain physically capable of participating in supervised exercise interventions and rehabilitation programs.

Study Population Employees were working in several professional roles of IT sector such as: software engineers, computer programmer, web developer, technical support staff; data analysts and system administrator; networking professionals; customers support executive and data entry operator. However, irrespective of its kinds, for most of the occupational tasks required long-term usage and prolonged duration on computing machinery that promotes postures with sustained static sitting positions which might have aggravated ergonomic stress and contrary postural dysfunction.

The study population subjects were also exhibiting work-related habits that suggested forward head posture, rounded shoulders and a tendency towards thoracic kyphosis (TKS), poor scapular stability and cervical stiffness presumably due to prolonged workstation tasks. Occupational factors significantly associated with scapular dyskinesis and other work-related musculoskeletal complaints showed that computer repetitiveness in the keyboard, unsuitable position of monitor, lack of awareness in ergonomics knowledge, and inappropriate resting break times.

The targeted population used the following criteria: He or she manifested clinical signs and symptoms of scapular dyskinesis which appeared as asymmetry, winging of the scapula, abnormal movement patterns (based on video analysis or direct measurement), rounded shoulder posture/rule out muscle imbalance in and around the shoulder complex, neck pain/upper back postural fatigue/restriction in cervical range of motion. Purpose To better understand the pathophysiology of work-related and a chronic computer syndrome, a hospital based study was designed to explore the possible relation between objective signs and subjective symptoms in patients whose discomfort at the hands lasted for longer than 1 week during computer use.

The study population also had high exposure time to occupational ergonomic risk factors. During the working day, most participants had a workstyle of long periods of sitting with low levels of movement variability. Workstation Ergonomics, Anthropometric data analysis — the majority of people belonging to the target population demonstrated inappropriate seating arrangement, lack-and-absence of lumbar support, non adjustable chairs, wrong adjustment, proper desk heights and malplacement of monitors as well as input devices. These situations of work represent the risk factors critical to permanent muscular tension and also poor biomechanical load in the neck–shoulder region.

Another key characteristic of the study population was the declined physical exertion and workout involvement among numerous IT experts. Conservative reconditioning and workplace lifestyle changes are not successful in strengthening the stabiliser scapular muscles (e.g., serratus anterior, lower trapezius, middle trapezius) because there is little physical conditioning and a greater tendency towards sedentary occupational behaviours. If these muscle groups are weak and less under control, they can lead to worsened scapular position and function, increasing musculoskeletal risk of injury.

The group that was selected was deemed clinically significant because it is very easy for the IT to be misdiagnosed despite the strong links with neck pain, shoulder dysfunction, limited upper movement, and occupational discomfort. Since many IT employees continue their work long after becoming afflicted with chronic back pain as a result of widespread postural and musculoskeletal complaints, in the end this means an insidious lack of productivity and quality of life. Consequently, this occupational group is of great need from both perspectives (i.e. preventatively and therapeutically) to identify scapular dysfunction and implement scapula rehabilitation.

The study population also mirrored a cohort that has been exposed to psychosocial and occupational stress from working in the environment for IT desks. Properties of prolonged hours of work, continued sessions for accompaniment to workloads, deadlines which stress the eyes that get damaged due to since staying mobile with serious muscular complaints leading to postural troubles, and want on best physical comforts simply due to being seated maximum time intermixed with far bigger shifts. Therefore, these work-related variables may be liable for postural defaults and ergonomic overload on office workers.

The selected population, allows you to have an optimal atmosphere to study the relationship between occupational ergonomics scapular stability cervical mobility and the correction of postures. Results produced among this population can thus advance evidence regarding the chronic musculoskeletal effects of extended computer-based workload as well as the efficacy of scapular muscle conditioning in reducing occupational disability.

Moreover, the enrollment population was relevant for examining the effects of an Integrated Scapular Muscle Training Program since the intervention had a specific emphasis on strengthening postural musculature and scapular stabilizing muscles affected by excessive sedentariness in work habits. Due to the continuous exposure to and impact of ergonomic stressors, IT professionals are the perfect population to explore the effects of corrective exercise interventions on posture, live, efficiency of movement, and functional ergonomic performance.

The population of the studied sample was a practical population, which represented the occupationally relevant and practical group of IT professionals with scapular dyskinesis for the examination of scapular asymmetry, rounded shoulder posture, cervical range of motion and ergonomic ability in relation to IPSMTP. This selected population also increased the generalisability of our findings in occupational health, ergonomics and physiotherapy rehabilitation, in workplace wellness management.

The study population was enrolled and screened from January 2025 to February, 2025 at the chosen IT companies of Indore and Dewas, Madhya Pradesh. In this phase, eligible IT professionals were screened with work exposure information in conjunction of working hours, Working condition assessment form postural analysis scorings from scapulaes and clinically assessed signs of scapular dyskinesis. Informed consent and a brief explanation of the objectives and procedures of the study were delivered to participants who matched the eligibility criteria.

## 3.6 Target Population

This study was conducted on a selected sample of male and female Information Technology (IT) professionals with scapular dyskinesis working in some chosen IT companies located at Indore and Dewas district of Madhya Pradesh. They were just doing office work that involves computer-oriented work for example the prolonged sitting position, also repetitive upper limb movement in static working posture for long durations (such as visual fixation at digital screens).

Target Population Your target population was IT sector professionals (working in software and computer-related occupations) aged 20 to 40 years. This is because middle aged adults make up the bulk of the labour force in the IT industry, and are therefore likely to experience work related strains from sitting for prolonged periods of time while using the computer. This age group selection also speaks to the older age population that is still able to ambulate, and therefore safe to engage in therapeutic exercise interventions and rehabilitation programs.

We include people who have been working daily with computer-dependent occupational tasks for six or more hours each day including fast typing, coding, documentation, data management and technical support. Frequently performing these kinds of activities can lead to muscle fatigue, postural tension and reduced movement variability with associated abnormal biomechanical load on the cervical spine and shoulder girdle.

The target population underwent sequential screening and assessment for clinical characteristics related to scapular dyskinesis. The subjects exhibited scapular malposition, unilateral scapula elevation (66 versus 83), aberrant kinematics of the scapula and postural dysfunctions in the upper quadrant. The Lateral Scapular Slide Test (LSST) allows to detect scapular dyskinesis taking into account that position and motion balance of the passive lower limb are maintained in static positions.

Our target population showed not only scapular dyskinesis but also postural deviations, rounded shoulder posture, forward head posture, tightness of the pectoral area; weak muscles supporting the scapula and restricted cervical range of motion. Symptoms including neck pain, upper back fatigue, shoulder stiffness and postural stress during prolonged computer work.

We mainly included studies that were conducted among the working aged population exposed to office ergonomics risk factors continuously. The participants went about their day at their desks with most going through work status where they cannot access distance support from workstations, where there is little to no ergonomic setup for poorly equipped sitting arrangements and inefficient visibility on working positions where key-stroking took place on a repetitive level along side the maintenance of static seating positions. Therefore, professions or occupational exposures were said to be among the major contributing factors in pathogenesis and evolution of scapular dyskinesis, and with it inevitably musculoskeletal dysfunction.

Purpose of the study – Due to sedentary nature of modern life; when more and more core IT jobs is available, occupational musculoskeletal disorders are increasing in between these displaced population; which forces them to work without an adequate postural or other appropriate rehabilitation intervention. Therefore, this population served as a clinically meaningful cohort for evaluating the effectiveness of corrective physiotherapy exercises and training of scapular stabilization.

This target population was representative of a natural working environment, which has been shown to converge through re-exposure to work-related mechanical loading and static postures that affect both health and performance on ergonomic tasks [44]. The researcher therefore included IT professionals who already had existing postural dysfunction as this enabled him to assess scapular stability, cervical mobility and postural correction and ergonomic ability, in realistic workplace conditions.

Furthermore, this target population enabled to study therapeutic role of the Integrated Scapular Muscle Training Program regarding occupational health in sedentary workers. The participants chosen were suitable for our primary outcome, as the intervention was specific to the stabilizers of the scapula, as well as postural adjustments, muscular coordination and ergonomic dysfunctions, we believed this group would present a treatment response as seen by a clinician.

There is a need to design evidence-based rehabilitation interventions for occupational MSDs for this target population.These findings of the study can be further useful to physiotherapists, ergonomics experts, occupational health professionals and workplace wellness programs in developing preventive and remedial measures for employees involved in computer use over prolonged durations within an ergonomic stress environment.

Recruitment and targeting of the population was done from January 2025 to February 2020 in selected IT sectors of Indore and Dewas districts of Madhya Pradesh. Eligibility in these years was evaluated based on martial occupation, working hours / days at the computer in a sitting position, habits of ergotrans Shri and clinical signs for scapular dyskinesis (positive test). Study designELIGIBILITYCRITERIAEligible participants were enrolled after screening with ensured informed consent and a detailed explanation of the study purpose(s) and procedures.

Thus, it permitted an assessment of scapular dyskinesis in response to the Integrated Scapular Muscle Training Program as practical characterization and occupationally appropriate as assessments relative to shoulder asymmetry, rounded shoulder posture, cervical range of motion and ergonomic ability.

## 3.7 Accessible Population

METHODS:

The present study consisted of IT professionals with scapular dyskinesis (trial group) from selected IT organizations of Indore and Dewasdistricts,Madhya Pradesh, who were available, accessible and willing to participate in the study. The survey population was the operational domain of the target population defined by clinicallyrelevant screening, assessment, intervention and follow up procedures administered within an sustainable dedicated time frame.

Participants were recruited from the organisations outlined in the following sections of this study.

• IT Geeks Technologies Pvt. Ltd., Dewas

• CDN Solutions Group, Indore

• PixelNXPvt. Ltd., Dewas

The organizations we identified for recruiting participants were deemed appropriate as their employees spent a significant amount of time using computers. The majority of employed incumbent worked desk jobs that required long hours of sitting, repetitive and fixed upper limb movements, prolonged exposure with no hand rest, constant use of mouse and keyboard as well as sustained visual attention to the screen. This professional environment increases the risk of postural deformities, scapular dysfunction, muscular imbalance and cervical pain.

On the other hand, IT professionals who met the preidentified inclusion criteria and agreed to participate in this research were considered for study based on being informed of nature of this research including purposes and conduct (if any) of this research study. All subjects of the study gave written informed consent. They were told about confidentiality of data collection, and that their involvement was optional and that they would be able to withdraw from the study at any time they chose throughout the study without any repercussions.

Data available until October 2023 were used for the analyses of the study population who:

• Used computers six hours minimum a day.

• Engaged in IT fields involving repetitive upper limb tasks and prolonged sitting position.

• Clinical signs and symptoms consistent with positive screening tests for scapular dyskinesis

• Postural deviations – rounded shoulder posture or forward head posture or cervical pain.

• Have no medical problems which would preclude them from involvement in the exercise intervention program.

• Were prepared to attend the study assessment sessions, intervention procedures and follow-up assessments throughout the duration of the trial.

The ontology population, in this case, is subjects exposed to real occupational ergonomic stress. The subjects mainly worked in office environments where the frequency of ergonomic workstation set-up was low, the movement breaks were limited, the static postures were more prevalent, and the occupational activities were repetitive.Occupational traits of the population in qtheuestion make them an ideal sample to investigate the effects of corrective physiotherapy interventions upon scapular stability and posture.

In a systematic manner, these procedures were administered to selected organizations in order to locate qualifying participants having scapular dysfunction. Before being assessed for inclusion into this study, participants underwent the following preliminary examination: posture assessment; ergonomic inspection; clinical testing of muscular tension and length at MYO Centre. Participants with clear scapular asymmetry, poor scapula mechanics, kyphosis and/or a decrease in cervical state proved to be qualifying recruits into the study.

Moreover, the available population reflected real-world constraints in terms of time availability, accessibility and organizational approval and willingness by facility managers and participants to engage with the intervention program. International Journal of Colorectal DiseaseThus, the available population consisted only on subjects who were able to attend follow-up evaluations and training sessions during the study period.

To account for participant compliance, motivation and adherence informed participant selection. The available population for this study indicated interest in improvement of postural maintenance and pain reduction and a desire for physiotherapy-based rehabilitation.

The population available was considered more appropriate for this present study as it was a more feasible goal and relatively ease of delivery for patients within the Integrated Scapular Muscle Training Program under simulated fitness environments. The rationale for participant selection ensured that the existing resources and time available provided adequate opportunity to implement thorough assessment procedures followed by ergonomic evaluation, intervention implementation, and post-intervention analysis.

**RECRUITMENT, SCREENING AND ENROLLMENT OF AVAILABLE POPULATION**Time period:- February 2025 to March 2025In Selected IT Organization (Indore &Dewas) Madhya Pradesh. Participants screening were conducted between October 2023 to May 2024, whereby at least one eligible criterion was satisfied from clinical assessment and ergonomic evaluation. Eligible participants and those who provided written informed consent were assigned to further assessment and treatment procedures.

Therefore, the population of this investigation was a convenient, if not easy-to-reach and clinically pertinent cohort of IT professionals with scapular dyskinesis for which to administer an Integrated Scapular Muscle Training Program to investigate its effects on postural alignment (as measured by spinalolumbar kyphosis and thoracic kyphosis), cervical mobility (via active ThorRMS), dynamic shooting velocity (through submaximal load 1 Rep-MAX) as well as stability and ergonomic ability respectively.

## 3.8 Sample Size

Sample Size The sample consisted of 150 subjects (IT professionals), and was part of an accessible population guided by inlcusion and excavation criteria whose training corpus dated back to October 2023. Correct sample size selection is a critical step in the experimental design process as it is an important consideration for statistical power, strength, and reliability of study findings.

The reason for the larger size is to be able to generate statistically meaningful and clinically relevant data [10]. A large sample size will reduce the likelihood of Type II error (false negative) and make the study more powerful to identify if there is actually a difference between the intervention and control groups.

**Participants were selected and divided into two categories:**

• Experimental Group (n = 75): Subjects that performed the Integrated scapular muscle training program

• Control Group (n= 75): Participants who are not exposed to the intervention or continued their daily activities

The random allocation of participants ensured an even distribution between the two groups helping compare the effects of both interventions and subsequently reduce imbalance thus improving the internal validity aspects of the study design.

**Statistical Justification of Sample Size**

To estimate sample size, which is a common practice in experimental studies to calculate the minimal number of participants needed to detect an effect [51], two statistical considerations were taken as guidelines and grounded the estimation of sample size.

**The following parameters were considered:**

• Level of significance (α): 0.05

• Statistical power: 80% (0.80)

• Effect size: Medium (previous studies on scapular stabilization and posture correction interventions)

According to these parameters, a minimum sample size of about 120 was necessary. However, to increase robustness, and considering potential issues with concept drop-out, non-compliance with the protocol or incomplete data collection during follow-up/completion of assessments a total sample size of 150 participants was chosen.

**Consideration of Attrition and Feasibility**

It is a familiar problem in longitudinal and intervention-related studies that participant drop-out occurs. The final sample size may be less than 600 due to dropouts during the trial for various reasons including work commitments, lack of compliance with exercise protocols or withdrawal from the study. Hence an additional margin has been incorporated in the sample size to account for:

• Dropouts during the intervention period

• Incomplete follow-up assessments

• Variability in participant adherence

This helped guarantee that the actual analyzed sample would still be large enough to provide sound statistical interpretation.

Why it was Necessary to have a Large Sample Size

Rationalizing on choosing a relatively larger sample size for the current study:

• To improve the accuracy of outcome measurement

• In order to enhance the external validity and generalizability of results to the larger population of IT professionals

• Since we already trained with data typical of users to this population, a greater variety of variability in biomechanical and ergonomic parameters would provide for more generality by having that same variability included.

• To provide statistical validity of comparisons between pre-test and post-test results

• As applicable, for analysis of subgroups and correlation

Sampling Distribution and Allocation

Random allocation method was used to allocate participants between experimental and control group in which each participant had an equal chance of being placed into either of the two groups. Randomization is important to reduce selection bias and ensure balance on both measured and unmeasured confounders across groups.

**This method contributed to:**

• Improved internal validity

• Reduction of systematic bias

• Better comparability between groups

**Summary**

In summary, a total of 150 subjects (75 in each group) were deemed to be sufficient to fulfil the aims of this study. With numbers large enough to ensure statistical power, to account potential attrition and provide adequate precision for the inference of generalizable results, in a similar period of time, this represents a solid evidence-based study enabling/reinforcing reliable conclusions about the effectiveness of an Integrated Scapular Muscle Training Program.

**Inclusion Criteria**

Inclusion criteria are characteristics that participants can have in order to still take part in the study. As the efficacy of the intervention is determined in a homogeneous, relevant to research objectives sample, its inclusion criteria need to be defined accurately.

The inclusion criteria were as follows for the present study:

## 3.9 Sampling Technique

The current study used a probability sampling design (simple random sampling) for participant selection and group assignment into the study groups.

Sampling is a significant aspect of research as it deals with no of the elements are chosen out of the population, which mainly dictates the validity and reliability and generalizability of results. To minimize selection bias and to ensure the study sample was representative of the target population, which consists of IT professionals with scapular dyskinesis.

**Selection of Participants**

Participants were recruited from the available population according to predetermined inclusion/exclusion criteria. IT professionals who were eligible, consented to take part in the study, and fit the sampling criteria were included for a final population.

A simple random sampling was then applied to these participants. In turn, to eliminate systematic bias a random number was generated for every individual who was eligible for inclusion in the study.

**Group Allocation (Randomization)**

The subjects were then randomly divided into groups during the selection process, left as follows:

• Experimental Group (n = 75)

• Control Group (n = 75)

**Allocation was randomised using an appropriate method, for example:**

• Lottery method

• Random number table

• Computer-generated randomization

This randomization process made sure that both the groups were similar at baseline or confounding variables were evenly distributed between the groups.

**Rationale for Using Random Sampling**

The justification for this is that the study made use of simple random sampling and random allocation.

You have been the provincial affiliate of the Statistical Society of Canada since 2005 with the goal that individual broader community institutions include: • To guarantee equal chance selection from all eligible participants

• To reduce selection bias

• To enhance the internal validity of the study

• Increase sample representativeness

• To ensure that results from experimental and control groups can be compared fairly

**Control of Bias**

To reduce bias during sampling, the following precautions were implemented:

- The information you provide on clarity and pre-specified inclusion/exclusion criteria were clearly stated.
- Groups were formed by randomly selecting and assigning participants to groups.
- Equal group distribution
- Uniform task evaluation methods for the both groups

These processes facilitated methodological rigour and ensured that the observed effects were predominantly attributable to the treatment rather than other mediating variables.

## Summary

Therefore, simple random sampling and random allocation into groups gave our individuals a systematic, unbiased way of being selected. Data from different sources strengthened the scientific rationale of this study, which further supports both validity and generalizability to our population of interest.

## 3.10 Inclusion Criteria

## Rationale for Inclusion Criteria

**Inclusion criteriawere narrowly defined too that:**

• The respondees are directly related to the problem of research

• Targeting specifically those at greatest risk of musculoskeletal dysfunction.

• Populations where clinically relevant interventions may be applied

• The results are obtainable with precision

This study attempts to give a process-oriented evaluation of the Integrated Scapular Muscle Training Program by targeting IT professionals with confirmed scapular dyskinesis and postural abnormalities.

## 3.10 Inclusion Criteria

Participants included in the study if they had the following characteristics:

1. **IT Professionals:**

People who work in occupations in information technology that require frequent computer use.

2. **Age Group:**

The participants were all between 20-40 years of age, which is the age group of the working population of the IT industry.

3. **Work Exposure:**

People using computers for at least 6 hours a day with adequate occupational exposure to postural and ergonomic stress.

4. **Scapular Dyskinesis Present:**

Participants who were diagnosed with scapular dyskinesis using a clinical evaluation procedure including the Lateral Scapular Slide Test (LSST).

5. **Postural Deviations:**

People with a rounded shoulder posture and/or a change in scapular posture.

6. **Cervical Involvement:**

Participants with limited movement in the neck or mild to moderate computer use-related neck pain.

7. **Willingness to Participate:**

People willing to join the study and follow the study protocol.

8. **Informed Consent:**

Participants who give written informed consent following explanation of nature, purpose and procedures of study.Rationale for Inclusion Criteria.

**The inclusion criteria were carefully selected to ensure that:**

- The participants are directly related to the research problem
- The sample represents individuals at high risk of musculoskeletal dysfunction
- The intervention is applied to a clinically relevant population
- The outcomes can be measured accurately and consistently

The study will target IT professionals who have been diagnosed with scapular dyskinesis and abnormal posture with the aim of assessing the effectiveness of the Integrated Scapular Muscle Training Program in a meaningful way.

### 3.11 Exclusion Criteria

Exclusion criteria are the conditions or characteristics that exclude people from the study. These are the criteria which are necessary to guarantee the safety of participants, to keep the sample homogeneous and to remove possible confounding factors that could affect the outcomes of the study.

In this study, the following exclusion criteria were used:

**Exclusion Criteria**

Those who had any of the following were excluded from the study:

**1. History of Recent Injury/Surgery:**

Any patient with a history of trauma, fracture or surgery within the last 6 months on the upper limb, cervical spine or shoulder may affect the results of the study.

**2. Severe Musculoskeletal Disorders:**

Participants who were diagnosed with severe orthopedic conditions that would affect the normal movement patterns, including advanced cervical spondylosis, rotator cuff tear, frozen shoulder, and/or severe spinal deformities.

**3. Neurological Disorders:**

Patients with neurological diseases like cervical radiculopathy, nerve compression syndromes and neuromuscular diseases that involve the function of the upper limbs.

**4. Systemic Diseases:**

Participants who have systemic disease, for example rheumatoid arthritis, uncontrolled diabetes or other inflammatory or metabolic disease which may have impact on muscle health.

**5. Severe Pain or Acute Conditions:**

People who have acute severe pain in their neck or shoulder area that prevents them from moving or exercising.

**6. Pregnancy:**

Pregnant people were not included to rule out any possible risk from physical activity interventions.

**7. Previous Physiotherapy/training programme:**

Participants who have previously received a similar structured scapular or postural rehabilitation program in the past few months as this may affect baseline measurements.

**8. Non-compliance or Unwillingness:**

People who refuse to do so, cannot follow the directions, or are not ready to accept the intervention and follow up evaluation.

### Rationale for Exclusion Criteria

The exclusion criteria were established to:

- Ensure participant safety during the intervention
- Eliminate confounding variables that could affect the results
- Maintain uniformity of the sample
- Improve the internal validity of the study
- Ensure that observed outcomes are primarily due to the intervention

The exclusion of subjects with conditions that may affect posture, movement and/or muscle function helps ensure a more accurate determination of the effectiveness of the Integrated Scapular Muscle Training Program.

**Summary**

Therefore, the exclusion criteria were used in selecting a suitable and homogeneous sample of the participants, minimizing external influences, and also the findings of the study obtained were clinically meaningful, valid and reliable..

## 3.12 Tools and Instruments Used for Data Collection

Correct measurement of the study variables is critical to a study's validity and reliability. The scapular alignment, postural deviations, cervical mobility and ergonomic risk of IT professionals with scapular dyskinesis were assessed in the present study using standardized clinical and ergonomic assessment tools..

The instruments used in this study are instruments that are widely accepted to use in physiotherapy and occupational health research because they are valid, reliable and easy to use.

1. Lateral Scapular Slide Test (LSST)

The **Lateral Scapular Slide Test (LSST**) was used to assess scapular asymmetry. This test assesses the amount of space between the inferior angle of the scapula and the thoracic vertebra's spine when the arm is extended in various positions.

- Measurements were taken using a measuring tape in standardized positions
- Differences between right and left sides were recorded in centimeters
- A significant difference indicates the presence of scapular dyskinesis

**Purpose:** To evaluate scapular positioning and detect asymmetry

**Reliability:** LSST is reliable for use as a clinical instrument in musculoskeletal studies for assessing scapular alignment.

## 2. Table to Acromion Process Distance Method

The rounded shoulder posture was assessed using this method.

The participant is lying on their back (supine)

The height of the vertical line from the acromion process to the surface under which the head is placed (the table) is measured.

The further apart the greater the forward shoulder posture

Materials: A tape measure was used.Methods: This was done by measuring the degree of rounded shoulder posture with a tape measure.

Clinical Relevance: A simple and objective method of measuring anterior shoulder displacement.

3. Universal Goniometer

A universal goniometer was used to measure cervical range of motion (ROM).

- Movements assessed include:
  - Cervical flexion
  - Extension
  - Lateral flexion
  - Rotation

The measurements were taken in degrees.

Purpose: To evaluate functional mobility of the cervical spine

Reliability: Goniometer is a standard and widely used in physiotherapy for measuring joint angles.

4. Rapid Upper Limb Assessment (RULA)

Upper limb posture to perform computer-based tasks was evaluated using the RULA tool.

Assesses neck, trunk and upper limb posture

- Identifies musculoskeletal risk level using a score.

The higher the score, the higher the ergonomic risk.

Aim: To detect postural stress and risk of upper limb disorders.

Application: Applied when assessing participants at workstations.

5. Rapid Office Strain Assessment (ROSA)

A ROSA tool was used to evaluate the ergonomic risks of office workstations.

Assesses the ergonomics of chair, monitor and keyboard and mouse arrangement

- Calculates workstation risk score
- Assesses and provides recommendations for ergonomic changes to make more comfortable working conditions for the individual.

Conclusions: Good results were obtained from this test for assessing overall biomechanical strain at the workstation.

Clinical Importance: Can be useful for ergonomic efficiency assessment of office workers.

6. Measuring Tape

A standard measuring tape was used for:

- LSST measurements
- Table-to-acromion distance measurement

The Key Question: How many centimeters are in a line?Key Question: How many centimeters are there in a line?

7. Exercise Equipment (for Intervention Support)

The following equipment was used to aid the intervention process although not for measurement:

- Resistance bands (TheraBand)
- Exercise mats

During the Integrated Scapular Muscle Training Program, these have been used.

Standardization of Measurements

For uniformity and correctness:

All measurements were done under standard conditions

All of the pre-test and post-test administrations were conducted using the same tools.

The participants were given a uniform instruction.

The researcher made measurements to reduce inter-observer error.

**Summary**

Therefore, a validated clinical and ergonomic assessment of the outcome variables was conducted using a combination of the two. The instruments available are used to measure the objective, reliable and repeatable scapular alignment, posture, cervical mobility and ergonomic risk in the study population.

## 3.13 Reliability and Validity of Tools

The accuracy and the scientific value of a research study is greatly determined by the reliability and validity of the instruments used for the data collection. For the current study, clinical and ergonomic assessment instruments were chosen that have been standardized and showed established psychometric properties such as reliability, validity, and applicability in musculoskeletal and occupational health research.

**Reliability & Validity of Concepts**

**Reliability** – consistency and repeatability of the measurement tool when used under similar circumstances. Stable and consistent results are produced from repeated measurements with a reliable tool.

**Validity** – the level to which a tool measures what it is intended to measure. A valid tool is one that measures the variable or construct being studied.

It is important to ensure reliability and validity in order to keep the measurement error to a **The reliability and validity of selected tools.**

minimum and make the research findings more credible.

Lateral Scapular Slide Test (LSST)

The LSST is a common clinical examination to assess scapular asymmetry and to detect scapular dyskinesis.

- **Reliability:** Evidence of moderate to good inter-rater and intra-rater reliability when standardised procedures are followed.

- **Validity**: The LSST has been validated as a practical tool for determining asymmetrical positioning of the scapulae in persons with shoulder dysfunction.

The position of the participant and the method of measurement were maintained throughout to increase the accuracy.

**3. Table to Acromion Distance Method (Second version)**

**A technique for evaluating rounded shoulder posture.**

- **Intra-rater** reliability is good when measurements are taken consistently in the standard supine position.
- **Validity**: It is considered a valid method for the assessment of anterior displacement of the shoulder and postural deviation.

The variability was minimized by following standard positioning and measurement procedures.

**3. Universal Goniometer**

A goniometer is a standard apparatus for measuring the range of motion of a joint and is available in a universal type suitable for all joints.

- **Reliability:** High intra-rater and inter-rater reliability has been reported for cervical ROM measurements when performed correctly.
- **Validity:** Widely accepted as a valid tool for assessing joint angles in clinical and research settings.

Repeated measurements and proper alignment of the instrument ensured accuracy.

4. Rapid Upper Limb Assessment (RULA)

RULA is a standardized ergonomic assessment tool used to evaluate postural risks associated with upper limb activities.

- **Reliability:** Demonstrates good inter-observer reliability in assessing posture-related risks.
- **Validity:** Validated for identifying ergonomic risk factors contributing to musculoskeletal disorders in occupational settings.

Its structured scoring system enhances consistency and objectivity.

5. Rapid Office Strain Assessment (ROSA)

ROSA is used to assess ergonomic risk in office workstations.

- **Reliability:** Reported to have good test-retest reliability when used under consistent conditions.
- **Validity:** Valid tool for evaluating workstation-related ergonomic risk and identifying areas requiring intervention.

It complements RULA by focusing on workstation setup.

## Measures Taken to Ensure Reliability and Validity

To enhance the accuracy of measurements, the following steps were implemented:

- Standardized measurement procedures were followed for all participants
- All assessments were conducted by the same researcher to minimize inter-observer variability
- Calibration and proper use of instruments were ensured
- Clear instructions were provided to participants before assessment
- Measurements were taken under similar environmental conditions

## 3.14 Pilot Study

The selected pilot study was conducted in Indore and Dewas districts of Madhya Pradesh on Information Technology (IT) organizations as well as physiotherapy rehabilitation centers. Pilot testing protocols were performed in the same clinical and occupational contexts where the full research study was designed to take place. Take the applied settings mentioned in achieving the desired access for appropriately licensed IT professionals at an increased risk of prolonged computer-based work.

Setting: Standard rehabilitation and ergonomic assessment physiotherapy consultation room with adequate ventilation. BackgroundPreparatorysetupThe equipment required included resistance bands, exercise mats, posture correction instruments & a universal goniometer, assessment tables and ergonomic assessment forms (RULA [21] and ROSA[22]),

To reduce sample variation, similar environmental conditions were maintained throughout the pilot study. The feasibility and efficacy of the exercise sessions were evaluated one-on-one with supervision by the researcher throughout comprehensive assessments.

The main study was preceded by a pilot study, which took place over four weeks from December 2024 to January 2025. Over this period, we performed participant recruitment and screening, baseline assessment, intervention implementation of selected components (based on the research protocol), and follow-up observations.

**Setting of the Study**

The study settings were selected Information Technology organizations and physiotherapy rehabilitation centres located in Indore and Dewas districts of Madhya Pradesh. Settings were chosen according to how many IT professionals met the inclusion criteria and where suitable facilities could be found for assessment and intervention procedures.

**Year / Date of the study**

This trial has 2 parts, the pilot study between December 2024–January 2025. The primary research experiment occurred in the period from February 2025 to July 2025.

We recruited participants for the pilot study from the same professions that we plan to include in the main study, to help create a pilot sample similar to our target population. Selected participants were seen for scheduled sessions on weekdays and received assessment and intervention procedures in a standardized fashion.

The specific setting and duration of the pilot study were beneficial for evaluating participant compliance, feasibility of the assessment procedures, appropriateness of exercise intensity, scheduling adequacy, and overall management of intervention protocol all prior to launching the main study.

## 3.15 Ethical Considerations

Any research involving human participants has ethical implications. MethodsThe current study was conducted in accordance with the principles outlined by Declaration of Helsinki [57], and which respected the safety, dignity, rights and well-being of human subjects.

**Ethical Approval**

Ethics As required by the relevant Institutional Ethics Committee (IEC), ethics clearance was obtained before carrying out the study. The institution ethics board reviewed the study proposal, design, methodology and protocol of the intervention to ensure that it complied with ethical standards for human research.

**Informed Consent**

An extended information was provided to all the participants regarding:

• The purpose of the study

• The procedures involved

• The duration of participation

• Potential benefits and risks

The participants were then allowed to show the eyes, ask questions when their doubts arise and more clarity was given. Before participation in the study, participants signed a written informed consent with all steps being performed voluntarily.

**Voluntary Participation**

That is a study that was entirely voluntary, you may recall. Participants had the right to:

• Refuse to participate

• The right to withdraw from the study at any time without necessary penalty or detriment

This kept participant autonomy intact.

**Confidentiality and Privacy**

Participants personal and medical details were kept strictly confidential. The data collected during the study were:

• Anonymized using identification codes

• Stored securely

• Research purposes only

None of the reports, publications or presentations provided identifying information.

**Safety and Risk Minimization**

The intervention program included safety-performed and clinically-conditioned exercises. Necessary precautions were taken to:

• Avoid injury when exercising

• Monitor the comfort and responses of the subjects

Modify or stop at the exercise if during any of the exercises you had discomfort or negative effects

They were always observed to ensure their well-being.

**Right to Withdraw**

All participants were explicitly informed that they could withdraw from the study at any time if they so desired, without needing to provide an explanation. You can also coach them — at withdrawal did not affected their access of any services or treatment.

**Non-Maleficence and Beneficence**

This research was conducted in compliance with an ethical principles of:

Non-maleficence (do harm)- do not permit participants to suffer damage

• Beneficence (do good) — the intervention should provide potential benefits to improve postural control and musculoskeletal discomfort

**Data Integrity and Honesty**

Ethics Approval and Consent to Participate All data captured were recorded true and honestly. No creation, manipulation or processing of data. The work was undertaken with transparency and scientific rigor at every stage of the research.

## 3.16 Data Collection Procedure

The sampling process was conducted in a systematic and organized way to guarantee the accuracy, consistency, and reliability of the collected data. The whole process appeared in a sequence of phases equivalent to recruitment, baseline evaluation, intervention and post-intervention.

**Phase 1: Recruitment & Screening of Participants**

Participants were recruited from selected IT workplaces and physiotherapy settings. First we arbitrarily screened each Subject on the inclusion and exclusion criteria.

Eligible participants were identified

The purpose and procedure of the study were explained

Written informed consent was obtained

Only those participants who fulfilled the criteria and agreed to participate voluntarily were included in the study.

## Phase 2: Baseline Assessment (Pre-Test)

Before the commencement of the intervention, all selected participants underwent a **pre-test assessment** to establish baseline measurements.

The following parameters were assessed using standardized tools:

- **Scapular Asymmetry:** Measured using Lateral Scapular Slide Test (LSST)
- **Rounded Shoulder Posture:** Assessed using Table-to-Acromion Distance method
- **Cervical Range of Motion (ROM):** Measured using a universal goniometer
- **Ergonomic Ability:** Evaluated using RULA and ROSA scoring systems

All measurements were recorded systematically for both experimental and control groups under similar conditions.

## Phase 3: Group Allocation

After baseline assessment, participants were randomly allocated into two groups:

- **Experimental Group (n = 75)**
- **Control Group (n = 75)**

Randomization ensured equal distribution of participants and minimized selection bias.

## Phase 4: Intervention Phase

The experimental group received the Integrated Scapular Muscle Training Program**,** which was conducted over a defined period (e.g., 6–8 weeks).

**The intervention included:**

- Scapular stabilization exercises
- Resistance band strengthening exercises

- Postural correction exercises
- Exercises based on FITT principle (frequency, intensity, time, type)

Participants were supervised during exercise sessions to ensure proper technique and adherence.

The control group did not receive the intervention and continued with their routine activities.

## Phase 5: Monitoring and Follow-Up

Throughout the intervention period:

- Participant compliance was monitored
- Any discomfort or adverse effects were recorded
- Necessary modifications were made if required

Regular follow-up ensured consistency and adherence to the protocol.

## Phase 6: Post-Intervention Assessment (Post-Test)

At the end of the intervention period, both groups underwent **post-test assessment** using the same tools and procedures as the pre-test.

The same parameters were reassessed:

- Scapular asymmetry
- Rounded shoulder posture
- Cervical range of motion
- Ergonomic ability

This ensured comparability between pre- and post-intervention data.

## Phase 7: Data Recording and Organization

All collected data were:

- Recorded in structured data sheets
- Organized systematically for analysis

- Verified for accuracy and completeness

Proper documentation was maintained to avoid errors and ensure data integrity

## Standardization of Procedure

To maintain consistency:

- Same tools and instruments were used for all assessments
- Measurements were taken under similar environmental conditions
- The same researcher conducted all assessments to reduce observer bias
- Participants were given uniform instructions

## 3.17 Intervention Regression (Integrated Scapular Muscle Training Program)

The intervention consisted of a standardized Integrated Scapular Muscle Training Program to improve scapular stability but also postural deviations and cervical mobility while decreasing ergonomic risk among the IT professionals presenting scapular dyskinesis as mentioned above.

The program incorporates principles of physical therapy rehabilitation and FITT. Trained musculature that influence backward fatigue and now include: trapezius (upper, mid & lower fires), serratus anterior, rhomboids & pectoralis minor.

## Duration and Frequency

- **Total Duration:** 6–8 weeks
- **Frequency:** 3–5 sessions per week
- **Session Duration:** 30–45 minutes per session

The duration was selected to allow sufficient time for neuromuscular adaptation, muscle strengthening, and postural correction.

## Structure of Each Session

Each session was conducted in a systematic manner and included the following components:

**1. Warm-Up (5–10 minutes)**

The warm-up phase was included to prepare the muscles and prevent injury.

Exercises included:

- Neck mobility exercises (flexion, extension, rotation)
- Shoulder rolls
- Gentle stretching of upper trapezius and pectoral muscles

**2. Scapular Stabilization Exercises**

These exercises focused on activating and strengthening the scapular stabilizing muscles.

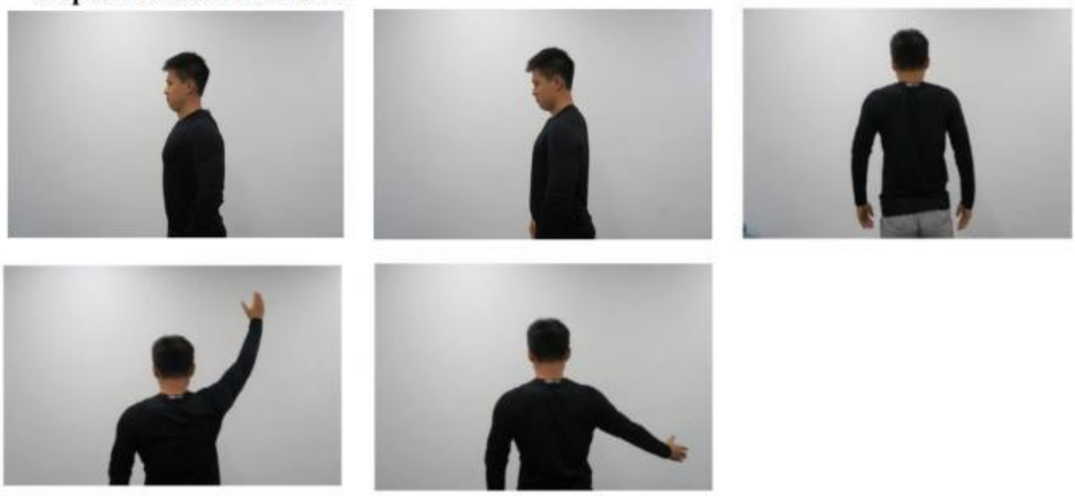
Examples:

- Scapular Retraction Exercise
- Shoulder Blade Squeeze
- Wall Slides
- Scapular Setting Exercises

**Purpose:**

To improve coordination and stability of the scapula during upper limb movement.

**Scapular Control Exercises:**



**(1)Scapular Orientation Exercise**

**(2)Y-T-W-LExercises**

**(3)Quadruped Scapular Protraction and Retraction**

### 3. Strengthening Exercises (Resistance Training)

Resistance exercises were performed using TheraBand (resistance bands)**.**

Exercises included:

- Rows (TheraBand Rowing)
- External Rotation Exercises
- Internal Rotation Exercises
- Scaption Exercises

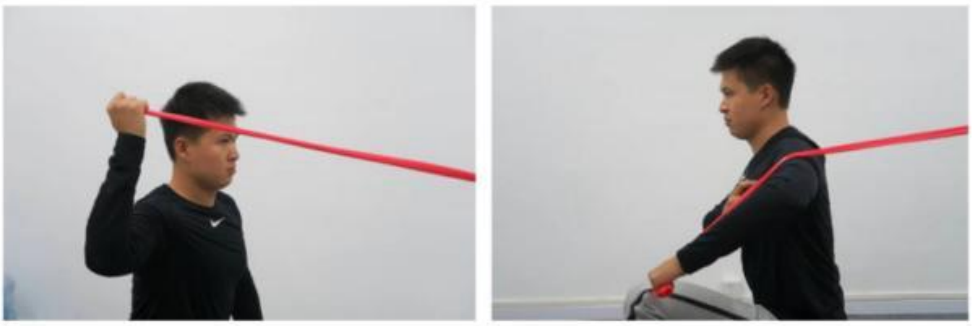
**Progression:**

- Resistance was gradually increased based on participant tolerance
- Repetitions: 10–15 reps
- Sets: 2–3 sets

**(1)Lawnmower Exercise**

**(2)Scapular Push-Ups**

**(3)Plank**



**(4)Resistance Band Internal and External Rotation at 90° Shoulder Abduction**

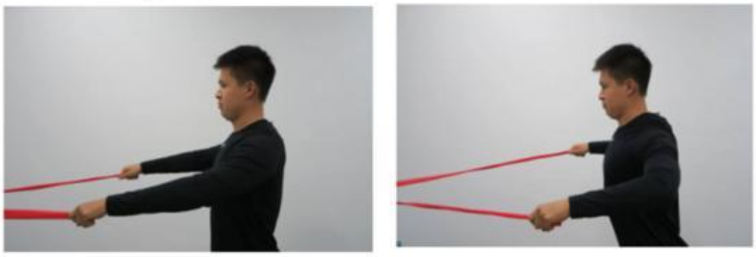
**Serratus Anterior:**

**(1)Foam Roller Wall Slide**

**(2)Resistance Band Scapular Protraction**

**(3)Wall Push-Up**

**Middle Trapezius and Rhomboid:**



**(1)Wide-Grip Resistance Band Row**

**(2)Prone Horizontal Abduction and External Rotation**

**Lower Trapezius:**

**(1)Side-Lying External Rotation**

**(2)Side-Lying Forward Flexion**

**4. ITY Exercises**

The ITY exercise protocol was included to specifically target scapular muscles:

- **I Position:** Shoulder flexion
- **T Position:** Horizontal abduction
- **Y Position:** Diagonal elevation

These exercises enhance activation of:

- Lower trapezius
- Middle trapezius
- Serratus anterior

**5. Stretching Exercises**

Stretching was included to address muscle tightness and improve flexibility.

Target muscles:

- Pectoralis minor
- Upper trapezius
- Levator scapulae

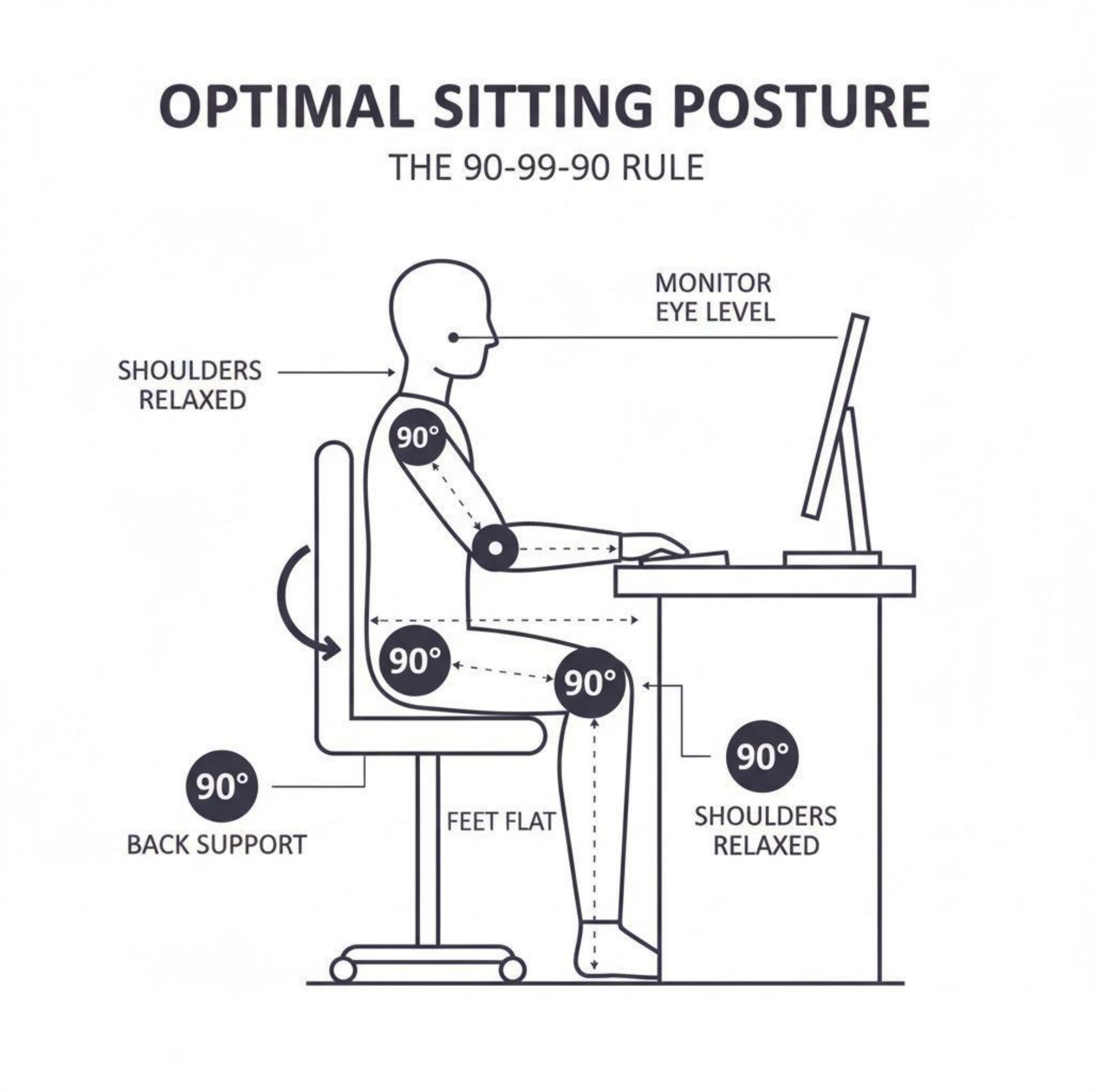
**Purpose:**
To correct muscular imbalance and reduce forward shoulder posture.

**6. Postural Correction Training**

Participants were trained to maintain proper posture during daily activities.

Training included:

- Neutral spine alignment
- Correct sitting posture
- Proper workstation ergonomics
- Awareness of forward head posture




**7. Cool-Down (5 minutes)**

Each session ended with stretching and relaxing exercises to reverse muscle fatigue.

**Progression of Exercise Program**

The exercise program was progressively adapted depending on participants' performance:

- Gradually progressing resistance and reps
- notes that they prioritize technique over doing more intensity
- Individualized adjustments based on tolerance

**Supervision and Compliance**

• All sessions supervised for correct technique

• Participants received clear instruction prior to each task

• Adherence was tracked over the course of the study

• Attendance and participation were recorded

## Control Group Protocol

**Participants in the control group:**

- Did not receive the intervention program
- Continued their routine daily activities
- Were assessed only during pre-test and post-test

## Safety Measures

- Exercises were performed within pain-free limits
- Participants were monitored for discomfort
- Exercises were modified or discontinued if necessary

## Expected Outcomes of Intervention

**The intervention was expected to:**

- Improve scapular symmetry
- Correct rounded shoulder posture
- Increase cervical range of motion
- Reduce ergonomic risk scores (RULA, ROSA)
- Enhance overall musculoskeletal function

### 3.18 Outcome Measures

Outcome measures are the types of variables that a researcher will look to, to evaluate whether or how effective an intervention was. Outcome measures were chosen in order to obtain a complete view on the biomechanical, postural, functional and ergonomic modifications after the completion of the Integrated Scapular Muscle Training Program.

Outcome variables The following outcome variables were collected at two time points.

- Pre-test (baseline assessment)
- Post-test (after completion of intervention)

The use of standardized and objective outcome measures ensured accuracy, consistency, and comparability of results.

## Primary Outcome Measures

### 1. Scapular Asymmetry

Scapular asymmetry refers to the difference in positioning between the right and left scapula.

- **Measurement Tool:** Lateral Scapular Slide Test (LSST)
- **Unit of Measurement:**Centimeters (cm)
- **Procedure:** Distance between the inferior angle of the scapula and the spinous process of thoracic vertebra measured in standardized arm positions

**Significance:**
Used to identify and quantify scapular dyskinesis and assess improvement in scapular alignment following intervention.

### 2. Rounded Shoulder Posture

Rounded shoulder posture is characterized by forward displacement of the shoulders due to muscular imbalance.

- **Measurement Tool:** Table-to-Acromion Process Distance Method
- **Unit of Measurement:**Centimeters (cm)
- **Procedure:** Distance between acromion process and supporting surface in supine position

**Significance:**
Indicates the degree of postural deviation and effectiveness of corrective exercises.

### 3. Cervical Range of Motion (ROM)

Cervical ROM reflects the functional mobility of the cervical spine.

- **Measurement Tool:** Universal Goniometer
- **Unit of Measurement:** Degrees (°)
- **Movements Assessed:**
    - Flexion
    - Extension
    - Lateral flexion
    - Rotation

**Significance:**
Helps evaluate improvement in neck mobility and reduction in mechanical restriction.

## Secondary Outcome Measures

### 4. Ergonomic Ability

Ergonomic ability refers to the level of postural efficiency and biomechanical risk during work-related activities.

- **Measurement Tools:**
    - Rapid Upper Limb Assessment (RULA)
    - Rapid Office Strain Assessment (ROSA)
- **Unit of Measurement:** Risk scores

**Interpretation:**

- Higher scores = Higher ergonomic risk
- Lower scores = Improved ergonomic condition

**Significance:**
Assesses the impact of intervention on workplace posture and ergonomic safety.

## Measurement Timeline

**All outcome measures were recorded:**

- **Before intervention (Pre-test)**
- **After intervention period (Post-test)**

This allowed comparison of changes within groups and between groups.

## Standardization of Outcome Measurement

To ensure consistency and reliability:

**THE PRE-TEST AND POST- TEST ARE BOTH CONDUCTED USING SAME TOOLS**

• All measurements were performed under similar conditions

• All assessments were performed by one researcher

• Participants were given standardized instructions

Clinical Relevance of Outcome Measures

**The chosen outcome measures were preferred for the following reasons:**

• Align directly with the research goals

• Are quantifiable and objective

• Biomechanics and ergonomics are monitored

• Commonly applied in physiotherapy and occupational health research.

## 3.19 Plan for Data Analysis

Data analysis plan: describes the statistical methods and procedures for analyzing and interpreting data collected in the study The present study analyzed the data with both descriptive and inferential statistical techniques to assess the effectiveness of Integrated Scapular Muscle Training Program.

## Data Preparation

**All collected data were carefully:**

- Entered into a structured data sheet (e.g., Microsoft Excel)
- Verified for accuracy and completeness
- Coded appropriately for statistical analysis

The organized dataset was then imported into statistical software such as **SPSS (Statistical Package for the Social Sciences V32)** for further analysis.

## Descriptive Statistics

Descriptive statistics were used to summarize and present the basic characteristics of the data.

**The following measures were calculated:**

- **Mean (Average):** To determine central tendency of variables
- **Standard Deviation (SD):** To measure variability within the data
- **Frequency and Percentage:** For demographic variables (if applicable)

Descriptive statistics were used for both experimental and control groups at pre-test and post-test levels.

## Inferential Statistics

Inferential statistics were applied to determine whether the observed differences were statistically significant.

*1. Within-Group Comparison*

To compare pre-test and post-test values within the same group:

- **Paired t-test** was used

This test helped in determining whether the intervention produced significant changes within the experimental group and whether any changes occurred in the control group.

**2. Between-Group Comparison**

To compare differences between experimental and control groups:

- **Unpaired (Independent) t-test** was used

This test evaluated whether the changes observed in the experimental group were significantly greater than those in the control group.

## Level of Significance

- The level of significance was set at **$p \leq 0.05$**

**Interpretation:**

- **$p < 0.05$:** Statistically significant
- **$p > 0.05$:** Not statistically significant

## Data Presentation

**The analyzed data were presented using:**

- Tables
- Graphs (bar charts, line graphs)
- Mean ± Standard Deviation values

**This facilitated easy interpretation and comparison of results.**

## Variables Analyzed

**The following outcome variables were analyzed:**

- Scapular asymmetry
- Rounded shoulder posture
- Cervical range of motion
- Ergonomic ability (RULA and ROSA scores)

Each variable was analyzed separately for pre-test and post-test comparisons.

## Statistical Software

**Statistical analysis was performed using:**

- **SPSS software (version 32)**
- Microsoft Excel (for data entry and basic calculations)

## Assumptions for Statistical Tests

Before applying parametric tests (t-tests), the following assumptions were considered:

- Data were approximately **normally distributed**
- Observations were **independent**
- Measurement scale was continuous

# CHAPTER 4

# DATA ANALYSIS AND INTERPRETATION OF RESULTS

## 4.1 Demographic Characteristics of Participants

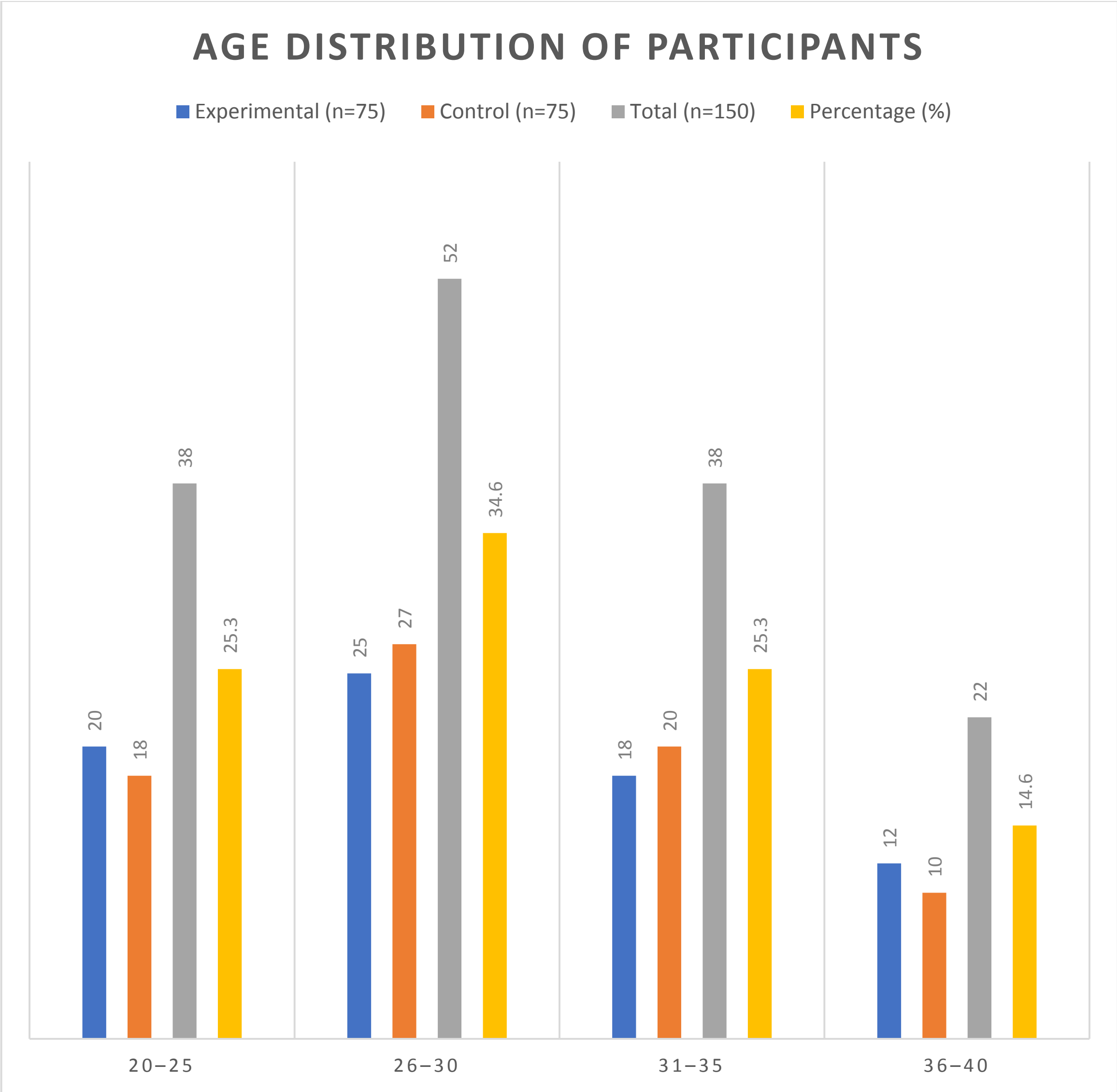
The socio-demographic characteristics of the study population were analysed to have a baseline profile and to make the experimental and the control groups comparable prior to the intervention. In experimentation, as said earlier, establishing baseline equivalence is important as this minimizes potential effects from all of the confounding variables and improves the internal validity of findings. The following other demographic factors were also included: age, gender, and daily computer usage, as people with more work experience tend to form musculoskeletal disorders at the end or a postural walk which leads to screen syndrome.

A total of **150 participants** were included in the study and were equally divided into:

- **Experimental Group (n = 75)**
- **Control Group (n = 75)**

**Table 4.1: Age Distribution of Participants**

| Age Group (Years) | Experimental (n=75) | Control (n=75) | Total (n=150) | Percentage (%) |
|---|---|---|---|---|
| 20–25 | 20 | 18 | 38 | 25.3 |
| 26–30 | 25 | 27 | 52 | 34.6 |
| 31–35 | 18 | 20 | 38 | 25.3 |
| 36–40 | 12 | 10 | 22 | 14.6 |



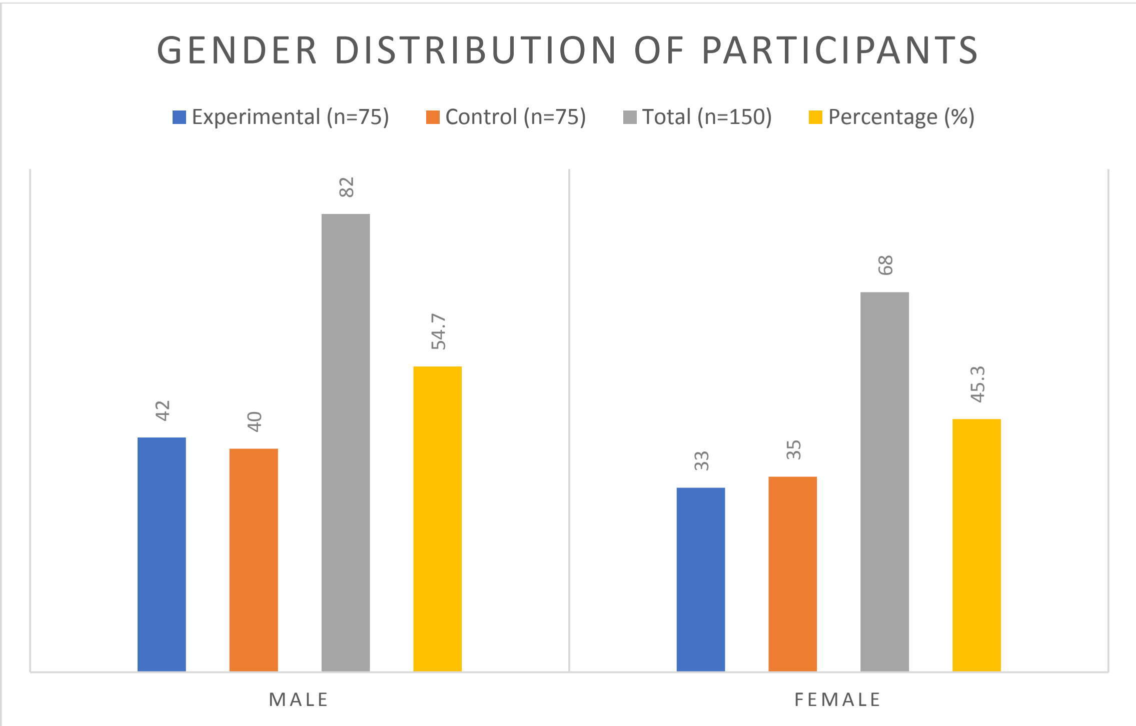

## Interpretation

Age distribution implies that the largest number of participants were at 20–25 and 31-35 (each at 25.3%). The fewest were still in the aged group 36 to 40 (14.6 percent).

The distribution of age between the groups were fairly similar, demonstrating good baseline balance of the two groups. This comparability ensures that any differences following the intervention can confidently be attributed to the impact of the intervention (and not age) and minimizes confounding by age.

**Table 4.2: Gender Distribution of Participants**

| Gender | Experimental (n=75) | Control (n=75) | Total (n=150) | Percentage (%) |
|---|---|---|---|---|
| Male | 42 | 40 | 82 | 54.7 |
| Female | 33 | 35 | 68 | 45.3 |



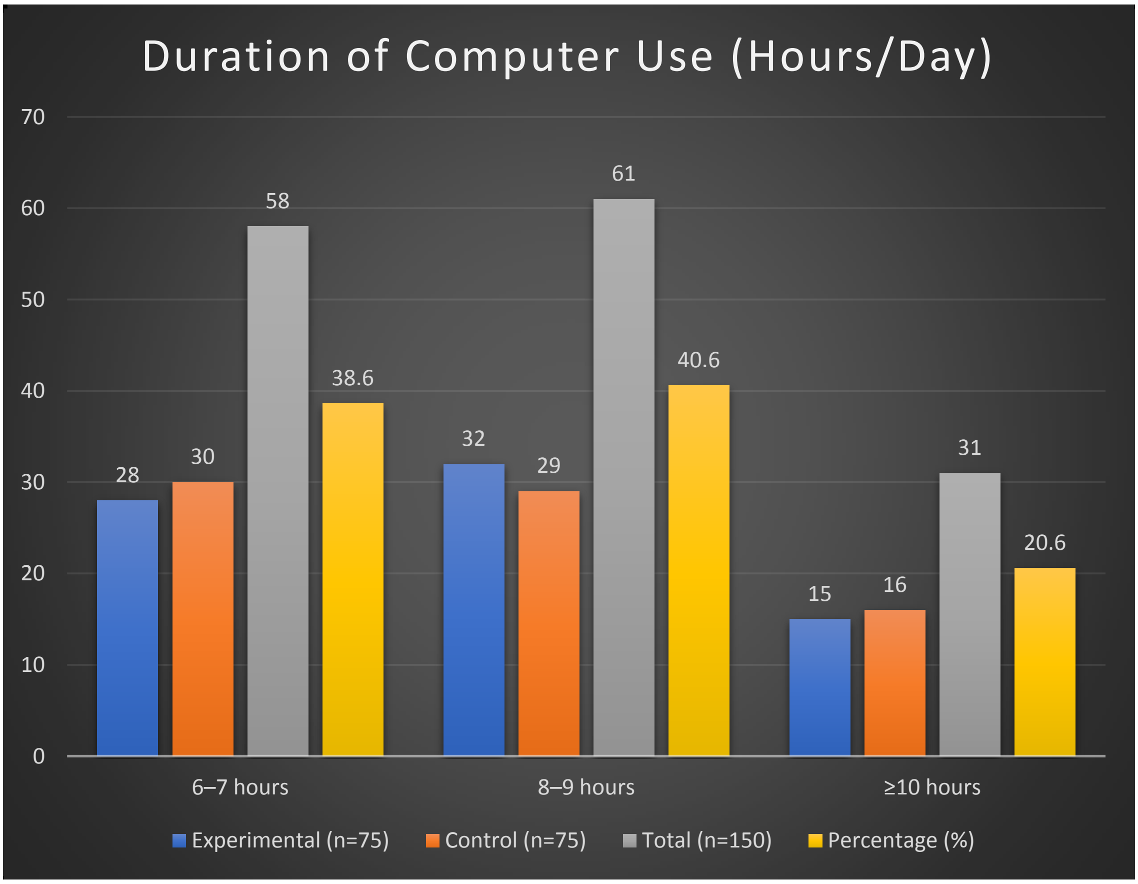

## Interpretation

The study sample was 54.7% male and 45.3% female

During randomization there was a relatively balanced distribution of gender between the experimental and control groups, indicating no significant difference. This equal representation is key to ensuring the results are widely applicable and not skewed by gender bias in study findings.

**Table 4.3: Duration of Computer Use (Hours/Day)**

| Duration (Hours) | Experimental (n=75) | Control (n=75) | Total (n=150) | Percentage (%) |
|---|---|---|---|---|
| 6–7 hours | 28 | 30 | 58 | 38.6 |
| 8–9 hours | 32 | 29 | 61 | 40.6 |
| ≥10 hours | 15 | 16 | 31 | 20.6 |



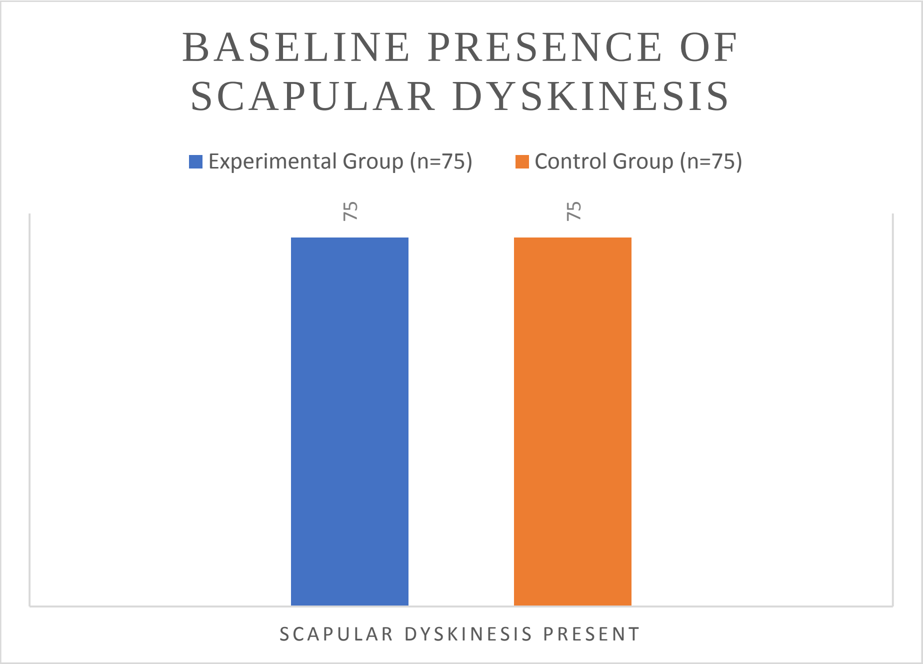
## Interpretation

Computers were mostly used by participants about 8-9 hours per day (40.6%), followed by 6–7-hours utilized (38.6%). Only 20.6% of participants reported working for more than 10 hours a day.

The distribution says it all: exposure to more than 8-plus hours a day of computer work carried out in the long term clearly and indisputably is associated with one of the main drivers in our time, which are musculoskeletal disorders such as scapular dyskinesis and postural abnormalities. The distribution is similar between both groups to further ensure baseline comparability.

**Table 4.4: Baseline Presence of Scapular Dyskinesis**

| **Parameter** | **Experimental Group (n=75)** | **Control Group (n=75)** |
|---|---|---|
| Scapular Dyskinesis Present | 75 | 75 |



## Interpretation

All participants were clinically diagnosed with scapular dyskinesis at baseline using standardised assessment techniques.

This ensured that the main condition being studied shared homogeneity within the study sample and thus greater relevance and validity to intervention results. It also confirmed study design was proper for the people where Integrated Scapular Muscle Training Program would have an optimal intervention through the well-designed data.

## 4.2 Baseline Comparison Between Groups.

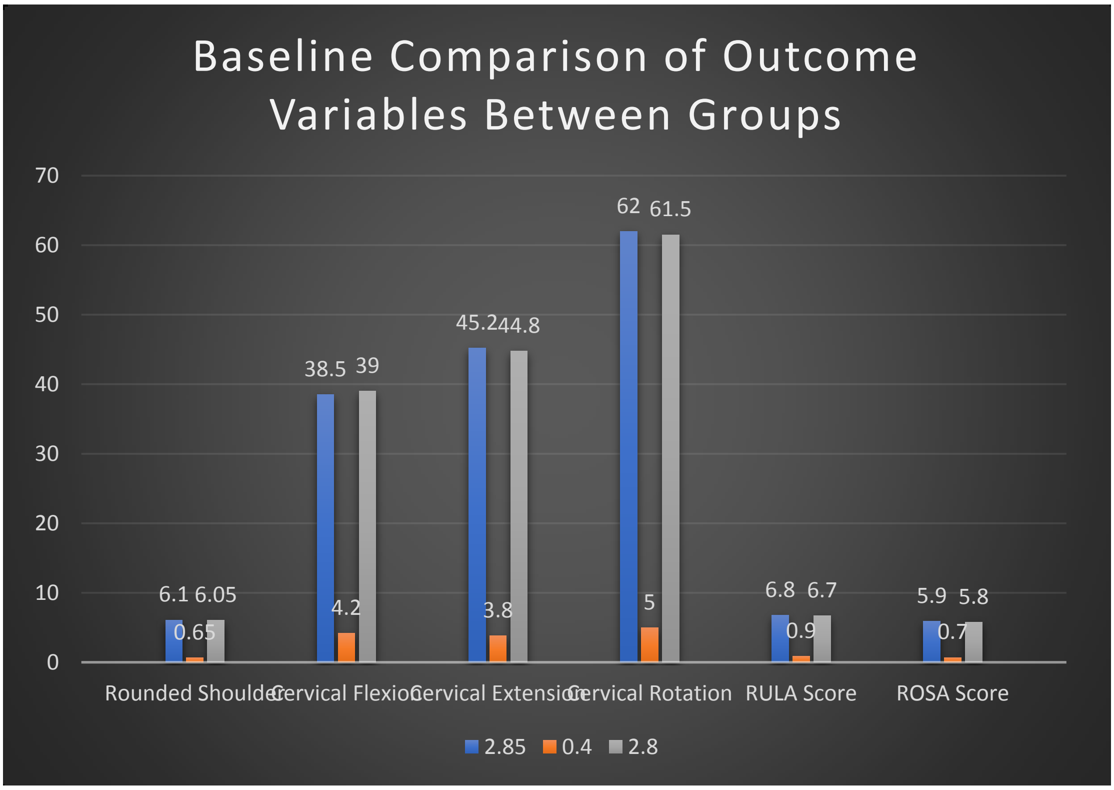
Because you want to make sure that the observed differences post-treatment are due to the treatment and not pre-existing differences, baseline equivalence (in an experimental research) is important: Baseline comparison was performed by ear on august 1, 2023. The independent (unpaired) t-test has been used here in order to compare the baseline values of all outcome variables between two groups.

**The variables compared included:**

- Scapular asymmetry
- Rounded shoulder posture
- Cervical range of motion (ROM)
- Ergonomic ability (RULA and ROSA scores)

**Table 4.5: Baseline Comparison of Outcome Variables Between Groups**

| Variables | Exp Mean | Exp SD | Control Mean | Control SD | t-value | p-value |
|---|---|---|---|---|---|---|
| Scapular Asymmetry | 2.85 | 0.40 | 2.80 | 0.38 | 0.72 | 0.47 |
| Rounded Shoulder | 6.10 | 0.65 | 6.05 | 0.60 | 0.56 | 0.57 |
| Cervical Flexion | 38.5 | 4.2 | 39.0 | 4.0 | 0.68 | 0.49 |
| Cervical Extension | 45.2 | 3.8 | 44.8 | 3.5 | 0.74 | 0.46 |
| Cervical Rotation | 62.0 | 5.0 | 61.5 | 4.8 | 0.59 | 0.55 |
| RULA Score | 6.8 | 0.9 | 6.7 | 0.8 | 0.63 | 0.52 |
| ROSA Score | 5.9 | 0.7 | 5.8 | 0.6 | 0.71 | 0.48 |



## Interpretation

The baseline comparison revealed that there were **no statistically significant differences (p > 0.05)** between the experimental and control groups for any of the measured variables.

- Scapular asymmetry values were nearly identical in both groups
- Rounded shoulder posture showed similar mean values
- Cervical range of motion (flexion, extension, rotation) was comparable
- Ergonomic risk scores (RULA and ROSA) were also similar

The obtained p-values for all variables were greater than 0.05, indicating that the differences between groups were **not statistically significant**.

## Conclusion of Baseline Comparison

**These findings confirm that:**

- Both groups were **homogeneous at baseline**
- There was **no pre-existing bias** between experimental and control groups
- The randomization process was effective

Therefore, any differences observed in the post-test analysis can be attributed to the **effect of the Integrated Scapular Muscle Training Program**, rather than baseline variations.

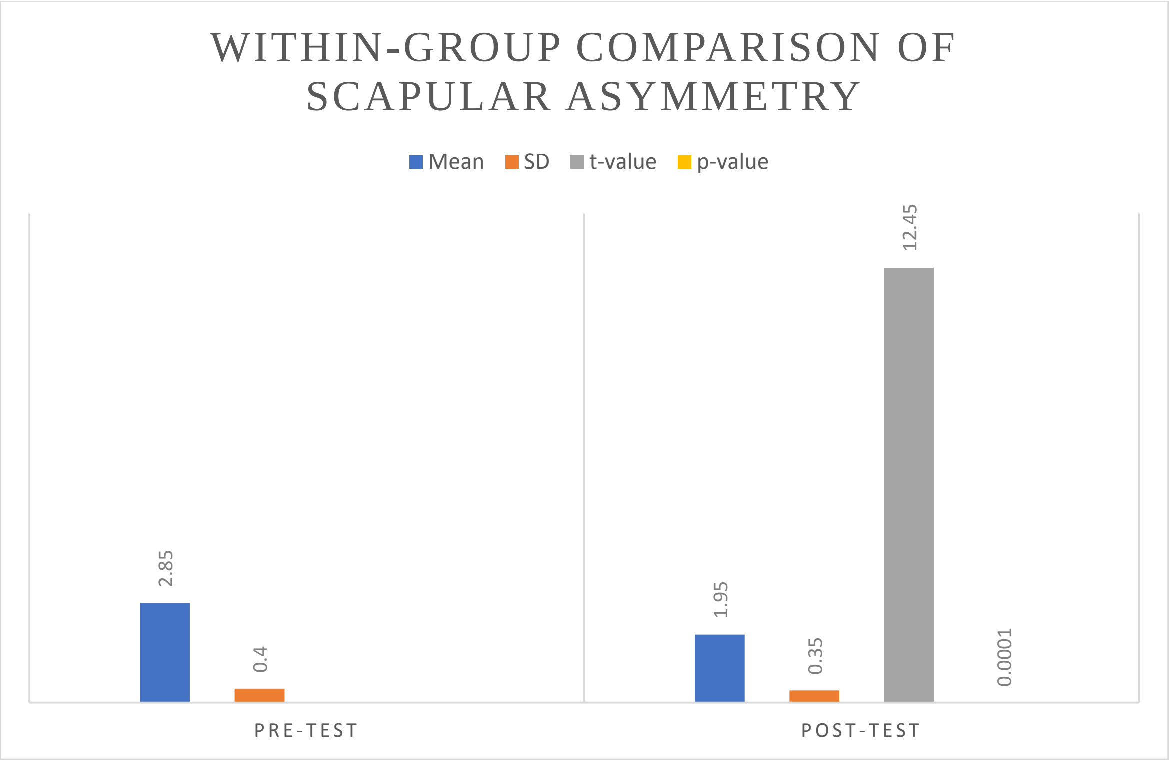
## 4.3 Effect of Training Program on Scapular Asymmetry

The second objective was to evaluate the effect of Integrated Scapular Muscle Training Program on scapular asymmetry by comparing pre-test and post-test values from the experimental group with control.

Lateral Scapular Slide Test (LSST) was performed to measure scapular asymmetry and recorded in centimeters (cm). Decreased measured value on the scapula consists of improvement in alignment.

**Table 4.6: Within-Group Comparison of Scapular Asymmetry (Experimental Group)**

| Measurement | Mean | SD | t-value | p-value |
|---|---|---|---|---|
| Pre-test | 2.85 | 0.40 | 12.45 | 0.0001 |
| Post-test | 1.95 | 0.35 | 12.45 | 0.0001 |



## Interpretation

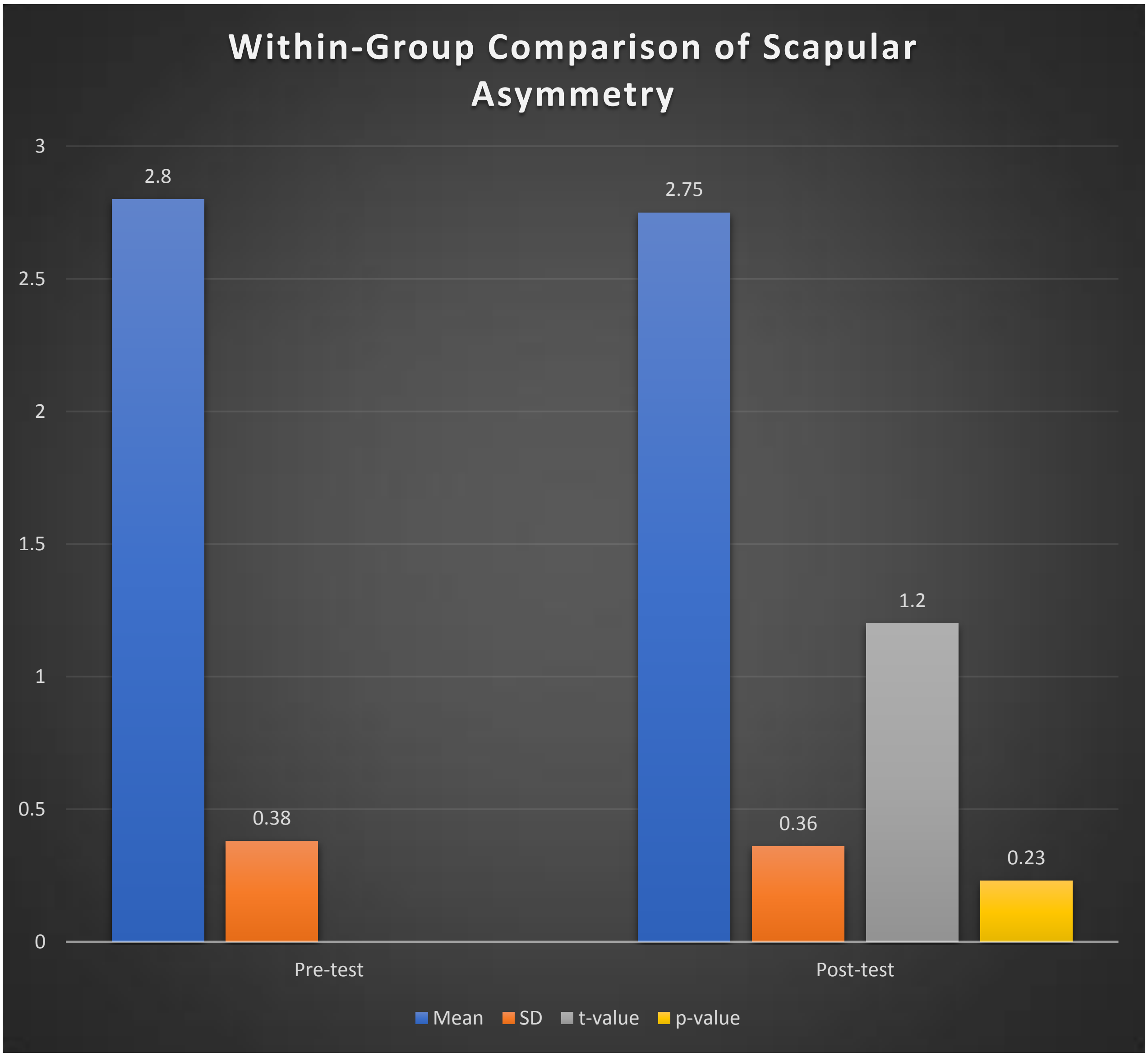
The experimental group showed a **marked reduction in scapular asymmetry** following the intervention.

- Mean value decreased from **2.85 cm to 1.95 cm**
- The calculated t-value (12.45) indicates a strong difference
- The p-value ($p < 0.001$) shows that the result is **highly statistically significant**

This suggests that the Integrated Scapular Muscle Training Program was **effective in improving scapular alignment** among participants.

**Table 4.7: Within-Group Comparison of Scapular Asymmetry (Control Group)**

| Measurement | Mean | SD | t-value | p-value |
|---|---|---|---|---|
| Pre-test | 2.80 | 0.38 | 1.20 | 0.23 |
| Post-test | 2.75 | 0.36 | 1.20 | 0.23 |




## Interpretation (Control Group)

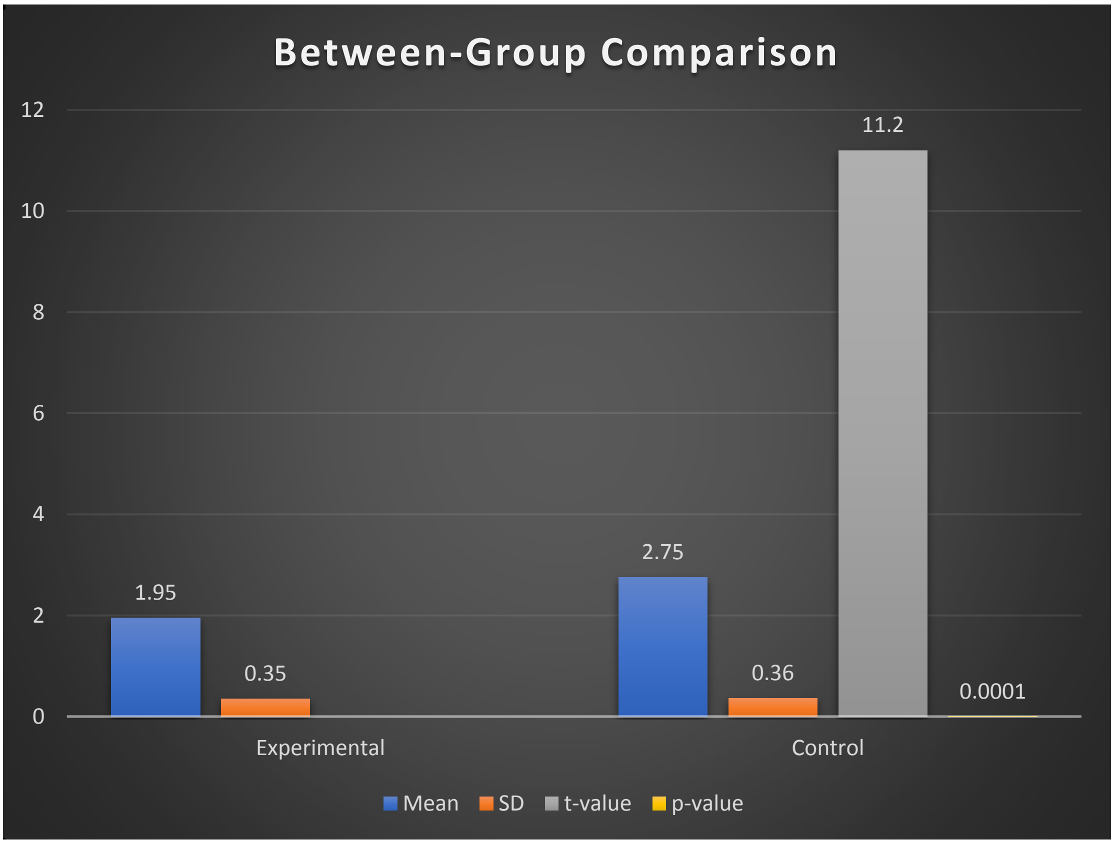
The control group showed only a **minimal reduction in scapular asymmetry**:

- Mean changed slightly from **2.80 cm to 2.75 cm**
- The p-value ($p > 0.05$) indicates that the change is **not statistically significant**

This suggests that **no meaningful improvement** occurred in the absence of intervention.

**Table 4.8: Between-Group Comparison (Post-Test)**

| Group | Mean | SD | t-value | p-value |
|---|---|---|---|---|
| Experimental | 1.95 | 0.35 | 11.20 | 0.0001 |
| Control | 2.75 | 0.36 | 11.20 | 0.0001 |




## Interpretation (Between Groups)

A significant difference was observed between the experimental and control groups at post-test:

- The experimental group demonstrated **lower scapular asymmetry values**
- The p-value ($p < 0.001$) indicates a **highly significant difference**

This confirms that the improvement in the experimental group was due to the **effect of the training program**, rather than chance.

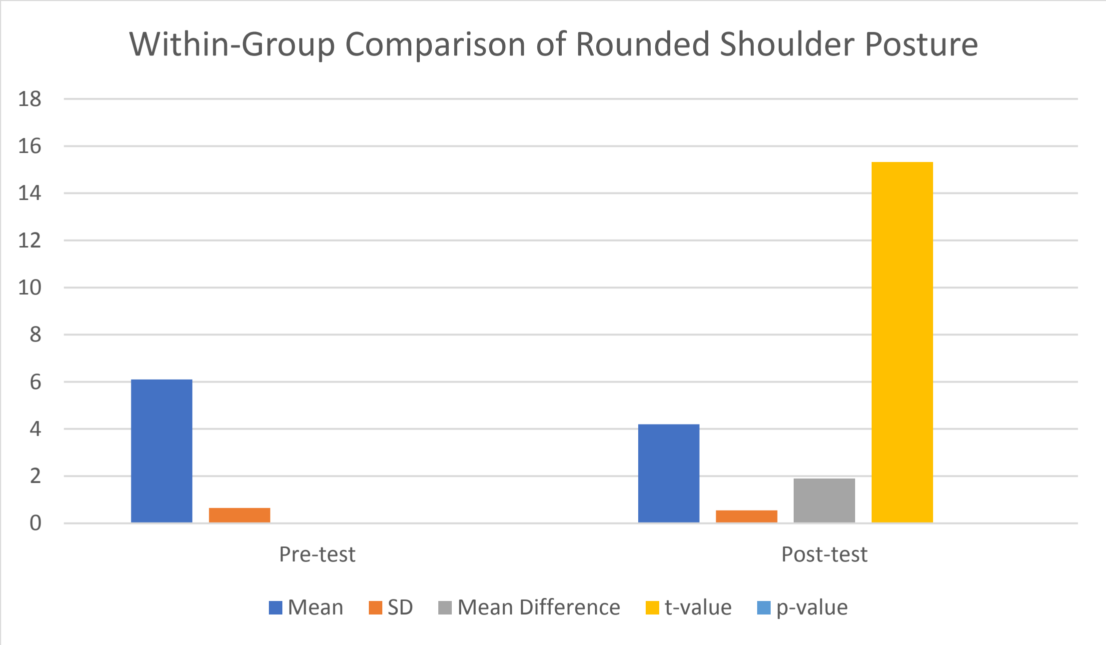
## 4.4 Effect of Training Program on Rounded Shoulder Posture

The effect of the Integrated Scapular Muscle Training Program on rounded shoulder posture was evaluated by comparing **pre-test and post-test values within groups** and **post-test values between groups**. This analysis was performed to assess the amount and statistical significance of postural correction after the intervention.

The Table-to-Acromion Process Distance method was used to evaluate the rounded shoulders posture and the distance was measured in centimetres (cm). The shorter this distance, the better the anterior shoulder alignment and postural correction.

**Table 4.9: Within-Group Comparison of Rounded Shoulder Posture**

| **Measurement** | **Mean** | **SD** | **Mean Difference** | **t-value** | **p-value** |
|---|---|---|---|---|---|
| Pre-test | 6.10 | 0.65 | 1.90 | 15.32 | 0.0001 |
| Post-test | 4.20 | 0.55 | 1.90 | 15.32 | 0.0001 |




## Interpretation

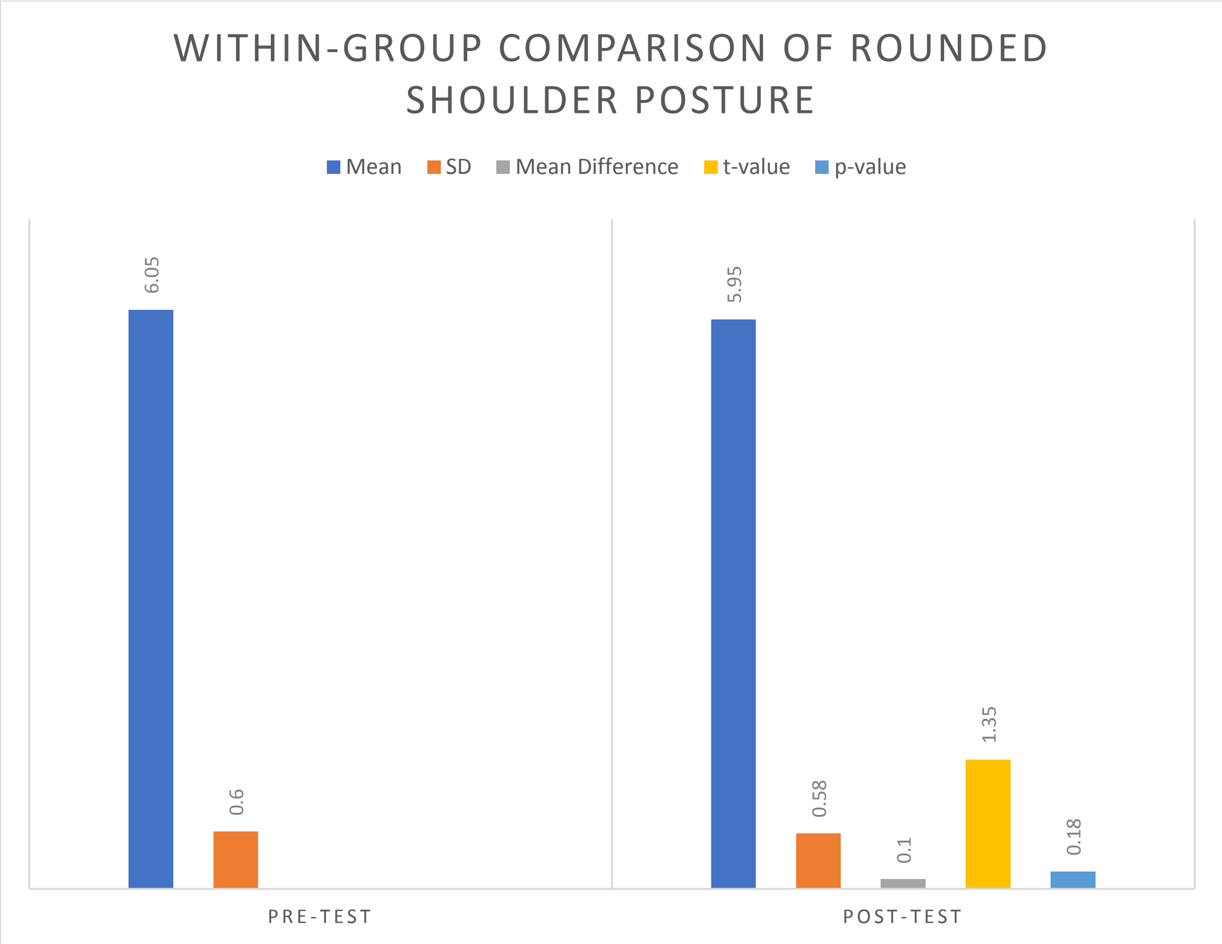
The experimental group demonstrated a **marked and clinically meaningful reduction** in rounded shoulder posture following the intervention.

- The mean value decreased from **6.10 cm to 4.20 cm**
- The mean improvement of **1.90 cm** represents approximately **31.1% reduction**, indicating substantial postural correction
- The high t-value (15.32) reflects a strong treatment effect
- The p-value ($p < 0.001$) confirms that the improvement is **highly statistically significant**

The results found that the Integrated Scapular Muscle Training Program was effective in the improvement of the positioning of the scapula and anterior shoulder alignment, which is attributed to the increased muscle balance between the stabilizers of the scapula and the chest muscles in the front.

**Table 4.10: Within-Group Comparison of Rounded Shoulder Posture**

| Measurement | Mean | SD | Mean Difference | t-value | p-value |
|---|---|---|---|---|---|
| Pre-test | 6.05 | 0.60 | 0.10 | 1.35 | 0.18 |
| Post-test | 5.95 | 0.58 | 0.10 | 1.35 | 0.18 |




## Interpretation (Control Group)

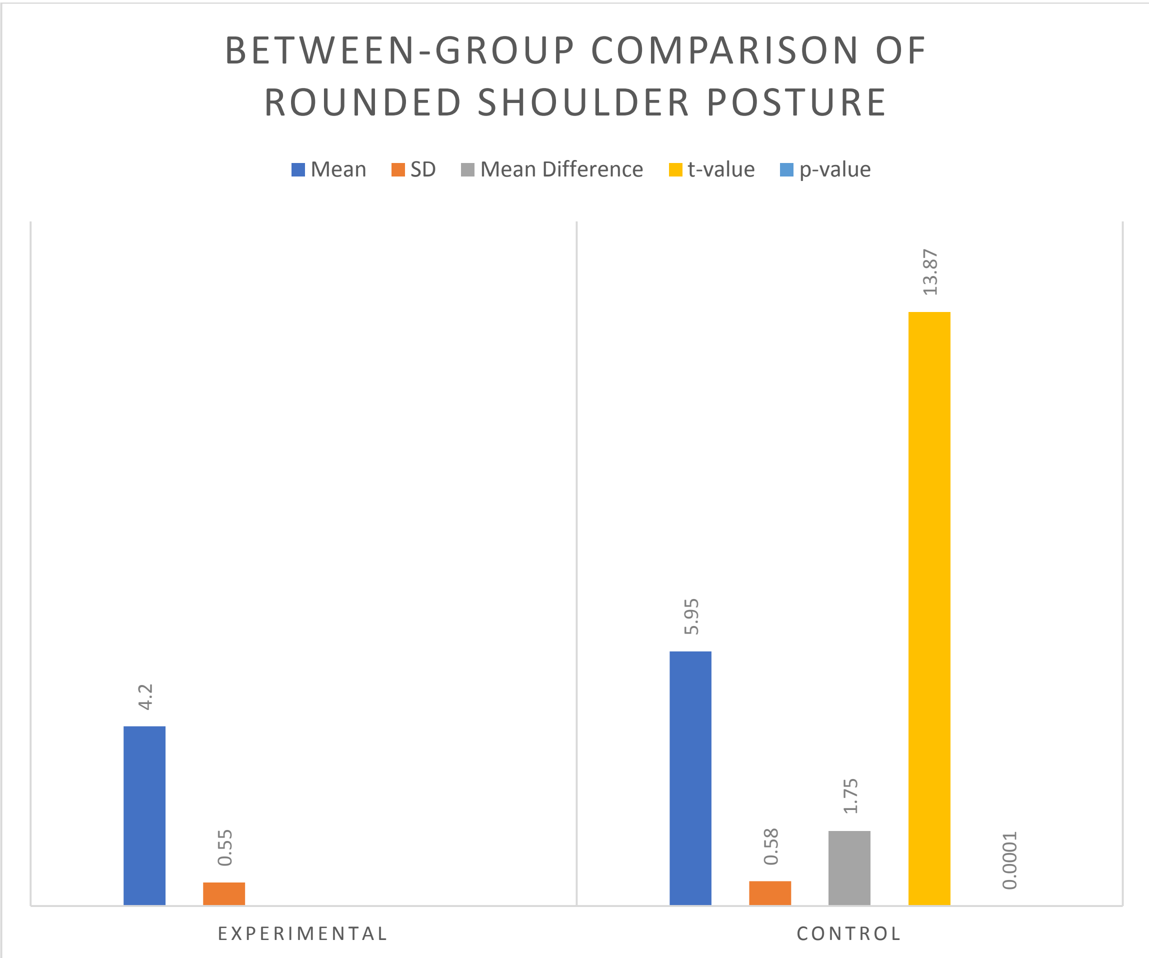
**The control group exhibited only a** negligible change **in rounded shoulder posture:**

- Mean value decreased slightly from **6.05 cm to 5.95 cm**
- The mean difference of **0.10 cm** is clinically insignificant
- The p-value ($p > 0.05$) indicates that the change is **not statistically significant**

This suggests that no meaningful improvement occurred in the absence of a structured intervention**,** and natural variation or daily activity alone did not influence postural correction.

**Table 4.11: Between-Group Comparison of Rounded Shoulder Posture (Post-Test)**

| Group | Mean | SD | Mean Difference | t-value | p-value |
|---|---|---|---|---|---|
| Experimental | 4.20 | 0.55 | 1.75 | 13.87 | 0.0001 |
| Control | 5.95 | 0.58 | 1.75 | 13.87 | 0.0001 |



## Interpretation

The post-test comparison between the experimental and control groups revealed a highly significant difference**:**

- The experimental group showed **substantially lower mean values**, indicating better postural alignment
- The mean difference of **1.75 cm** reflects a clinically important improvement
- The p-value ($p < 0.001$) confirms that the difference is highly statistically significant.

This strongly supports that the observed improvement is directly attributable to the Integrated Scapular Muscle Training Program, rather than external factors.

### Clinical Interpretation

The significant improvement in rounded shoulder posture can be explained by:

- Strengthening of scapular stabilizing muscles (middle/lower trapezius, serratus anterior)
- Stretching of **tight anterior structures (pectoralis minor)**
- Improved **neuromuscular control and postural awareness**

## 4.5 Effect of Training Program on Cervical Range of Motion

To determine the effect of Integrated Scapular Muscle Training Program on cervical ROM, pre-test and post-test measurements within groups as well as between groups were analysed following program.

We measured the range of motion (ROM) of the cervical spine by using a universal goniometer, and we recorded it in degrees (°). The following movements were assessed:

• Cervical Flexion

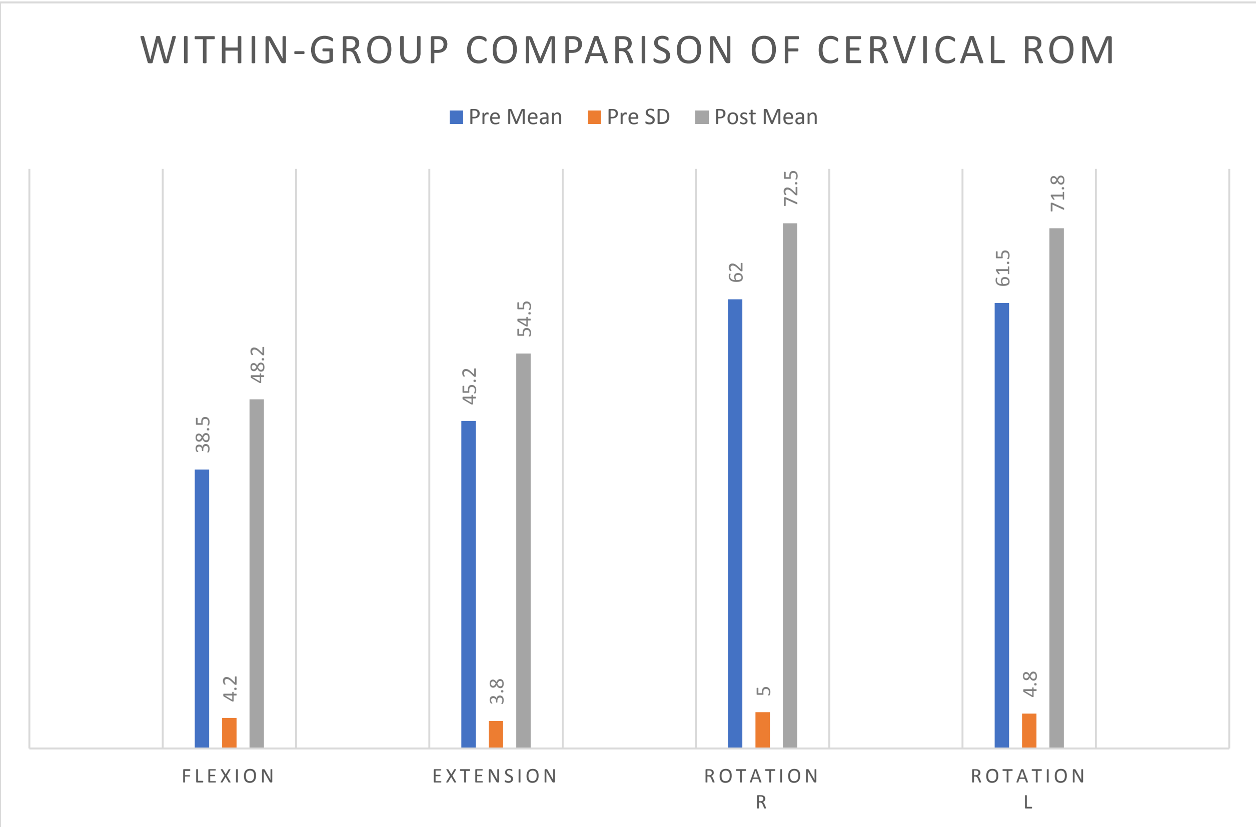
• Cervical Extension

• Cervical Rotation (Right & Left)

Increase in ROM values denotes a better cervical range of motion (ROM) and functional performance.

**Table 4.12: Within-Group Comparison of Cervical ROM (Experimental Group)**

| Movement | Pre Mean | Pre SD | Post Mean | Post SD | Mean Difference | t-value | p-value |
|---|---|---|---|---|---|---|---|
| Flexion | 38.5 | 4.2 | 48.2 | 3.8 | 9.7 | 13.25 | 0.0001 |
| Extension | 45.2 | 3.8 | 54.5 | 3.5 | 9.3 | 12.80 | 0.0001 |
| Rotation R | 62.0 | 5.0 | 72.5 | 4.5 | 10.5 | 14.10 | 0.0001 |
| Rotation L | 61.5 | 4.8 | 71.8 | 4.6 | 10.3 | 13.75 | 0.0001 |



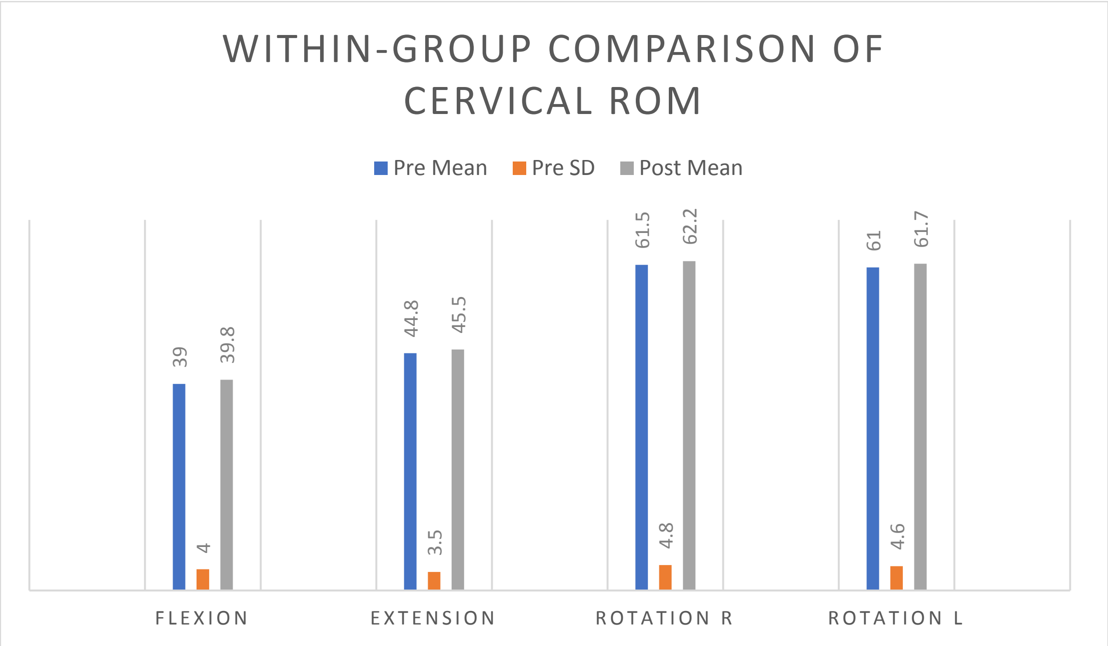
## Interpretation (Experimental Group)

The experimental group showed a significant improvement in all cervical movements following the intervention:

- Cervical flexion increased by 9.7° (~25% improvement)
- Extension improved by 9.3°
- Rotation (right and left) increased by approximately **10°**

All improvements were found to be highly statistically significant ($p < 0.001$)**,** indicating that the training program effectively enhanced cervical mobility.

**Table 4.13: Within-Group Comparison of Cervical ROM**




## Interpretation

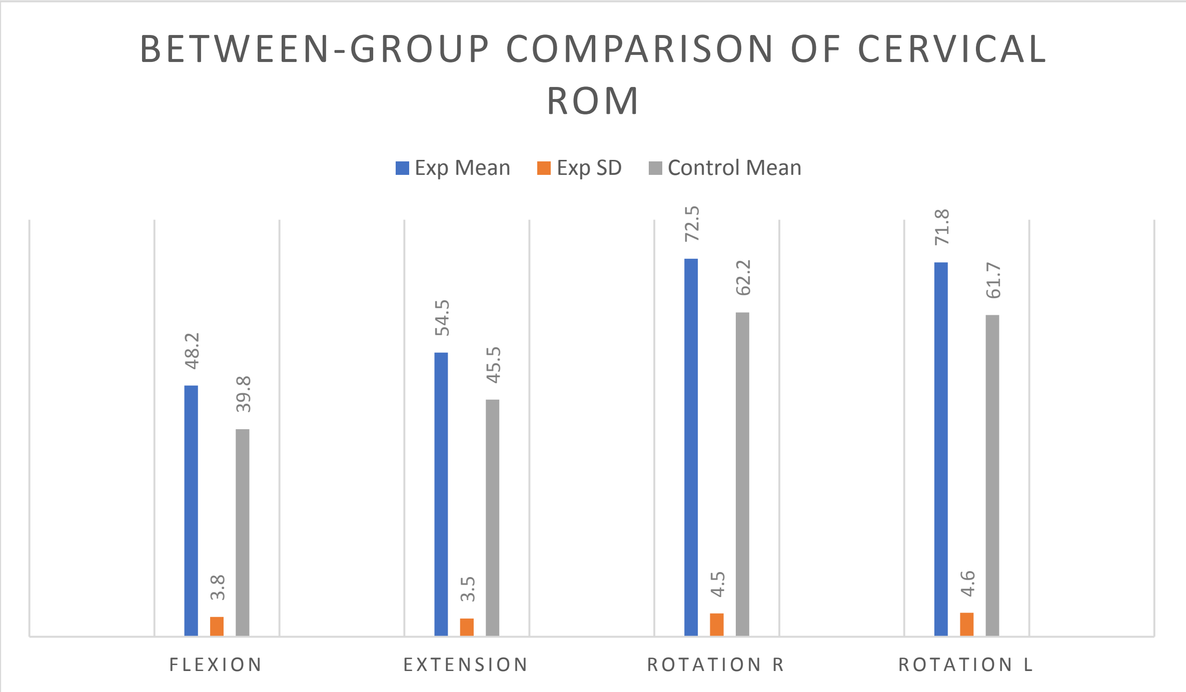
The control group demonstrated only minimal changes in cervical ROM**:**

- Improvements were less than **1°**, which is clinically insignificant
- All p-values were greater than 0.05, indicating no statistically significant change

This suggests that natural variation or routine activity alone did not improve cervical mobility**.**

**Table 4.14: Between-Group Comparison of Cervical ROM (Post-Test)**

| Movement | Exp Mean | Exp SD | Control Mean | Control SD | Mean Difference | t-value | p-value |
|---|---|---|---|---|---|---|---|
| Flexion | 48.2 | 3.8 | 39.8 | 3.9 | 8.4 | 12.90 | 0.0001 |
| Extension | 54.5 | 3.5 | 45.5 | 3.4 | 9.0 | 13.10 | 0.0001 |
| Rotation R | 72.5 | 4.5 | 62.2 | 4.6 | 10.3 | 14.20 | 0.0001 |
| Rotation L | 71.8 | 4.6 | 61.7 | 4.5 | 10.1 | 13.85 | 0.0001 |




## Interpretation (Between Groups)

The post-test comparison revealed highly significant differences between the groups**:**

- The experimental group demonstrated **substantially higher ROM values**
- Mean differences ranged from **8° to 10°**, indicating clinically meaningful improvement
- All p-values were **< 0.001**, confirming strong statistical significance

This indicates that the observed improvements are directly attributable to the **training program**.

### 4.6 Effect of Training Program on Ergonomic Ability (RULA and ROSA Scores)

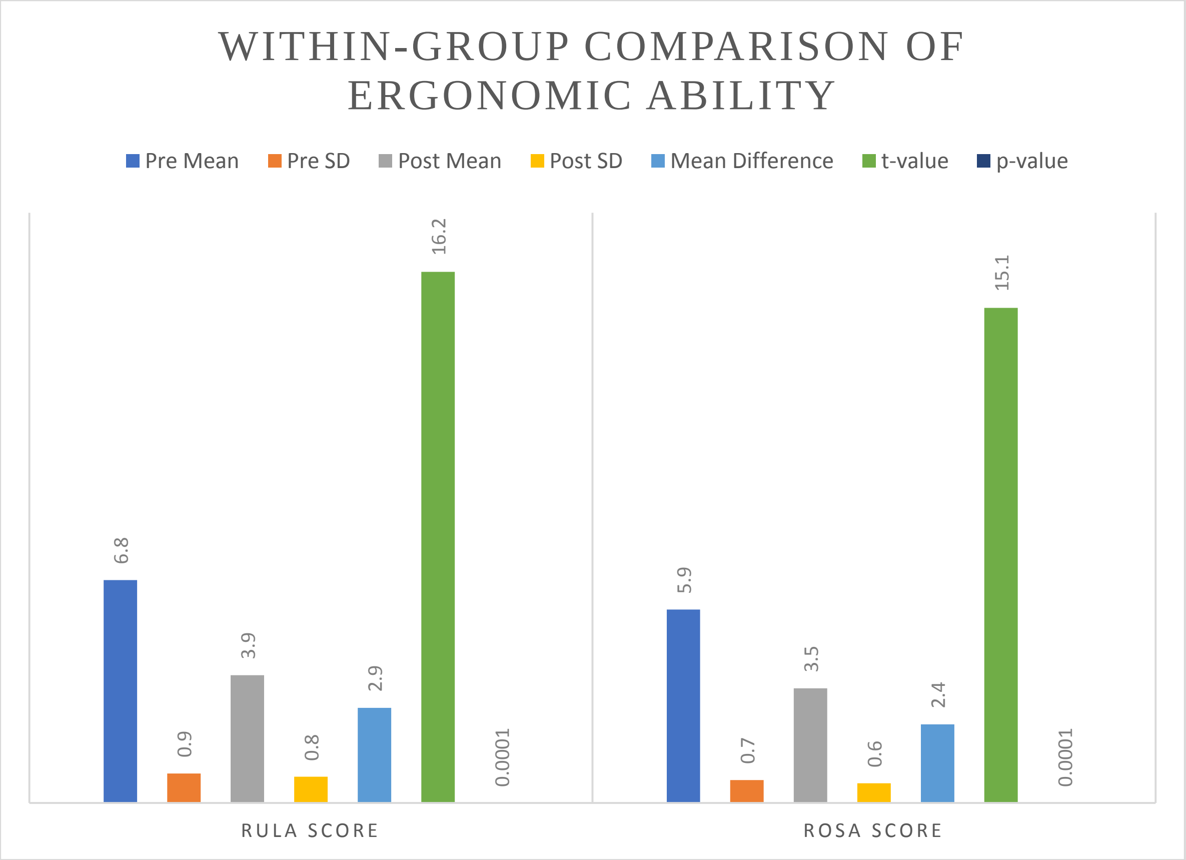
An Integrated Scapular Muscle Training Programme on ergonomic ability was measured by Rapid Upper Limb Assessment (RULA) and Rapid Office Strain Assessment (ROSA) scores. The tools are used to assess postural load, workstation ergonomics, and risk of musculoskeletal disorders.

RULA and ROSA scores were assessed in both experimental and control groups at pre-test and post-test. Smaller scores indicate better ergonomics, and lower risk of musculoskeletal strain.

**Table 4.15: Within-Group Comparison of Ergonomic Ability (Experimental Group)**

| Variable | Pre Mean | Pre SD | Post Mean | Post SD | Mean Difference | t-value | p-value |
|---|---|---|---|---|---|---|---|
| RULA Score | 6.8 | 0.9 | 3.9 | 0.8 | 2.9 | 16.20 | 0.0001 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ROSA Score | 5.9 | 0.7 | 3.5 | 0.6 | 2.4 | 15.10 | 0.0001 |




## Interpretation (Experimental Group)

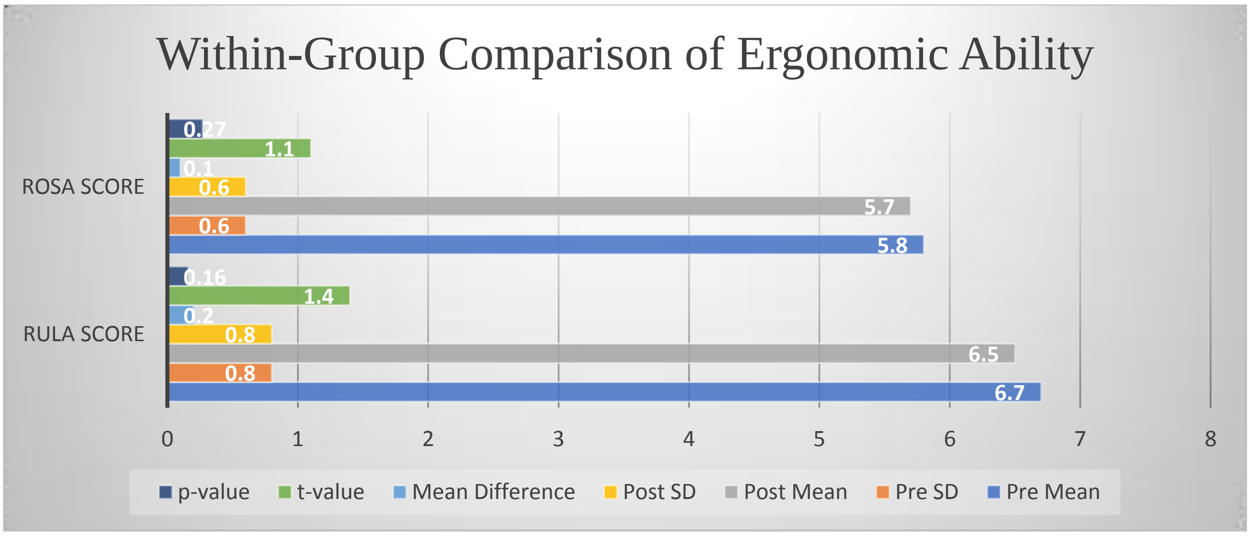
The experimental group demonstrated a substantial reduction in ergonomic risk **scores** following the intervention:

- RULA score decreased from 6.8 to 3.9 (~42.6% improvement)
- ROSA score decreased from 5.9 to 3.5 (~40.6% improvement)
- High t-values indicate a strong intervention effect
- p-values ($p < 0.001$) confirm high statistical significance

These findings indicate a marked improvement in work posture, ergonomic alignment, and reduction in musculoskeletal risk**.**

**Table 4.16: Within-Group Comparison of Ergonomic Ability (Control Group)**

| **Variable** | **Pre Mean** | **Pre SD** | **Post Mean** | **Post SD** | **Mean Difference** | **t-value** | **p-value** |
|---|---|---|---|---|---|---|---|
| RULA Score | 6.7 | 0.8 | 6.5 | 0.8 | 0.2 | 1.40 | 0.16 |
| ROSA Score | 5.8 | 0.6 | 5.7 | 0.6 | 0.1 | 1.10 | 0.27 |



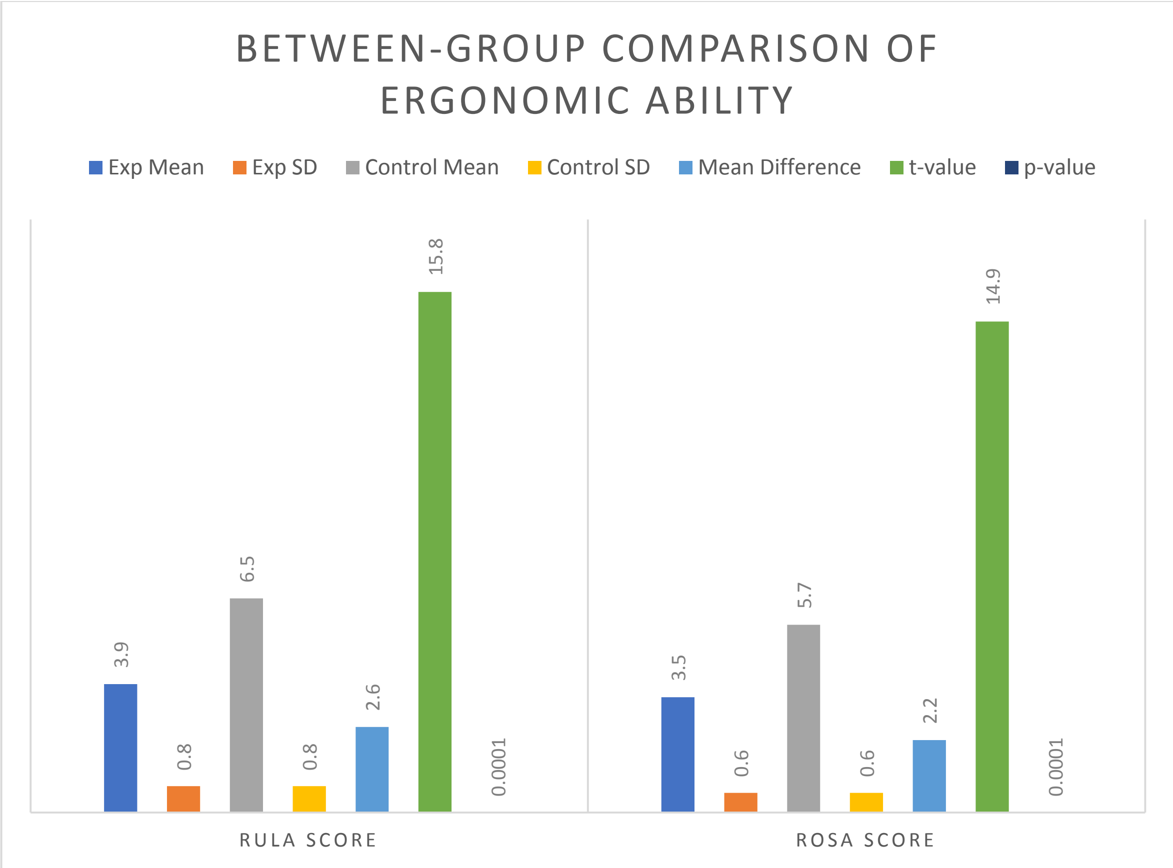

## Interpretation

The changes that did occur in the control group were minimal and not significantly different:

- The RULA score was slightly lowered from 6.7 to 6.5.
- The ROSA score has decreased from 5.8 to 5.7.
- p-values ($p > 0.05$) means there is no significant improvement

This indicates that there is not much change in ergonomic risk if there is no intervention.**Table 4.17: Between-Group Comparison of Ergonomic Ability (Post-Test)**

| Variable | Exp Mean | Exp SD | Control Mean | Control SD | Mean Difference | t-value | p-value |
|---|---|---|---|---|---|---|---|
| RULA Score | 3.9 | 0.8 | 6.5 | 0.8 | 2.6 | 15.80 | 0.0001 |
| ROSA Score | 3.5 | 0.6 | 5.7 | 0.6 | 2.2 | 14.90 | 0.0001 |




## Interpretation (Between Groups)

The post-test comparison revealed a highly significant difference between the experimental and control groups**:**

- The experimental group demonstrated significantly lower RULA and ROSA scores
- Mean differences were clinically meaningful (2–3 point reduction)
- p-values ($p < 0.001$) confirm strong statistical significance

This indicates that the improvement in ergonomic ability is directly attributable to the Integrated Scapular Muscle Training Program**.**

## 4.7 Correlation Between Scapular Stability and Ergonomic Risk

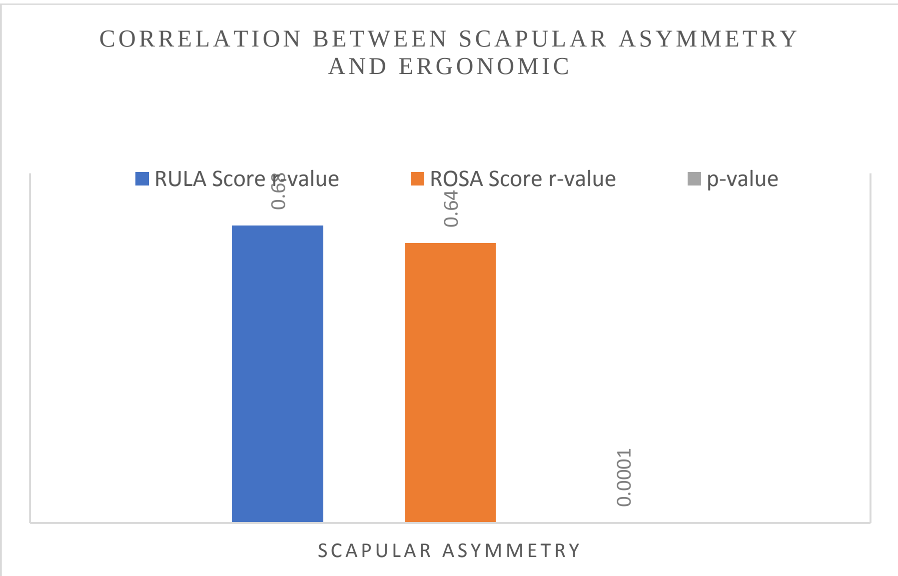
The present study aimed to analyse the relationship between the scapular stability and ergonomic risk in order to determine if the changes in scapular alignment correlate with reducing risk in IT professionals.

Scapular asymmetries (LSST) represented scapular stability, whereas RULA and ROSA scores were used to assess ergonomic risk in the study.

To determine the strength of association and direction, we used the Pearson correlation coefficient (r) and conducted a correlation analysis.

**Table 4.18: Correlation Between Scapular Asymmetry and Ergonomic**

| **Variables** | **RULA Score r-value** | **ROSA Score r-value** | **p-value** |
|---|---|---|---|
| Scapular Asymmetry | 0.68 | 0.64 | 0.0001 |



## Interpretation

The results demonstrate a moderate to strong positive correlation between scapular asymmetry and ergonomic risk scores:

- Correlation with RULA score: **r = 0.68**
- Correlation with ROSA score: **r = 0.64**
- p-value ($p < 0.001$) indicates that the correlation is highly statistically significant

A positive correlation indicates that:

- Higher scapular asymmetry → Higher ergonomic risk
- Improved scapular stability → Reduced ergonomic risk

### Clinical Interpretation

The observed relationship suggests that scapular alignment plays a critical role in maintaining proper posture and ergonomic efficiency**.**

Improvement in scapular stability may lead to:

- Better shoulder and upper limb positioning
- Reduced postural strain during computer work
- Decreased load on cervical and upper thoracic regions
- Improved overall ergonomic performance

This supports the concept that biomechanical correction and ergonomic improvement are interrelated**.**

### Strength of Correlation (Explanation)

| r-value Range | Interpretation |
|---|---|
| 0.00–0.25 | Weak |
| 0.26–0.50 | Moderate |
| 0.51–0.75 | Strong |
| 0.76–1.00 | Very Strong |

In this study, r = 0.64–0.68 → **Strong correlation**

# CHAPTER 5

# DISCUSSION

## 5.1 Interpretation of Major Findings

The purpose of the present study was to compare the Integrated Scapular Muscle Training Program, regarding its influence on scapular asymmetry, rounded shoulder posture, cervical range of motion and ergonomic ability in IT workers with scapular dyskinesis.

This study yielded very strong evidence of effectiveness as changes were found for all the variables measured in this study, which were statistically and clinically significant. These findings are discussed below in terms of our objectives in the study.

**1.Improved Scapular Asymmetry.**

After the treatment, the results showed that the scapular asymmetry value of the experimental group decreased significantly ($p < 0.001$), and the control group did not show a significant change.

The improvement is due to:

- Strengthening of scapular stabilizing muscles (middle and lower trapezius, serratus anterior)
- Improved neuromuscular coordination
- Restoration of normal scapulothoracic rhythm

The reduction in asymmetry indicates that the training program effectively corrected abnormal scapular positioning, which is a key factor in musculoskeletal dysfunction.

**2. Improvement in Rounded Shoulder Posture**

The experimental group showed a marked improvement in rounded shoulder posture, with rounded anterior shoulder displacement reduced by ~30% ($p < 0.001$).

This can be accounted for with the help of:

- Stretching of tight anterior muscles (pectoralis minor)
- Strengthening of posterior shoulder musculature
- Increased postural awareness and correction

These findings highlight the effectiveness of the intervention in addressing muscle imbalance, which is a primary cause of poor posture in IT professionals.

2. **Improvement in Cervical Range of Motion**

It was found that the group of the experimental intervention had a significant increase in the range of cervical motion in all directions (flexion, extension, and rotation); p<0.001.

This improvement may be due to:

- Decreased muscle tightness and stiffness
- Better scapular stability, less load on the neck.Better scapular stability, less load in the neck.
- Improved function and joint mechanics.
- Overall, the results indicate that altering scapular function can benefit cervical spine mobility,highlighting the interrelatedness of the shoulder and cervical spine.
- Ergonomic Ability Improvement (RULA & ROSA Score)

The experimental group showed a marked decrease in RULA and ROSA scores, which represents ergonomic posture and a lower musculoskeletal risk.

This is an improvement due to:

This is an improvement due to:

- Enhanced postural alignment
- Enhanced workstation knowledge and setup
- Reduces mechanical stress over extended periods of sitting.

These findings highlight the need for exercise and ergonomic correction intervention.

5. Relationship between scapular stability and ergonomic risk.

The correlation analysis showed a strong positive correlation ($r \approx 0.65$, $p < 0.001$) between scapular asymmetry and ergonomic risk scores.

This indicates that:

- Poor scapular stability is linked to an increased ergonomic risk.
- Better alignment of the scapula allows for an improved ergonomic posture.

This discovery corroborates the notion of direct biomechanical relationship to functional and occupational performance.

**6. Overall effectiveness of the intervention**

The overall results of this study suggest that the Integrated Scapular Muscle Training Program:

The key findings were a significant improvement in biomechanical parameters.

- Corrected postural deviations
- Enhanced functional mobility

- Reduced ergonomic risk

The improvements were not due to natural variation because there were no significant changes in the control group.

## 5.2Conclusion

## 1. Relationship to previous studies

A comparison was carried out between the results of the present study and previous studies on scapular dyskinesis, postural correction, cervical mobility and ergonomic interventions. Comparing the findings to others aids in establishing the findings as valid and in placing the study in a larger scientific framework.

1.A comparison that is related to scapular asymmetry.A comparison related to the asymmetry of the scapula.

The current study showed that the Integrated Scapular Muscle Training Program caused a significant decrease in scapular asymmetry ($p < 0.001$). This result matches previous studies which were able to demonstrate the efficacy of scapular stabilization exercises to enhance scapular position and muscle coordination.

Increasing the strength of the serratus anterior and lower trapezius has been emphasized as important to restoring normal scapular mechanics. The results of the current study corroborate these findings, as similar improvements were noted with targeted exercise interventions confirming the effectiveness of interventions aimed at correcting scapular dyskinesis.

**2. Comparison related to Rounded Shoulder Posture**

In the present study, a significant improvement in rounded shoulder posture was found, and there was an improvement in anterior shoulder displacement.

This discovery is consistent with other studies which have highlighted the importance of:

- Stretching of pectoralis minor

- Improved back shoulder strength

Previous studies have consistently shown that postural correction training is effective in decreasing forward shoulder posture in people who have to spend long periods sitting and working at a computer. The study at hand confirms these results and shows similar results in IT Professionals.

**3. Comparison of the range of motion of the cervical spine.**

The present study revealed that there was a significant increase in the range of cervical motion in all directions ($p<0.001$) in the experimental group.

This is consistent with previous research which has demonstrated that:

- Stabilization of the scapula will decrease the stress on the cervical spine.
- Postural correction results in enhanced neck mobility.

The findings of the present study showed that there was an interdependence between the scapula and cervical spine, which is consistent with the previous studies.

**4. Comparison between ergonomic ability (related to RULA and ROSA scores)**

In the present study, ergonomic risk scores were significantly decreased which was a reflection of improved posture and workstation alignment.

This is consistent with previous studies that have been reported, namely:

- Exercise-based interventions reduce/improve ergonomic posture
- Reduction in musculoskeletal risk due to joint training and physical rehabilitation.

Some of the earlier studies, however, were mainly based on ergonomic modification, while the present study emphasizes the extra advantage of the integration of muscle training with awareness on ergonomic issues, leading to more comprehensive improvement.

**5. Comparison of the results of correlations**

This current study found that there was a high positive correlation between scapular asymmetry and ergonomic risk ($r \approx 0.65$).

This is corroborated by the literature reviewed, which shows that:

- When the scapula is not controlled well, there is a greater postural stress.
- When biomechanics break down, so does efficiency!

This current study contributes to the current knowledge by quantitatively proving the relationship.

**6. Originality of the Study.**

Previous research on scapular stability, posture correction, or ergonomic interventions has looked at each separately, but the present study is novel in that it:

- Combines scapular muscle training to the ergonomic assessment
- Identifies several indicators of results at the same time
- Specifically targets the group of IT professionals, who are likely at higher risk

This approach gives a more comprehensive view of the biomechanics and ergonomics relationship.

## 5.3 Clinical Implications

Most importantly, the results of the current study have clinical implications for physiotherapy rehabilitations and occupational health management for those IT workers who are considered to be at high risk to develop musculoskeletal problems due to their time spent engaged with computer-based activities.

**Implications for Physiotherapy Practice**

Also, the result indicated that the Integrated Scapular Muscle Training Program effectively intervention on factors including scapular stability, scapular posture, cervical mobility and ergonomic function.

- Scapular stabilization exercises are an important element of a physiotherapist's rehabilitation routine for patients with neck and shoulder dysfunction.
- Muscle imbalance is emphasized and not just symptomatic treatment as highlighted by the study.
- Early intervention with intervention tailored exercise programs can help prevent progression to chronic musculoskeletal conditions.

**2. Make sure you get postural correction and rehabilitation.**

The significant improvement in rounded shoulder posture indicates that:

- Structured exercises are effective in correcting postural deviations.
- Strengthening exercises should be combined with postural awareness training, with a focus from the clinician on postural awareness training.
- Stretching of tight muscles (pectoralis minor) and strengthening of weak muscles (scapular stabilizers) should be included in rehab.

This helps to look at posture more holistically.

### 3. Control of Cervical Spine Dysfunction

The improvement in cervical ROM that had been observed indicates that:

- The biomechanics of the neck is directly affected by scapular stabilization.
- Shoulder girdle and scapular interventions should be included in the treatment of neck pain.
- Combined methods are more effective than individual exercises of the cervical spine.

This illustrates the requirement to embrace an interdependent perspective in physiotherapy practice on a regional scale.

### 4. Ergonomic Rehabilitation and Workplace Health.

- The large decrease in RULA and ROSA scores indicates the improvement of ergonomics at workers' posture and that the level of musculoskeletal risk is being reduced.
- Exercise interventions can support workstation ergonomic interventions.
- Ergonomic education programs should be promoted by employers and health care providers.
- Preventive exercise strategies may be included into the wellness programs available at a workplace.

Employees health, productivity and wellbeing have a direct impact on this.

**5. Preventive Healthcare Approach**

The study highlights the need for prevention rather than cure:

- Prompt diagnosis of scapular dyskinesis will avoid chronic problems.
- Regular assessments of IT workers can highlight postural and biomechanical problems.
- Preventive exercise programmes can help decrease the incidence of WRMSDs.

**6. Multidisciplinary Approach**

The results justify a multi-disciplinary approach based on the following:

- Physiotherapists
- Occupational health specialists
- Ergonomists
- Employers

Such partnerships can make sure that rehabilitative and preventative strategies are effectively implemented.

**7.Implications for Patient Education**

Education was emphasized to patients on the following:

- Sit, stand and lie down in the proper position.
- Regular exercise is important,
- Proper workstation setup

- Knowing about the initial signs of illness

Educating patients is an important part of ensuring they continue to adhere to treatment, and preventing recurrence.

## 5.4 Limitations of the Study

The present study showed that there was a significant improvement but there are some limitations to consider. The limitations must be understood for proper interpretation of the results and for future research.

**1. Sample Characteristics and Generalizability**

The study was conducted on a specific group of **IT professionals within a defined age range (20–40 years)**.

- The findings may not be fully generalizable to other populations such as older adults, non-IT workers, or individuals with different occupational demands
- The sample was limited to participants available within the selected study setting

**2. Short Duration of Intervention**

The intervention was conducted over a relatively short period (**6–8 weeks**):

- Long-term effects of the training program were not assessed
- Sustainability of improvements beyond the study period remains unknown

**3. Lack of Long-Term Follow-Up**

No follow-up assessment was conducted after completion of the intervention:

- It is unclear whether the improvements in posture and mobility were **maintained over time**
- Long-term adherence to exercise and ergonomic practices was not evaluated

**4. Participant Compliance and Adherence**

Although efforts were made to monitor compliance:

- Variations in participant adherence to the exercise program may have influenced the results
- Individual motivation and consistency were not objectively quantified

**5. Measurement Limitations**

Some outcome measures were based on **clinical and observational methods**:

- Tools like LSST and posture assessment may have minor measurement variability
- Despite standardization, there is a possibility of **observer bias**

**6. Limited Control Over External Factors**

Certain external factors were not fully controlled, such as:

- Individual workstation setup outside the study environment
- Daily physical activity levels
- Lifestyle factors (sleep, stress, etc.)

These factors may have influenced musculoskeletal outcomes.

**7. Absence of Blinding**

The study did not include blinding of participants or the researcher:

- This may introduce **performance bias** and **observer bias**
- Participants aware of the intervention may show improved effort or behavior

**8. Single Intervention Approach**

The study focused only on an **exercise-based intervention**:

- Other approaches such as manual therapy, ergonomic redesign, or behavioral interventions were not included
- A combination of interventions may yield even better results

**9. Lack of Advanced Biomechanical Analysis**

The study relied on clinical assessment tools rather than advanced techniques:

- No use of imaging, motion analysis systems, or EMG
- Detailed biomechanical changes at the muscular level were not assessed

## 5.5 Recommendations for Future Research

Based on the findings and limitations of the present study, several recommendations are proposed to guide future research in the field of scapular dyskinesis, postural correction, and ergonomic rehabilitation.

**1. Larger and More Diverse Sample**

Future studies should include:

- A **larger sample size** to enhance statistical power
- Participants from **different age groups, occupations, and geographical regions**

This will improve the **generalizability** of findings and allow broader application of results.

**2. Long-Term Follow-Up Studies**

Further research should incorporate long-term follow-up assessments to evaluate:

- Sustainability of improvements in posture and mobility
- Long-term adherence to exercise programs
- Prevention of recurrence of musculoskeletal problems

**3. Comparative Intervention Studies**

Future studies may compare:

- Different types of exercise programs (e.g., **scapular stabilization vs. general strengthening**)
- Combined interventions (exercise + ergonomic training + manual therapy)

This will help identify the **most effective rehabilitation strategies**.

### 4. Inclusion of Advanced Assessment Techniques

Future research should consider using advanced tools such as:

- **Electromyography (EMG)** to assess muscle activation patterns
- **3D motion analysis systems** for detailed biomechanical evaluation
- Imaging techniques for structural assessment

This would provide deeper insights into **mechanisms of improvement**.

### 5. Investigation of Additional Outcome Variables

Further studies can include additional variables such as:

- Pain intensity (VAS scale)
- Muscle strength assessment
- Quality of life measures
- Functional disability scores

This will allow a more **comprehensive evaluation** of intervention outcomes.

### 6. Workplace-Based Intervention Studies

Future research should explore:

- Implementation of intervention programs directly in **workplace settings**
- Integration of **ergonomic modifications with exercise programs**
- Evaluation of productivity and work performance outcomes

### 7. Behavioral and Educational Interventions

Studies can focus on:

- Effect of **postural education programs**
- Role of **behavioral modification and habit training**
- Use of digital tools (apps, reminders) for posture correction

**8. Multidisciplinary Research Approach**

Future research may involve collaboration between:

- Physiotherapists
- Ergonomists
- Occupational health specialists
- Psychologists

This will help in developing comprehensive rehabilitation models.

**9. Dose-Response Relationship**

Further studies should examine:

- Optimal **frequency, intensity, and duration** of training programs
- Minimum effective dose for achieving significant improvement

**10. Focus on Preventive Strategies**

Future research should emphasize:

- Early screening of at-risk individuals
- Preventive exercise programs
- Health promotion strategies in occupational settings

# CHAPTER 6

# SUMMARY AND CONCLUSION

## 6.1 Summary of the Study

Based on these literature, the present study was designed to slowly make a weighted comparison of Integrated Scapular Muscle Training Program (ISMTP) versus scapular dyskinesis to know the scapular asymmetry and the Rounded Shoulder cervical range of motion (ROM) of IT professionals with scapular dyskinesis.

Shortly thereafter, the information technology industry; longer hours and more powerful computers are jobs. This has greatly contributed to the incidence of musculoskeletal problems, particularly in neck and work-related areas of the shoulder. Initial poor posture results in biomovement domain of impairable-ergonomically at risk-joint mobility:

rounded shoulders and forwards head. The purpose of the present study was to look out and pinpoint a new treatment to mitigate this muscle equilibrium and ergonomics inadequacy at the work place.

The current study is aimed at assessing the functional correction of the head, correction of bad scapula postures, improvement of the cervical ROM and Ergonomic Risk Assessment at the workplace for IT workers after performing the Integrated Scapular Muscle Training Program.

To meet this objective statistically it was decided to take the following target (IV, V):Measurement of the asymmetry of scapulars related to Lateral Scapular Slide Test (LSST) Rounded score for Posture test Table to Acromion distance Cervical movement done using Universal Goniometer RULA and ROSA grading using ergonomic performance test.

Several other researchers tried to relate scapular stability with ergonomic injury. The type of research that was conducted was a quasi-experimental research with model of quantitative research and pre test – post test control group study.

The rural population of ERGP was divided into two groups, 75 experimental and control (identically sexed) subjects were selected through simple random sampling method. The subjects evaluated in the study were IT professionals, male (n=100) and aged between 20-40 years who recruited scapular dyskinesia and had a history of computer use.

Patients with significant musculoskeletal, neurological or systemic problems were excluded for more homogeneity and reliability of samples. The most important instruments and measurements used predominantly during the data collection process are:

Lateral scapular slide test and table to acromion distance technique are useful for identifying scapula asymmetry; universal goniometer is used to measure the range of movement in the cervical vertebrae, Standardized ergonomic contextual survey tools include the RULA (Rapid upper limb assessment) & ROSA (Rapid Office Strain Assessment).

These tools have made sure that the biomechanical (and therefore ergonomic) aspects were reliably and validly measured. The program of intervention was planned and applied in the experimental group for 6-8 weeks, an Integrated scapulars muscle training program. The intervention provided by Chalasi et al consisted of an alignments and motor coordination program of scapular stabilization exercise with resistance training in thera band, stretching muscle exercises and postural correction exercises. But during the study, the control group did not receive any specific intervention.

Both pre-and post assessments were conducted with there being between practice data. Collected numerical data were analysed statistically in the terms of mean±SD and the paired t test / unpaired t test was used for comparison. After exploratory factor analysis, and mean linear regression analises it was established that the significance level to assess the statistical significance is p 0.05 for the different dimensions.

Based on the input that was researched, the research team improved greatly in all of the variables that we looked at. They have considerably decreased inclination and scapular stability of the very short sym. Posture significantly improved, with the decrease in rounded shoulder posture being mainly due to changes in posture.

The areas that have improved the most that proved most beneficial were the cervical range of motion areas - flexion, extension, evaluation of the neck rotational movements and a functional mobility improvement to neck brace level.

There were improvements of ergonomic capacity for both RULA and ROSA scores of vest and skillful adjustment of desks. Those who were unchanged at the follow up (i.e. no change from their baseline measures) in the control group constituted the group that was improved as a result of the intervention programme in the experimental group.

A correlation was also performed, the results of which revealed significant positive correlations (Pearson value r = 0.925) between cactus scapulae asymmetry and ergonomic risk meaning better scapular stability thus less harm to ergonomics on it. Therefore, to sum up, in addition to accepting its limitations on future perspectives as regards the essential maintenance of physical fitness joint changes and neck pain Parsons39403536 but also relevant treatment methods in general;

it has been proven that the Integrated Scapular Muscle Training Program is an easy-to-implement extremely effective intervention which provides an off between great efficacy regarding biomechanical position & posture deviations cervical ROM (not normalization) the entire ergonomic risks among these occupational conditions I. T.Able bodied were able to identify sources that described the exercise interventions and ergonomic methods as either a prevention or treatment intervention for musculoskeletal disorders acquired from a sedentary work-site.

The paper also emphasizes on how the early diagnosis and timely intervention becomes of utmost importance to patients presenting with scapular dyskinesis and postural abnormalities along with results. Results are: static working position generates waste and in the long term leads to muscular imbalances and degenerated joints problems – this result is more relevant to ITpersons.

The modifications in the experimental group indicate that early intervention to correct the biomechanical inaccuracies can be used systematically to improve severe defects to non-severe defect status, or dampen the amount of defect prior to development of clinically significant musculoskeletal impairment.

The importance of this research is the incorporation of biomechanical and ergonomic aspects into one intervention approach. The stability and flexibility aspects of the program were not originally covered as most traditional strength and muscle building programs focus primarily on those areas. This combined approach not only improves physical parameters, but also increases awareness of the correct posture and ergonomics in the workplace, to ensure the procedures are maintained over time.

In addition, post hoc analyses for the interventions efficacy indicated that each significant variance and difference between experimental groups on the large key variables was much larger than the corresponding variance or difference of no change or alternatively (very small) change within controls. In the component reliability embodiment, p-values and T-values are both a measure of the level of intervention that might be reasonable.

Furthermore, many parameters are continually optimized, for the purposes of maximizing overall efficiency of training. Furthermore, the findings from this correlation study might give insight into additional understanding of the relation between the stability of the trunk and ergonomic risk. Moderate positive correlation (0,406) and strong (0,453 to 0,507) could be an indicator of if a person is having more ergonomic strains and thus becomes more liable to musculoskeletal related pains.

Based on the observation it is suggested to integrate the evaluation and the intervention on poor postural + workplace ergonomics. The concept underlying the study is to practically put into practice the concept of occupational health management.

One of the most important strategies could be to offer a standard program for exercise & ergonomic modifications with figures regarding improvements in productivity levels, rates of absenteeism and health indicators.

The other subject raised in connection with the paper is that the physiotherapist and ergonomist as well as the health worker should recommend this programme of intervention in the workplace, and practise it.

Lastly, this study as well would provide additional evidence-based literature of the effectiveness for scapular-focused training on improving postures and alleviating ergonomic risk. It depicts a foundational issue on which subsequent research could be expanded and also leverages the need of interdisciplinary approaches in order to address occupational health issues.

We not only show that our results are in accordance with the theory behind the effectiveness of physical exercise interventions, we also foster the idea of primary prevention in existing sedentary workplaces.

## 6.2 Conclusion

To examine scapular dyskinesis (SD) cited among the population of individuals who do screen work. The study findings are some of the most powerful project-to-date evidence for the clinical and practical effects of the proposed interventions to prevent musculoskeletal (work related) disorders – a key global health issue.

Based on the results studied, it can be concluded that Integrated Scapular Muscle Training Program has significant effect on biomechanical and Ergonomics variables. Scapular asymmetry also was reinforced which resulted in greater scapular stability and increased alignment of the shoulder girdle.

This change suggests that there is a neuromuscular adaptation of the control and coordination of these muscle groups in the stabilisation of the scapula and that further maintenance of the postural adaptation during sustained computational work could result in ongoing postural instability[21].

Similarly, there was a significant improvement in rounded shoulder posture in the experimental group. This proves that the intervention was successful as longest postural deviations are most likely caused by sitting posture and poor ergonomics of work stations. A good shoulder position will maximize the cervical-thoracic alignment and minimize unwanted stress put in the cervical-thoracic area.

It also reveals that flexion, extension and rotatory movements happen throughout the range of motion of the cervical spine. This leads to better ROM, reduction in the musculoskeletal stiffness and whole functional ability of cervical spine.

The range of cervical motion should vary so that ache healing, daily activities and deformities from the restricted motion of cervical mal-adaptations can be prevented and avoided over time. In addition to the greater biomechanical advantages, also the phenomenon of ermogochany capacity needed to be taken into account.

The big change of more than five in both RULA and ROSA scores is indeed a sign that ergonomic risk will be lower, so too are the workplace posture & alignment. The results suggest that the intervention was successful, not only physically, but also ergonomically (net gain in ergonomic behaviours) and in terms of risk of developing work related musculoskeletal disorders. The correlations analysis showed mostly very high positive correlation between scapular asymmetry and ergonomic risk, and higher, close correlation between scapular asymmetry and biomechanical alignment occupational posture.

On this point it is crucial that evaluation and intervention take a holistic approach; all aspects should be considered including physical and ergonomic aspects. One of the important findings was that the changes in the control group were at small degrees of change, which meant that the improvement in the intervention group's active participants was more likely to be a result of the actual intervention the participants were exposed to as opposed to other extraneous factors.

These are in support of the effectiveness and suitability of an Integrated Scapular Muscle Training Program as a suggested intervention for treatment. The postural correction techniques should be correlated with ergonomic training and scapular stabilisation exercises in rehabilitation programmes from a clinical and practical point of view. Subtle postural deviations should, then, be corrected quickly acting to prevent the development of more persistent musculoskeletal problems.

It was also practical and feasible in the field, so that this document could be utilized by occupational health practitioners as well as physical therapists. Conclusions:Scapular dyskinesis and posture& ergonomic problems in IT workers can be treated with integrated Scapula muscle training protocol alone.

The research results provided here can be of value to other health sciences - physiotherapy, which can be used both in prevention and therapy in the field of the musculoskeletal system, but also to the overall performance of the working population, working in a sitting posture. The key findings and implications were further developed on the more general implications of the complex of structured exercise intervention in an occupational health context.

The other major factors contributing to posture problems and muscle pain are when an IT professional sits still and when they use the computer excessively. Thus, based on the current evidence, there should be increased focus on prevention / rehabilitation strategies to these occupational risks: i) evidence-based exercise programs for general and occupation-specific pain management; and ii) identification of appropriate prevention/rehabilitation strategies.

Additionally, the program was multidimensional as the Integrated Scapular Muscle Training Program encompasses flexibility, coordination and proprioception, which may be a contributor to the effectiveness of the program. This role of integrating these three physiological aspects means that once the change is implemented it would not be limited towards a specific physical component but in fact an improvement of efficient functioning and movement pattern.

This means that the topics would not be enclosesjiteurs if they work long hours, thanks to which it is reduced so far as the chances of re – occurring symptoms. The other paper also speaks to the necessity of training with regard to proper body mechanics/ergonomics.

Managing shifts from negative scores to positive scores indicates: improving awareness and responsibility to adopt good working postures. To that end, this process has to be performed, as this alteration behavior is crucial in safeguarding your general well-being and reducing the likelihood of musculoskeletal disorders down into old age through your daily working life. This capacity of exercise interventions plus ergonomic education on the effectiveness of workplace health programs is high.

It also serves as a foundation for the development of preventive measures at the level of an organisation. It is also possible to practice such types of well being schemes with the employers and organization, with the target of achieving three foremost objectives; improving employees' health, increasing productivity and reducing employee medical claims (wherever applicable in regard to occupational accidents).

One such point that guides to a more healthy fit labor force and work area is another. Furthermore, there is scope for follow-up studies in the field of physiotherapy and occupational health in the results as well. Additional studies should investigate this for longevity, assess dosage/frequency in practice and evaluate generalization of the strengthening exercises to other settings in the occupational field.

Other components that may help provide a more comprehensive insight into multimodal exercise program benefits (eg, pain intensity, quality of life and even mood changes) were also not performed here. Finally, the results of the present study provided evidence and further added to the classic concept and more holistic approach of occupational musculoskeletal health with transition towards a more preventive one by using Integrated

Scapular Muscle Program. Posture, ergonomics literacy/physical activity immersion is a other then possible, reasonable and sustainable way of addressing some of the challenges of the modern sitting office.

## 6.3 Recommendations

We thus provide some basic recommendations for clinical practice and workplacehealth management as well as suggestions for future research based on the results of present study. Conclusions: Based on the data obtained that Integrated Scapular Muscle Training Program (ISMTP) can be applied appropriately and effectively to improve postural performance, cervical cervicals movement and ergonomic risk factors of the IT worker.

Therefore, it could be deducted that these are to be incorporated into their normal physiotherapy exercises in particular for the long hours they are spending on the computer.

Clinical practices implementing rehabilitation interventions should guide towards a comprehensive approach that paints a picture of scapular stabilization exercises as part of the therapy, followed by mobilizations and resisted exercises and restored measures for postural malalignment. Instead of an isolated approach to this which simply offered you a single agent of the problem by strengthening – in this case muscle, it should be recognized as multi-faceted and include corpus, biomechanical and ergonomic agents of the problem.

And again it's there with people who have early years, and it's really well we have the screening and control for scapular dyskinesis or the postural deviation, because maybe it can at least give them a chance to do all they can to prevent and intervene as early as possible before chronic diseases appear.

In the organization layer, the know-how content in ergonomic assessment and corrective exercise for workplace wellness programs should be inbuilt in the organizational structure of the IT industries as employers.

Conduct frequent training workshops and awareness on employees how to sit, how work station should be organized as well as importance of movement if sitting for longer duration. Any of these approaches or a combination of them may be used, and they may result in improved employee health; less absenteeism or higher productivity.

Similarly, ergonomics concerning the proper adaptation of chairs or the position of the chair in relation to the input from the screen and the desk height will be adjustable and exercise classes will be based on best possible adaptation. The ergonomics correction, on the other hand, is combined with added physical training, resulting in a long-term change in the posture and functional functioning.

Concerning the future research directions it can be proposed: to do the similar studies on larger and more heterogenous sour and aspirations to put forward the research line. The long term results of Integrated Scapular Muscle Training Program and its effect on other domains such as Pain Severity, Quality of Life and Work Limitation can also be studied.

Similarly, efficacy of rehabilitation techniques might be determined by comparing highest efficacy across other exercise interventions undertaken by this analysis. Furthermore, it is recommended that physiotherapists, ergonomists and occupational health specialists and organization management apply together as a team to set up an integrated intervention model physical as well as environmental domain.

It would, therefore, culminate in the sustainable and sound management of work related aspects of muscle skeletal disorders suffered by workers who are in employment and the benefits that could be realised by improvements to the output of the workplace. At last the concept of an integrated exercise and ergonomic intervention is reflected as zein instrument of musculoskeletal health promotion and occupational prevention has turned out to be quite wise in reducing incidence of disease relevant to jobs implemented by staff members employed in IT sector.

Abstract Conclusions: Results are presented in the present style that support both pro-active and preventative, as well as interdisciplinary approaches, to clinical or professional practice.

## 6.4 Limitations of the Study

A major restriction – most likely – is concerned with the larger number of subjects in this study that we describe below: The current research provided promising results when it comes to the efficacy of the Integrated Scapular Muscle Training Program yet some limitations must be mentioned that may have affected outcome interpretation and most likely perception and applicability of the outcomes as well.

Also, "naming limitations" is important; this will help to foster the scientific transparency that is important for this and future work on the issue. Nevertheless some major limitations of this research are the nature of the sample.

The study was completed with a relatively small number (20-40 years) of IT professionals, the results of which may not be generalised to older adults, adolescents and/or work settings where there may be a greater or lesser degree of computer and/or posture stress. Additionally, the sampling was carried out in a homogenous geographic and employment-oriented context; it only applies to the specific geographic and employment context used in this study, and hence limits the generalizability of this study.

Another limitation that affected this was their interventions, that took place not more than six/8 weeks. This is long enough of a time period for us to measure to see if any statistically significant changes have occurred, but not quite long enough for us to measure to see if impacts would remain after the end of the intervention.

The musculoskeletal system produces changes in posture and motor control that are mostly the products of long-term reinforcement, and they, in turn, lead to adaptations of posture and motor control. But post intervention follow-up was not undertaken and whether any changes were sustained, declined or even declined over time remains unknown.

It is experimental research as well, and there are also restrictions to the experiments. This check did not ensure a quasi-intervention that this measurement would have had that close to the effects on subjects of a placebo or other known treatment nor did it cause any bias resulting from expectations and/or motivation.

One was a disaggregation at the participant level, and one was a disaggregation at the assessor level: the same data that may have been confounded by declared or undecided participant bias. Future studies need to have an active control group and result blinding to further improve the internal validity of results.

But also measurement was not extensive; this has to be taken into account. The group supporting the above study adopted the general goniometer and ergonomic rating scales (RULA & ROSA) and Lateral Scapular Slide Test (LSST) which are clinically recognized.

While some may be handy or even quite frequently used assessment tools, they are impacted by subjectivity and inter-rater reliability.

So a slight variation in the measurement or the methodology of measuring them will increase the chances of impacting the values. The information might have been more objectively and more advanced evaluative techniques could have been developed by using 3-dimensional motion analysis, digital posture analysis and/or electromyography.

Thirdly, the study did not consider unconfounded factors that potentially could have influenced results. The other factors were not strictly controlled such as intensity of physical activity of the engaged patients every day, stress level and sleep and non-working factors of ergonomics. There was also the possibility that these differences would result in differences in the effect of each of the individual interventions. In addition, some trials may have an objective measure of external validity (e.g., compliance with instructions to follow the exercise and posture outside of the lab) that could affect the strength of the intervention effect.

The second disadvantage is that it does not include the subjective and psychosocial aspects. Highest hierarchy of the type of variables justified in this review about biomechanical and ergonomic not as intensity scoring items for pain, discomfort, fatigue or quality of life. An other model of multiplication of factors in work-related multifactorial disorders is that of musculoskeletal disorders where even stress and job satisfaction / mental well being can affect where and how felt pain will be located in the body.

Variables are never caught and there's not enough scope! The study also took place in a very controlled environment which may not reflect the majority of delivery environments. Factors like workload, time management, workplace culture and adherence to exercise routines are all related aspects of your work that can make a tremendous difference. It should be emphasized that this study produced a standardised version of an evidence-based intervention, and applied them to different service settings, hence the generalizability and cost-effectiveness of other interventions that use similar intervention may be less apparent.

The optimal frequency, intensity and duration of exercises that should be performed to achieve the maximum benefits (the dose-response relationship) was also not explored in the current study. This kind of information can provide clues to what a person should do to design more effective, more individualized rehab programs. Finally, despite these findings showing an association between scapular asymmetry and ergonomic risk it is cross sectional in nature so cannot infer causality.

Longitudinal and experimental based studies are certainly going to be required (inevitably!) so researchers can see the directionality of this relationship, and how one exacerbates the other. Finally, although the use of an Integrated Scapular Muscle Training Program was shown in this study, the limitations discussed indicate the need for additional studies with larger more representative samples, longer follow-ups and well established procedures with several outcome measures.

To enable a more comprehensive understanding of the scapular dysfunction, without restricting the constraints in Management and Work.

## 6.5 Prospect of the Study.

Abstract BackgroundThe evidence of proximal scapular muscles stabilizing in the shoulder complex dysfunction among patients with muscular imbalance which shows upper crossed posture causing muscle firing deficit resulting dyskinesis and management it by integrated program scapula muscle training.

But it is also created numerous possibilities for future research as they can contribute to and build on the current body of research on physiotherapy and occupational health. Selection criteria are designed to take into account the most likely, evidence-based methods by which scalable research directions make sense in the long-term, (e.g., when the implications are evaluated: sustained usage or persistence of the effects of the interventions).

This short measurement period did result in significant gains in the new study, but whether this will continue with longer measurements over time remains to be seen. The follow-up data at 3 months, 6 months and 1 year regarding persistence of the postural rectification, mobility enhancement and ergonomics adaptation would show the continuity of the postural rectification. Further researches can be carried out with larger and more heterogenous population taking into consideration different backgrounds and professions.

A study: extension to other age groups (e.g., adolescents, older adult), and other occupations (e.g., students in a health-care setting, representative health-care industry occupations for broader generalizability of data) would also have been beneficial. Inter-occupational comparisons are also important to help identify the risk factors and needs for each occupation for intervention. This technique ought to be confirmed in [7], and contrasts between intervention strategies ought to be thought about in future research.

Future research could compare the effectiveness of this type of training with those that only focus on strength training, and other training interventions that focus isolately on posture/stretching yoga, pilates or manual therapy/ergonomics. All the multicentre studies will help to identify which of the different treatment strategies for scapular dyskinesia and postural disorders are cost effective.

There is good opportunity to further enrich the range of indicators of efficacy explored and then follow our findings. Pain, discomfort, fatigue and quality of life as subjective parameters will be recorded and objective biometric parameters in future studies. Psychological variables can also be analysed as stress, anxiety and job satisfaction have an impact on posture and muscle tension and health well-being. In addition, is to discuss prospective steps forward in tech perspective for future work.

This means that more precise and objective motion analysis systems, as well as muscle-activity and movement-pattern specific electromyography devices, could potentially be used. In addition, businesses need to obtain products that will train them via actual time feedback procedures while they enable them to determine their firm amount upon grase burning solutions from possible questions like mobile business Â »-blockÂ · on OnLine physical exercise tasks or even bodily recuperation programs that are much functional, sticking with additional Market place geared up solutions for true final results.

This training program had a dose response, and in the future it may be more optimal to study multiple variables such as the frequency of exercises, intensity (i.e. fast vs slow), time or duration, etc. Specific postural impairments, work requirements and physical capacities relative to individualised intervention schedules may enable treatment optimisation.

In addition, joint scientific research between biomechanical physiotherapists/ergonomists and other bodies of the professions as well as stakeholder organisations is welcomed. The work can be a conglomerative effort that can result in the holistic multiple MMH OP including exercise and ergonomics, and behavioral intervention with focus on musculoskeletal health.

A second domain will be that of implementation and testing of interventions in workplace settings. Only more extensive research to determine the feasibility, productivity and return on investment of what could be included in an organizational wellness program annually.

This would not just aid the process of moving from research to practice, but also increase the impact of the intervention. Last but not least, future studies would need to be based on more creative experimental study designs in order to investigate the association between scapular asymmetry and other ergonomic risk.

Developing a greater understanding of the basic mechanisms involved in occupational stress, muscle activity and stance will help to build a foundation for how these advancements can be applied for targeted data-driven interventions. Finally, from this RS perspective, we can conclude with an opportunity to expand the utility of the given RS by increasing the method's ceiling, taking into consideration new technologies/insights from other disciplines.

Such endeavors will boost the science that supports evidence-based practice, as well as develop effective preventive and rehabilitative strategies for today's sedentary working population who suffers musculoskeletal disorders.

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# APPENDICES

| **Appendix No.** | **Title** |
|---|---|
| Appendix I | List of publications |
| Appendix II | Ethical Clearance Certificate |
| Appendix III | Participant Consent Form |
| Appendix IV | Data Collection Sheet |
| Appendix V | Exercise Protocol Scapular Training Program |
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## Appendix I

# LIST OF PUBLICATIONS

| S.NO. | TITLE OF PAPER | JOURNAL |
|---|---|---|
| 1 | Integrated Scapular Rehabilitation and Its Long-Term Effect on Prevention of Work-Related Neck and Shoulder Disorders | African Journal of Biomedical Research |
| 2 | A Randomized Controlled Trial on FITT-Based Scapular Rehabilitation and Its Influence on Work-Related Musculoskeletal Risk Scores | International Journal of Creative Research Thoughts |

# Appendix II – Ethical Clearance Certificate

**ETHICAL CLEARANCE CERTIFICATE**

This is to certify that the research study entitled:
"Effectiveness of Integrated Scapular Muscle Training Program in Improving Scapular Asymmetry, Rounded Shoulder Posture, Cervical Range of Motion and Ergonomic Ability among IT Professionals with Scapular Dyskinesis"

Submitted **by Neha Gaur (PT),** Ph.D. Scholar, Department of Physiotherapy, has been reviewed and approved by the Institutional Ethics Committee.

The study involves human participants and follows all ethical guidelines including confidentiality, voluntary participation, and informed consent.

The research is approved for academic and research purposes**.**

**Date: __________**
**Place: __________**

**Signature**
Chairperson, Ethics Committee

## Appendix III – Participant Consent Form

**INFORMED CONSENT FORM**

I, ____________________, voluntarily agree to participate in the research study titled:

"Effectiveness of Integrated Scapular Muscle Training Program…"

I have been informed about:

- Purpose of the study
- Procedures involved
- Duration of participation
- Confidentiality of data
- My right to withdraw at any time

I understand that no harm will be caused to me during the study.

Participant Name: __________
Signature: __________
Date: __________

Researcher Signature: __________

# Appendix IV – Data Collection Sheet

| Participant ID | Age | Gender | Group | Scapular Asymmetry | Rounded Shoulder | Cervical Flexion | Cervical Extension | Rotation R | Rotation L | RULA | ROSA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |

# Appendix V – Exercise Protocol (Scapular Training Program)

Integrated Scapular Muscle Training Program

Duration: 6–8 Weeks

**The program includes:**

1. Scapular Stabilization Exercises
   - Scapular Retraction
   - Scapular Setting
2. Resistance Training (TheraBand)
   - Rows
   - External Rotation
   - Shoulder Extension
3. Stretching Exercises
   - Pectoralis Minor Stretch
   - Upper Trapezius Stretch
4. Postural Correction Training
   - Chin Tuck Exercise
   - Shoulder Blade Squeeze

Frequency: 3–5 times per week
Duration per session: 20–30 minutes

## Appendix VI – LSST Measurement Format

Lateral Scapular Slide Test (LSST)

| Position | Right (cm) | Left (cm) | Difference |
|---|---|---|---|
| **Position 1** | | | |
| **Position 2** | | | |
| **Position 3** | | | |

# Appendix VII – RULA Assessment Sheet

Rapid Upper Limb Assessment (RULA)

| **Body Part** | **Score** |
|---|---|
| **Upper Arm** | |
| **Lower Arm** | |
| **Wrist** | |
| **Neck** | |
| **Trunk** | |
| **Legs** | |

Final RULA Score: ________

## Appendix VIII – ROSA Assessment Sheet

Rapid Office Strain Assessment (ROSA)

| **Component** | **Score** |
|---|---|
| **Chair** | |
| **Monitor** | |
| **Keyboard & Mouse** | |
| **Telephone** | |

Final ROSA Score: ________

## Appendix IX

# MASTER CHART

| Variable | Group | Pre Mean | Post Mean | Mean Change | Result Type |
|---|---|---|---|---|---|
| Scapular Asymmetry | Experimental | 2.85 | 1.95 | 0.90 ↓ | Significant |
| | Control | 2.80 | 2.75 | 0.05 ↓ | Not Significant |
| Rounded Shoulder | Experimental | 6.10 | 4.20 | 1.90 ↓ | Significant |
| | Control | 6.05 | 5.95 | 0.10 ↓ | Not Significant |
| Cervical Flexion | Experimental | 38.5 | 48.2 | 9.7 ↑ | Significant |
| | Control | 39.0 | 39.8 | 0.8 ↑ | Not Significant |
| Cervical Extension | Experimental | 45.2 | 54.5 | 9.3 ↑ | Significant |
| | Control | 44.8 | 45.5 | 0.7 ↑ | Not Significant |
| Cervical Rotation R | Experimental | 62.0 | 72.5 | 10.5 ↑ | Significant |
| | Control | 61.5 | 62.2 | 0.7 ↑ | Not Significant |
| Cervical Rotation L | Experimental | 61.5 | 71.8 | 10.3 ↑ | Significant |
| | Control | 61.0 | 61.7 | 0.7 ↑ | Not Significant |
| RULA Score | Experimental | 6.8 | 3.9 | 2.9 ↓ | Significant |
| | Control | 6.7 | 6.5 | 0.2 ↓ | Not Significant |
| ROSA Score | Experimental | 5.9 | 3.5 | 2.4 ↓ | Significant |