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Comparative Analysis of Gluteal Strengthening Exercise and Core Stabilization Exercises Program for Gluteus Dysfunction in Chronic Low Back Pain among Residence of Ziro, Arunachal Pradesh

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Enrolment No :-

A THESIS SUBMITTED TO THE INDIRA GANDHI TECHNOLOGICAL AND MEDICAL SCIENCE UNIVERSITY ZIRO, ARUNACHAL PRADESH, FOR THE IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF

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Under the Guidance of
……

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DECLARATION BY CANDIDATE

I hereby declare that the research work in this thesis entitled "Comparative analysis of Gluteal strengthening exercise and Core Stabilization Exercises program for gluteus dysfunction in chronic low back pain among residence of Ziro, Arunachal Pradesh",is a bonafide and genuine research work carried out by me under the guidance of …… this work has not formed the basis for the award of any other degree or award-ship previously in India or abroad . The particulars given in this research are true to the best of my knowledge and belief.

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This is to certify that the thesis titled "Comparative analysis of Gluteal strengthening exercise and Core Stabilization Exercises program for gluteus dysfunction in chronic low back pain among residence of Ziro, Arunachal Pradesh," is a bonafide research work done independently and satisfactorily by Somsankar Mukherjee, Department of Physiotherapy, Faculty of Medical and Paramedical Sciences, Indira Gandhi technological and medical sciences university, Ziro , Arunachal Pradesh under my personal supervision and guidance. All the data collection, results and observations and their interpretation embodied in the thesis has been done by the candidate and periodically checked by me. He has fulfilled all the requirement under the regulation for the M.Phill course of Indira Gandhi technological and medical sciences university, Ziro, for the preparation and completion of the thesis for the degree of Master in philosophy (M.Phill) in the Faculty of Medical and Paramedical Sciences (Physiotherapy). No part of this thesis has been submitted to any other university.

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ABSTRACT

A study titled "Comparative analysis of Gluteal strengthening exercise and Core Stabilization Exercises program for gluteus dysfunction in chronic low back pain among residence of Ziro, Arunachal Pradesh."

Back ground of the study: Chronic low back pain is the major problem irrespective of age, gender, occupation, and several other factors. The worst consequence of chronic back pain is it reduces work productivity. Surgeries to therapies are the options but all are symptomatic basis. In physiotherapy there are several exercise protocols but there is no clear cut documentation.

Objectives of study: To determine the prevalence of gluteus medius weakness and tenderness in people unilateral chronic low back pain.

1. **To compare gluteus medius strength and tenderness between symptomatic and asymptomatic side of chronic low back pain.**
2. **To determine if this gluteus medius strengthening program improved gluteus medius muscle strength.**
3. **To determine the effectiveness of a gluteus medius strengthening program compared to a standard exercise program in participants with chronic low back pain.**

Method:The research approach adopted was descriptive and analytical approach. The research design selected for this present study was randomized clinical trial design. The study was conducted at Naturopathy, Yoga, Physiotherapy and life style intervention center of Indira Gandhi technological and medical sciences university, Ziro. 135 clients were identified with chronic low back pain. Based on selection criteria 83 participants were included out of which 34 clients were chosen on conveniences sampling.

Data collection procedure:The tool such as manual muscle testing, tenderness points were assessed by therapist as test-retest method and tenderburg sign is an observatory method by three of the therapist independently. SF-36, ODI, FABQ standardized questionnaire were used. content validity of the tool was established by giving to professional experts for translating the questionnaires into local language.

Result:The participants were divided into two groups as Group-1: Stabilization exercise program and Group-2: Gluteus medius strengthening group. On evaluating the components we found that Group-2 has good progress in Gluteus medius muscle strength, Significantly reduce in pain as compare to Group-1. Further we found that Both the components of FABQ and SF-36 have been improved significantly in Group-2 as compare to group-1. Surprisingly we got improvement in Oswestry low back pain disability index and 5 times sit to stand test in group-1 as compare to group-2 but statically it is not so significant.

Conclusions: The present study indicates that weakness of Gluteus Medius muscle is one of the strong indication for chronic low back pain and strengthening of same muscle can lead to be a one of the best outcome from such pain. Moreover exercises prove again that quality of life can be improved as one of the psychological motivator.

ISSN No:-2456-2165

TABLE OF CONTENTS

ISSN No:-2456-2165

LIST OF TABLES

ISSN No:-2456-2165

LIST OF FIGURES

ISSN No:-2456-2165

CHAPTER 1

INTRODUCTION

From traditional era to modern world, types and disciplines of medical and health care system changes with time. From time to time new therapeutic systemshave emerged and developed depending on demand of society, geographical chacteristics, life style and livelihood.Certain health associated problem(s) are more prominent to certain area. The present study has been conducted in Ziro, Arunachal Pradesh. Though it is a small town with population around 13000 as per census of 2011, Ziro is the head quarter of Lower Subansiri district, Arunachal Pradesh. Majority of the residents are ~~rice~~ farmer. Due to their ~~farming~~ agricultural life style and hard life style, the physical injuries are quite common among the inhabitants.

Low back pain is one of the major problems in any stage of life, irrespective to any kind of job[79]. In general, patient complains the pain in vast area, from lower rib cage to lower gluteal fold, with or without radiating to unilateral or bilateral lower extremity.[19] There are several underlying causes for back pain but majority of the lower back ache are of unknown etiology.[18] In general, complain of acute episode of low back pain are not specified and gets heal in due course of time.[58]

In general, till date experiences and discussions~~ed~~ from several scholar and clinical experts found that mostly low back pain gets carry forward rather than permanent cure. Deyo RA et al. (2014) and Deyo RA and collegues(2008) defined Chronic pain as pain continues for more than three months, the nature of pain may be continuous or may be remitting and relapsing for three months or more [17,19] . Many of the clients complain as non-specific pain and radiating and burning sensation to lower limb(s) and reduce the work productivity.

Karayannis NV and colleagues (2012) reported that physical therapist has classified low back pain in several groups, but most of the them has focused on basic classification as: O'Sullivan classification system(OCS), Movement system impairment syndrome(MSIS), Treatment based classification(TBC), mechanical and diagnostic treatment(MDT) &path-anatomy based classification (PBC).[35]

Philosophy behind O'Sullivan classification system(OCS) is to identify the mal-adaptive movement or impairment in motor control focus them for treatment.[57]whereas Movement system impairment syndrome(MSIS) further subdivided into several category viz- Lumbar flexion syndrome (symptoms aggravated on flexion), Lumbar extension syndrome (symptoms aggravated on extension) , Lumbar rotation syndrome (symptoms aggravated on rotation), Lumbar flexion and rotation syndrome (symptoms aggravated on rotation and flexion), Lumbar extension and rotation syndrome (symptoms aggravated on rotation and extension).[64] Treatment based classification (TBC) try to analyze the basic pathology and then justify with appropriate for physical therapy management viz Manipulation, Stabilization, Specific Exercise, and Traction.[15,26]

Mechanical Diagnosis and Treatment (MDT) focused on Postural Syndrome, (the Source of symptoms is believed to be secondary cause to postural dysfunction and is treated with postural correction), Dysfunction Syndrome,(Problems are related to anatomical dysfunction of the soft tissue and treatment is based on remodel the affected tissue); Derangement Syndrome,(joint surfaces are abnormally positioned and therapy is direct by directional preference of movement) [18,30] Pathoanatomic Based Classification focused on one of thirteen categories based on assumed pathology. These are Syndromes of disco-genic originated, associated with Nerve Root, Nerve Root Entrapment, Nerve Root Compression, Spinal canal Stenosis, Zygapophysial Joint derangement , Postural, Sacroiliac Joint syndrome, spinal Dysfunctions, Myofascial Pain syndrome , Adverse Neural Tension, Abnormal Pain, & indecisive conditions.[59]

ISSN No:-2456-2165

Out of above, most of the Indian physical therapist practices on Treatment based classification system. But the chronic non-specific low back pain has heterogeneous causes and present available systems failed to discover the standard intervention method. Majority of the physical therapist chooses exercise intervention which are unimportant and the simple fact that they are doing some sort of exercise [58] with purpose of benefiting for patients.

Out of my clinical experiences while working with different clinics and hospitals, it is observed that low back pain syndrome is associated with gluteal medius muscle weakness. Till dated I didn't found any such study which correlates the role of exercise of gluteus medius exercises on non-specific low back pain dysfunction especially on north east Indian citizen.

Thus my investigate has been carried on, to find out the effectiveness of exercise program on gluteus medius in patient with chronic nonspecific low back pain and effect on gluteus medius strength. The aim of the study is to find out the intervention of gluteal muscle exercise on nonspecific low back pain, whereas the objective of the study is to compare the low back syndrome with and without gluteus muscle strengthening.

ISSN No:-2456-2165

CHAPTER 2

HYPOTHESISAND OBJECTIVES

A. Hypotheses

H-1. The first hypothesis was weakness of gluteus medius and tenderness in gluteus region occurs in the majority of people unilateral chronic non-specific low back pain.

H-2. The second hypothesis was, gluteus medius strengthening is more effective than a standard exercise program for people with chronic non-specific low back pain with gluteus medius weakness and gluteus tenderness.

B. Aims and Objectives of study.

- To determine the prevalence of gluteus medius weakness and tenderness in people unilateral chronic low back pain.
- To compare gluteus medius strength and tenderness between symptomatic and asymptomatic side of chronic low back pain.
- To assess the ability of gluteus medius weakness and tenderness to explain the presence of chronic low back pain in this sample of people.
- To determine if this gluteus medius strengthening program improved gluteus medius muscle strength.
- To determine the effectiveness of a gluteus medius strengthening program compared to a standard exercise program in participants with chronic low back pain.

ISSN No:-2456-2165

CHAPTER 3

REVIEW OF LITERATURES

A. Correlation among the Hip and Low Back Pain

Several researchers clinically assessed and correlated that the deficits at the hip may impact low back pain. Delitto A, et al.(1995) mentioned the criteria of interaction between hip rotational movement and Lower Back Pain for calculated the success with manipulation in the Treatment Based Classification system.[16] Similarly Flynn and colleagues(2002) relative considered that the hypomobility in the spine and hip internal rotation greater than 35 degrees are part of the criteria for manipulation.[24]

The relationship between the hip and low back has been great form of discussion and had been quoted in several literature and may be grouped into several categories such as specific gluteal muscle weakness originated from Nuro-myo-skeletal disorders, hypo mobility of hips, hip-spine syndrome, greater trochanteric pain syndrome (GTPS) and many more.

Harris-Hayes M. et al.(2009) studied on athletes and suggested the interaction between hip function and role in sub group patients with Low Back Pain.[28] Likewise Offierski and McNab (1983) described an about hip spine syndrome, and explained about the relationship between the arthritic hip arthritis and pathology and spine.[56] Again, Yoshimoto H et al.(2005); Matsuyama Y et al. (2004) & Radcliff KE et al.(2013) found and explained the compensatory mechanism on spinal mechanics related to multiple disorders related to hip joint.[43,61,83]

Many study correlates with Hip joint pathology which overlaps clinically with back pain. Sembrano and Polly (2009) reported that hip or pelvic dysfunction syndrome are synchronized with few of the spinal surgery clinical population. [67] Ben-Galim and colleagues (2007) statement that total hip arthroplasty was able to improve hip joint symptoms, and contemporaneously with lower back pain and contralateral hip joint pain. They concluded that direct hip treatment has effective outcome for lower back pain.[4]

In several studies it has been mentioned that hip range of motion has also been concerned in low back pain. Such as Mellin et al.(1988) noted the correlations between hip hypo-mobility with low back pain. [44] Moreover Ellison and colleagues(1990); Chesworth and colleagues(1994); Cibulka and colleagues(1998) studied discretely at different point of time and all researcher analyzed the hip rotation with lower back pain and they found that range of motion of internal rotation is less than external rotation.[10,11,20] The relationship between trochanteric bursitis, or greater trochanteric pain syndrome (GTPS), as it is more widely and properly termed, and low back pain has been supported by several studies.

Swezey (2015) reported that actual cause of one-third of elderly adults has trochanteric bursitis, but complain of lower back pain and symptoms mimics as psuo-radioculopathy. [72] Similarly, Collée and colleagues (1990 & 1991), explored in rheumatology or orthopedic specialty clinics, rural general outpatient practice and occupational health clinic and found that Greater trochanteric pain syndrome, specifically trochanteric bursitis is the chief pathological cause among one-third of patients who had a complain of chronic low back pain.[12,13]

More recently Tortolani PJ et al.(2002) studied at orthopedic spine specialty clinic and found that 20.2% patients having pathology of greater trochanteric pain syndrome but complain of low back pain.[73] Sayeg F et al.(2004) study outpatient orthopaedic clinic described that female patients complain of lower back pain had a symptomatic GTPS as the primary problem.[66] The above theses and studies suggest the overlap symptoms of lower back pain and pelvic and hip dysfunction.

ISSN No:-2456-2165

B. Role of Gluteus Medius Dysfunction in Low Back Pain

Researchers of different part of the globe found the direct interactions between gluteus medius dysfunction and low back pain. Simons DG et al. (2004) describe the gluteus medius myofacial pain syndrome can be a cause of lower back pain. They explain that the pain referred from gluteus medius as presenting medial toward the sacrum, superiorly along the iliac crest as well as throughout the buttock. [68] Later Njoo and van der(1994) found that the gluteus medius myofascial trigger points are more tendered of patients seeking care for low back pain as compaired to control population, They suggest that pain from the gluteus medius muscle has a strong association with low back pain and weakness of the hip abductors had been recorded in people with lower back pain. [52]

Kendall and colleagues (2012) found a difference in hip abductor strength in people with non-specific Chronic Low Back Pain compared to healthy group.[37] Similarly, Nourbakhsh & Arab (2002) recorded significant shortage in strength of hip abductor, adductor, flexor, and extensor group of muscles in a large sample of people with chronic Low Back Pain compared to a control population.[53] These study shows a relation between hip strength and low back pain. In additional, strength disproportion in the region of the hip has been concerned with low back pain.

Nadler and colleagues,(2000) found a significant variation in bilateral hip extensor strength evaluated by dynamometry among the female athletes who had experienced low back pain. Further, they retrospectively about hip?? abductors but didn't found any kind of asymmetry in strength. [47] To confirm their report they conducted a prospective study in the year 2001on bilateral comparison of strength of hip extensor, abductor in both genders. They concluded that asymmetry in Hip extensor muscles can be predictive and need treatment for lower back pain among collegiate athletes, whereas we didn't found in male athletes more over unable to correlate the bi lateral hip abductor strength with low back pain. [45] but again in the year 2002, they contradicting to their own study by stated that few of athletes with low back pain have disproportion in bilateral hip abductor muscle strength but nothing to do with hip extensor muscles.[46] Overall they concluded that Gluteal muscle weakness and bilateral strength asymmetry has a positive correlation with low back pain and can be stated that gluteal muscle dysfunction leads to low back pain.

Nelson-Wong et al,(2008) compared on gluteus medius, rectus abdominin, and para spinal muscles of lumar and thoracic region muscle activity during standing position between low back pain patient and control group. The outcome of Electromyography shows a different recruitment pattern of gluteus medius in low back pain patient as compared to control group.[48] On further investigation in their research, they found that minimum three years standing task can experience low back pain.Further he concluded that poor trunk control is one of the cause of low back pain and in particular gluteus medius muscle weakness or dysfunction.[51] Multiple studies done by Bewyer et al.(2003 and 2006) suggest that there are patients with low back pain may have gluteus medius, pain, ternderness and dysfunction.[5] specifically seen in pregnant women [6] and strengthing exercises focused on gluteal muscle will be advisable.[5] but, further biomechanics and patho mechanics analysis are need.

C. Functional Assessment of Gluteus Medius

In 1985, the outstanding functional assessment for gluteus medius is the Trendelenburg Test. He elaborated the loss of control on frontal plane movement during standing or walking due to gluteus medius weakness.[74]

Later on several controversy and improvisation and utilization have been done such as, standerdisation of test have been tried by Hardcastle and Nade(1985).[27] where as Youdas and colleagues (2010) utilized the test for discriminating the presence of hip arthritis from other associated problems. [84] Kendall and colleagues (2010) tried to analyzed and standardized the Trendelenburg test. In their first attempt of research they tried to associate performance on Trendelenburg's Test with hip abductor strength in healthy people and thereafter compared with non-specific low back pain patients. They found difference in strength of hip

abductor muscles between groups but unable to correlate the strength of hip abductor muscles and pelivic drop with static trendelenburg's test. [37] In next attempt of test in 2013, they tried to find cut-off in strength with Trendelenburg test. On several attempt they concluded that hip abductor muscles weakness and be noticed if the strength is 17% of body weight and positive Trendelenburg test can be marked if the strength is less then 10% of body weight. [36] Based on above remark Trendelenburg test can be accepted as one of the sign of hip weakness but need more appropriate functional assessment scale.

Nelson-wong and colleagues (2009) tried to establish the Active Hip Abduction test (AHAbd), to predict developing low back pain. In this test the client has to be in side lying position on couch with trunk, pelvis, and lower extremities aligned in the frontal plane. The client is instructed to abduct the upper side of hip joint. i.e the client is instructed to keep knee straight and lift the top thigh and top leg towards cilling and should be aligned straight with respect to your body line and try not to let your pelvis tip forwards or backwards. [49]

The results were analysed on both ways viz- examiner view and participants view. Examiner evaluate on four point scale:

Zero (0)- (no deviation from the frontal plane) if the participant is able to maintain their pelvis and lower extremity in the frontal plane;

One(1) (minimal deviation from the frontal plane) if they demonstrate some departure, but are able to regain control to keep their pelvis in the frontal plane;

Two(2) (moderate deviation from the frontal plane) if they rotate their shoulders, trunk, or pelvis from the frontal plane or if they flex, extend, or rotate at the hip with abduction; Three(3) (severe deviation from the frontal plane) if they demonstrate the same deviations as 2, but at a greater severity.[49]

Similarly participants were asked to express difficulty level in five point scale, ranging1 as no difficulty and 5 as unable to do the test. The analysis will be done based on dichotomous scale, where grade- 0 and 1 will be consider as negative (no difficulty) based on receiver operating characteristic (ROC) analysis and grade 2 and above will be consider as positive (difficulty to perform test).[49] Later on in 2010, the authors report a sensitivity of 0.41 and specificity of 0.85 for predicting who will develop LBP during prolonged standing. [50] Though such test has not been examined in clinical population.

Frese E, et al.(1987) studied on Clinical reliability of manual muscle testing on middle trapezius and gluteus medius muscles and they concluded that Manual Muscle Testing & Dynamometry Assessments can be consider as one of the best ways for assessing the strength of hip abductor. MMT is commonly used in clinic for assessment of muscle strength where therapist use anti gravity force and own manual strength. Similarly for more quantitative and specific measurement, different types of dynamometer were used ranged from simple hand held dynamometer to laboratory- based dynamometer. Though there is significant variability in hip abductor strength assessment which includes patient positioning, means of resistance application, and type of testing. The Reliability for this testing for gluteus medius is relatively low,with Kappa's of 0.30 to 0.42 . [25]

Hislop HJ (2002) had mention in his book that the main reason is that in MMT there is absence of criteria for assessment beyond anti-gravity strength.[25,33] but has been overcome by using dynamometer in different position for testing. Kramer JFet al.(1991) stated that the reliability of hip abduction test with supine position was ICC: 0.84- 0.97 [38] similarly Jaramillo J (1994) stated that sideling position was ICCs :0.91 to 0.98 [34] and Bohannon RW (1997) mentioned that gravity eliminating position was ICC: 0.949-0.950 [7]. After analyzing several studies it is found that hip abduction is reliable and best performed in a side-lying position, using a break test, with force applied just proximal to the ankle, in order to best assess hip abduction function.

ISSN No:-2456-2165

D. Exercise Intervention in LBP

Kendall and colleagues (2010) conducted a pilot test on hip abductor strengthening program in ten non-specific low back pain client. They divided into two group, in Group-1: clients are standing and and abducted their lower limb using resistant band in frontal plane. Group-2: clients standing and abduct and extend their limb in a plane 45° from frontal plane. The amount of resistance by resistance-band for both group are self decided. The clients were instructed for 10 to 15 repetition for 3 sets, daily for duaration of 3 weeks. The result for both group was better and significant improvement. The overall strength of muscles improvement of 6.6 N/kg to 7.4 N/kg (p=0.02) and pain was subsided 5.9 to 1.8 on basis of 10 point scale VAS. The number of subject were too small to decide stasticial significance. [37] Such studies indicates that dysfunction of gluteus medius had a role on low back pain and even vice versa, but still to decide the acuteness and chronicity of low back pain.

E. Psychological Factors in Chronic Pain

Vlaeyen and Linton stated that chronic pain condition leads to fear of pain and further leads to avoidance of activity. As a consequence of fear and avoidance leads to disuse, disability, and depression which all negatively feed back into the pain experience, and the vicious cycle continues. This is also called fear-avoidance model. [78] Such factors should be kept in mind by physical therapist while assessing low back pain as per concluded by Chapman JR(2011) et al. and Deyo RA (2014) et al. from their respective study. [,9,17]

Sullivan MJL and colleague (1995) mentioned that these psychological factors can be easily assessed easily by psychoanalytic questionnaires such as Catastrophizing Scale (PCS) [70] , Waddell G (1993) highlighted The Fear-Avoidance Beliefs Questionnaire (FABQ) [80], Vlaeyen JW (1995) and Chapman JR (2011) mentioned about Tampa Scale and The Beck Depression Inventory [9,78] Zigmond AS and colleague (1983) described on Hospital Anxiety and Depression Scale (HADS) [85] and the Center for Epidemiological Studies Depression Scale (CES-D).[62] and many more such scale can be used.

F. Monitoring Outcomes in Chronic Low Back Pain

Low back pain is a subjective symptoms which need a definite scale for assessment, and can be used for, to quantify the severity of the pain or symptom, to analyse the progression of symptoms, to compare the treatment protocol for specific chronic low back pain and for other records. Further Deyo RA (2014) suggested that such data help us to study the demographic information as well as self-report of pain, function, psychosocial factors. [17]

Several studies such as Further Deyo RA (2014) and Roland M and colleagues(1983) establish monitoring outcome scale such as Patient Reported Outcomes Measurement Information System (PROMIS), Oswestry or Roland-Morris Disability Questionnaires respectively. [17,63]

Novy and colleagues (2002) and Simmonds MJ et al. (1998) advocated on functional assessments as a combination of two factors viz. speed & coordination and endurance & strength. They further described speed and coordination test such as cluster of testes such as fifty-foot walk, repeated trunk flexion, repeated sit-to-stand, and rollover tests. Where as endurance test such as 5-minute walk, loaded reach, and Sorensen test.[54,69]

G. *Summary*

After analyzing several studies, it is understood that there is connection between gluteus medius dysfunction and chronic nonspecific low back pain but its unclear or didn't found evidence as a gluteus medius dysfunction is the cause of low back pain or vice versa.

Though there are several way to assess the gluteus medius function, but it is more directed towards strength assessment. Even the chronic low back pain have several reasons incliding gluteus medius dysfunction but on same point of view we should not forgot about psychological point of view.

ISSN No:-2456-2165

Several studies have suggested various types of exercise protocol for chronic low back pain and many research laboratory tried to justify their therapeutic protocol by using sophisticated instruments such as EMG, US, f MRI and so on. Even several subjective monitoring scales were develop for analyzing the outcome of treatment.

ISSN No:-2456-2165

CHAPTER 4

METHODOLOGY

A. Study design:

Using a randomized clinical trial design, I compared a standard exercise program with a gluteus medius strengthening program for the treatment of non-specific chronic low back pain.

B. Measuring variables

a) Instruments used -

- Strength assessment- Though the hand held dynamometry was the better option but I assessed strength with Manual muscle testing due to lack of sponsorship
- Functional strength assessment by - the Active Hip Abduction Test and Single Limb Squat Test.

b) Questionnairs

- The primary outcome was self-reported pain.- Visual Analog Scale (VAS)
- Secondary outcomes included,
  - Low back pain-related disability,
  - Quality of life, function, and
  - Fear-avoidance.

a. Inclusion Criteria

- Gender- Male and female
- Age- at least 18 years old.
- Non-specific low back pain. (pain anywhere from the inferior costal margin to the inferior gluteal fold, with or without radiating pain to the lower extremity.)[19]
- Chronic Pain (present for three or more months) [17,19]
- Pain complain unilateral with or without radiating .
- Negative straight leg raise test bilaterally-on examination,
- Muscle Strength-below 4/5 on MMT of gluteus medius muscle strength
- May or may-not have tenderness over the lumbar paraspinal muscles, gluteal muscles, and/or greater trochanter region.

b. Exclusion Criteria

- Any signs or symptoms of serious spinal pathology, including radiculopathy, cauda equine syndrome, inter-vertebral disc associated injury or pathology, cancer, or fracture.
- Any specifically identified pathology as a source of their back pain,
- Super senior citizen
- Not volunteer to participate in our study.
- A prior history of
  - Thoracolumbar or pelvis fracture,
  - Thoracic or lumbar spine surgery or abdominal surgery,
  - Neurological injuries,
  - Diseases affecting the lower extremities,
  - Lower extremity musculoskeletal injuries or diseases,
  - Any lower extremity orthopedic surgeries

ISSN No:-2456-2165

C. Participants

One hundred and thirty five clients came with Lower Back Pain complaining more than three months. The study was done at the Naturopathy, Yoga, Physical Therapy and lifestyle interventional center of Indira Gandhi technical and Medical Sciences University, Ziro.

After thorough screening examination of all one hundred thirty five clients by team of specialized team, only eighty-three clients comes under our inclusion criteria. Out of fifty two excluded criteria there are nine are spondylolysthesis, three are spondylities, two are osteoporosis, ninteenteen prolapsed inter-vertibral disc and disc herniation, four are diabetics neuropathy, eleven are acute para-spinal muscle strain and four are super senior citizen.

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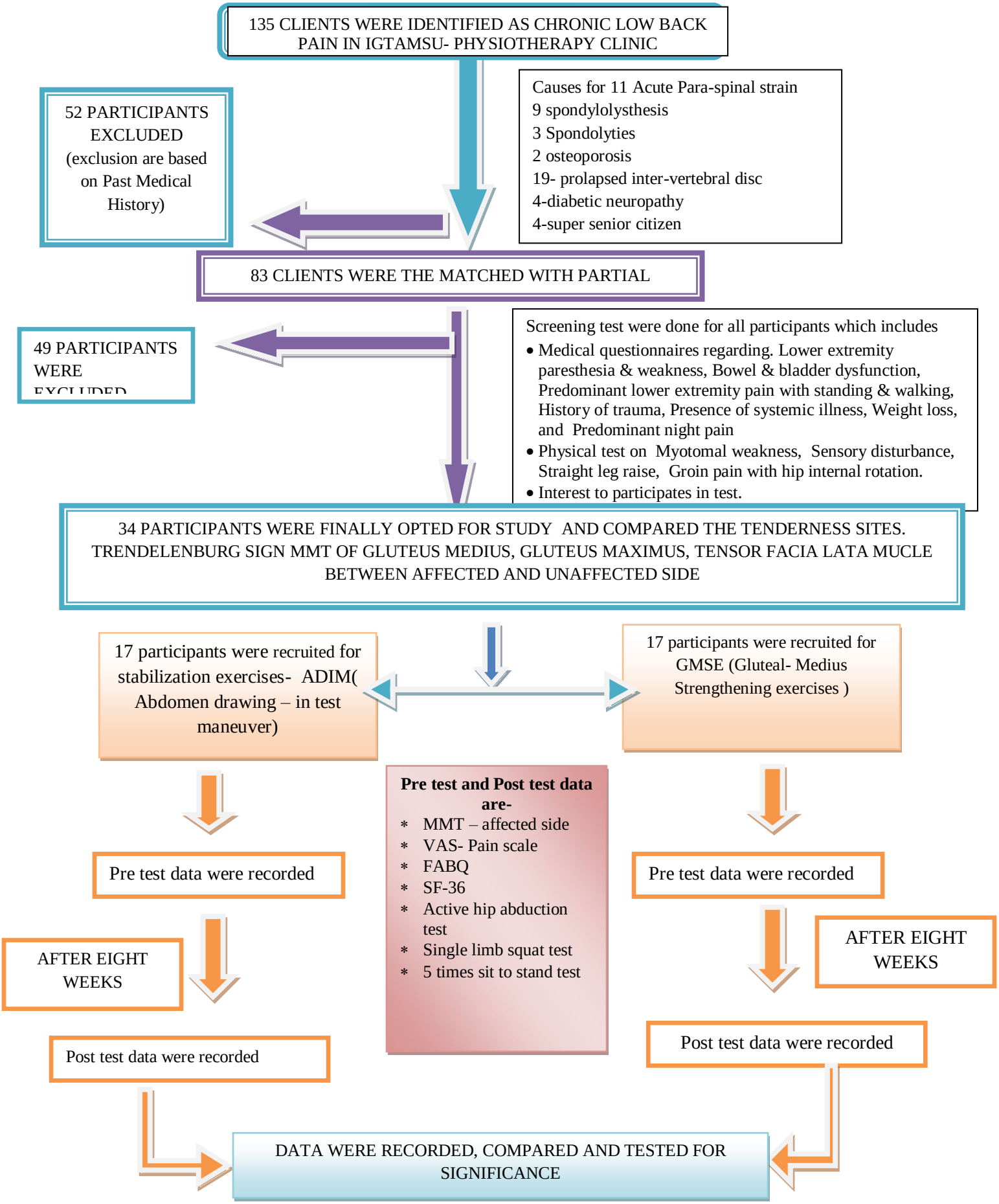

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D. SCREENING EXAMINATION

All participants were screened properly by several expertise and diagnosed with a standardized history and physical examination. All participants were instructed to come in appointed time and should wear loose and hygienic cloths. They are further requested to cooperate with us and feel free if any discomfort felt, so as proper measures can be adopted.

This included **questions screening** done by Dept. of Naturopathy and Physiotherapy for
- ✓ Lower extremity paresthesia & weakness,
- ✓ Bowel & bladder dysfunction,
- ✓ Predominant lower extremity pain with standing & walking,
- ✓ History of trauma,
- ✓ Presence of systemic illness,
- ✓ Weight loss, and
- ✓ Predominant night pain.

The **physical examination** screening done by Physical therapist which included assessment for reflex asymmetry,
- ✓ Myotomal weakness,
- ✓ Sensory disturbance,
- ✓ Straight leg raise,
- ✓ Groin pain with hip internal rotation.

All participants were examined by same gender therapist to maintain privacy. The participants were excluded where ever co-morbid and pathogenesis are correlated with medical history, sign and symptoms and investigatory reports.

E. Muscle Strength

Gluteus medius & maximus and Tensor Facia Lata musces strength were assessed by manual muscle tests (MMTs) and break tests as illustrate by Hislop & Montgomery.[79]

F. Assessment Technique

a) Gluteus medius strength
The clients were instructed to sleep on side-lying. They were asked to abduct and slightly extend the hip while keeping the pelvis rotated slightly forward. Resistance was applied at the ankle.

b) Tensor Facia Lata strength
The clients were instructed to sleep on side-lying on the examination table. They were instructed to flexed the hip of upper side and then abducted the flexed position hip joint. The resistance was applied at the ankle.

c) Gluteus maximus strength
The clients were were instructed to sleep in prone with the knee flexed. They were instructed to extend the hip with the knee remaining flexed. The resistance was applied at the posterior thigh just above the knee.

G. Scoring Technique

MMTs were scored using the criteria defined by Hislop & Montgomery.[33]
5/5 = full Range of motion against gravity with maximal external resistance
4/5= full Range of motion against gravity with minimal external resistance
3/5= full Range of motion against gravity
2/5= full Range of motion on elimination of gravity
1/5= flicker of contraction on partial Range of motion on elimination of gravity

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H. Trendelenburg Sign

To assess the functional measure of gluteus medius strength, trendelenburg sign test was adopted and was followed as per Hardcastle & Nade instruction. [27]

I. Technique

The client was instructed stand straight on floor without any footwears. The examiner stood behind the client and had a visually observe and palpate iliac creast. Further the client was asked to lift one foot off the ground by flexing hip and knee.

J. Measurement-

- Positive sign- The sign was considered positive if the participant was not able to maintain the pelvis in neutral or drop with the non-stance side or shift the trunk to keep the pelvis level.
- Negative Sign- The sign was considered negative if the participant was able to maintain the pelvis in neutral or elevated with the non-stance side.

K. Tenderness

Tenderness was defined as reproduction of the participant's pain complaint when using enough pressure to blanch the examiner's nail.

After taking verbal permission the following areas are palpated for tenderness bilaterally.

- ✓ Gluteals- medius and maximus,
- ✓ Greater trochanters,
- ✓ Lumbar paraspinals, and
- ✓ Piriformis

Anatomical demarcation for tenderness palpation

- ➢ Gluteus medius was palpated from its distal insertion at the greater trochanter over the muscle belly toward the posterior superior iliac spine (PSIS) and then over its proximal attachment along the ilium just inferior to the iliac crest.
- ➢ Gluteus maximus was palpated at its origin along the posterior ilium and lateral sacrum, then over the muscle belly to its distal insertion at the iliotibial band inferior to the greater trochanter.
- ➢ The greater trochanters were palpated most laterally initially and then posteriorly and superiorly to the apex of the trochanter. The lumbar paraspinals were palpated from just medial to the PSIS superiorly to the thorax.
- ➢ The piriformis can be palpated from its lateral insertion at the greater trochanter, over the muscle belly, toward its origin on the sacrum.

Thus after thorough screening test we had only eighty three clients who matches over all inclusion criteria and volunteer to participate our study. The research proposal were forwarded to Research Board of indira Gandhi technological and medical sciences University, ziro and then informed the participants about the study and requested to fill the informed consent, if they are volunteer to participate. Out of eight three clients only thirty four were ready to participate in study. The main causes of withdraw are lack of confidence to new exercise protocol, lack of time, unable to attend on appointed time schedule, unable to understand the exercise protocol, unable to attend eight week protocol. Thus for this research the sampling technique is convenience sampling technique which is a type of non-probablity sampling method.

ISSN No:-2456-2165

L. Exercise protocols

Thirty four volunteer clients were divided into two different group, purposefully tried to balance gender in both group. Now Group-1 has seventeen volunteers with seven females and Group-2 has seventeen volunteers with eight females. All participants demographic data such as age, sex, height, and weight were collected form case history. all the participants were again instructed that the training protocol is of eight weeks and they are free to leave in mid-session if they are not comfortable with new exercise program. Further they are instructed not to use any kind of stimulants, use loose dress, hydrate them self properly and non solid food thirty minutes prior to exercises.

Two standardized exercise protocols were selected, and administered in two different group.

Group-1: The stabilization exercise

This exercise protocol was designed by Hicks and colleagues and Rabin and colleagues.[32,60] they used abdomen drawing in maneuver (ADIM) to improve the stabilization of core muscles. The exercises have been begins from four different starting postion, viz- Quadruped Progression, Supine Progression, Sidelying Progression and Standing Progression. The details of the exercises protocol have been discussed in Table format(TableNo-1) The reason behind for selection this protocol as this have been widely used by physical therapist globally for caring chronic nonspecific low back pain.[16]

Exercise protocol for group-1 :	Stabilization Exercise Protocol
Exercise	**Progression Criterion**
Quadruped Progression	
ADIM in quadruped	30 reps with 8 sec hold
ADIM in quadruped, UE lifts	30 reps with 8 sec hold, both sides
ADIM in quadruped LE lifts	30 reps with 8 sec hold
ADIM in quadruped UE & LE lifts	30 reps with 8 sec hold
ADIM in quadruped, dynamic UE & LE lifts	
Supine Progression	
ADIM in supine	30 reps with 8 sec hold
ADIM in supine heel slides	20 reps with 4 sec hold, both sides
ADIM in supine LE lift	20 reps with 4 sec hold, both sides
ADIM in supine bridge	30 reps with 8 sec hold
ADIM in supine SLS bridge	30 reps with 8 sec hold, both sides
ADIM in supine curl up, elbows at sides	30 reps with 8 sec hold
ADIM in supine curl up, elbows elevated	30 reps with 8 sec hold
ADIM in supine, curl up, hands at head	
Sidelying Progression	
ADIM in sidelying	30 reps with 8 sec hold
ADIM in sidelying, side plank, knees bent	30 reps with 8 sec hold, both sides
ADIM in sidelying , side plank, knee extended	30 reps with 8 sec hold, both sides
ADIM in sidelying, side plank with tilt	30 reps with 4 tilts A/P, both sides
ADIM in sidelying, side plank with roll	
Standing Progression	
ADIM in standing	30 reps with 8 sec hold
ADIM in standing row	30 reps with 8 sec hold
ADIM in standing, walking	

Table 1: Exercise Protocol for Stabilization Exercises for Torso Muscles

ISSN No:-2456-2165

Group-2: Gluteus medius strengthening exercise
These group performed exercises targeting the gluteus medius muscle. these set of exercises are based on literatures mentioned in previous reported articles. 63,98-100.
The progress have been describe below in table format (Table no- 2)

Exercise protocol for group-2 :	Gluteus Medius Strengthening Protocol
Supine Progression	
Bridge	30 reps with 8 sec hold
Bridge with Arms Crossed	30 reps with 8 sec hold
Bridge with Arms Crossed & Feet Together	30 reps with 8 sec hold
SLS Bridge	
Sidelying Progression	
Clam at 45 degrees	30 reps with 8 sec hold
Sidelying hip abduction, knees extended	30 reps with 8 sec hold
Side plank, knees bent	30 reps with 8 sec hold
Side plank, knees extended	30 reps with 8 sec hold
Squat Progression	
Squat	30 reps
SLS mini squat	30 reps
SLS squat	
Standing Progression 1	
Standing abduction	30 reps
Standing abduction, yellow band	30 reps
Standing abduction, red band	30 reps
Standing abduction, green band	30 reps
Standing abduction, blue band	30 reps
Standing abduction, black band	
Standing Progression 2	
Standing abduction with extension	30 reps
Standing abduction with extension, yellow band	30 reps
Standing abduction with extension, red band	30 reps
Standing abduction with extension, green band	30 reps
Standing abduction with extension, blue band	30 reps
Standing abduction with extension, black band	

Table 2: (Exercise Protocol for Gluteus Medius Strengthening exercises)

M. Exercise duration and progression for both groups.

The progression speed for exercise is individual based. Prior to exercises a general warm up such as stretching and free hand exercises were introduced. The exercise protocols are criterion based progression thus the clients are advised to progress as per their confidence and adaptation to exercises loads. The duration of exercise is for eight weeks and each and every client have been supervised by physical therapist as per their schedule time. The clients are advised to have five clinical sitting in a week. And load of exercises depend on clients until they feel tired. Followed by exercises a general massage or sauna bath was advised as a part of cool down phase of exercises.

ISSN No:-2456-2165

N. Instruments for measuring out come.

- Initailly a demographic data were collected form clients case history.
- Cinical observation
  - Tenderness- site of tenderness , comparasion of tenderness on contralateral side.
  - Tenderburg test.
- To assess the strength- Manual muscle testing have been used
- Oswestry low back disability scale
- Pain intensity by Visual analog scale
- Evaluate the quality of life by FABQ and SF-36
- Functional strength assessment by – active hip abduction test , single limb squat test, five times sit to stand test .

ISSN No:-2456-2165

CHAPTER 5

RESULT

A. Demographic data

	Screened (N=135)			Selected for inclusion criteria (n=83)			Actual participants		
	Total	M	F	Total	M	F	Total	M	F
N	135	63	72	83	32	51	34	19	15
Age	38.13±14.25	42.23±6.07	33.03±.023	39.03±9.23	41.03±2.23	36.23	38.47±8.81	34.72±6.65	39.8±10.94
Hight (cm)	165±6.23	168±2.1	160±5.2	165±9.89	167±5.3	160±4.2	158.79±9.8	161.79±10.89	155±6.93
Weight	68.2±2.2	71.2±13.03	64.2±7.1	67.3±12.23	69.2±5.5	62.2±6.2	58.2±9.36	62.95±8.49	52.2±6.7
BMI	25.3±2.3	25.7±1.3	25.6±3.2	24.8±1.1	25.1±2.1	24.2±2.3	23.02±2.15	24.02±2.1	21.7±1.47

Table 3: Clients characteristics, on age height and weight

The following data (Table-3) shows the mean value± standard deviation of client's age height, weight and BMI of who were screened initially, selected for inclusion criteria and actual volunteers.

To analyze our first hypothesis we compared the affected and unaffected sided mean values of gluteus medius, gluteus maximus, tensor facia lata muscles strength, compaired the number of trendelenburg sign positive and presence of pain & tenderness of gluteal region, greater trochanter and lumbar spine at affected sided.

B. Muscle Strength Analysis.

Muscle strength Analysis	Gluteus Medius		Gluteus Maximus		Tensor Facial lata	
	Affected side	Unaffected side	Affected side	Unaffected side	Affected side	Unaffected side
Male	3.42±0.5	4.68±0.48	3.79±0.71	4.7±0.41	4.47±0.26	4.68±0.22
Female	4±0.85	4.6±0.5	4.33±0.9	4.53±0.51	4.53±0.51	4.8±0.41
Overall	3.68±0.72	4.64±0.48	4.06±0.82	4.68±0.47	4.5±0.51	4.73±0.44

Table 4: Comparation of Muscle strength among groups

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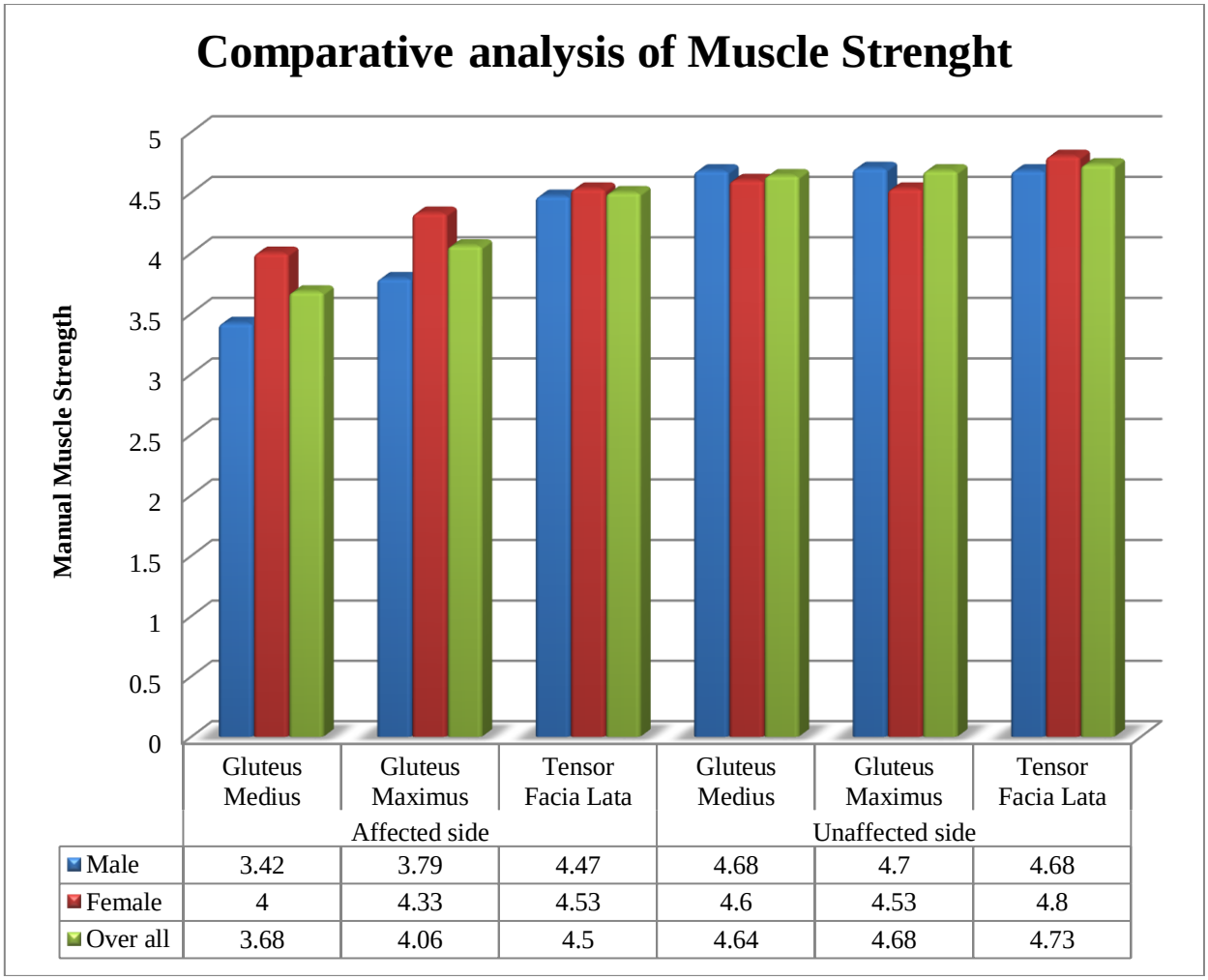


	Gluteus Medius	Gluteus Maximus	Tensor Facia Lata	Gluteus Medius	Gluteus Maximus	Tensor Facia Lata
	Affected side			Unaffected side		
Male	3.42	3.79	4.47	4.68	4.7	4.68
Female	4	4.33	4.53	4.6	4.53	4.8
Over all	3.68	4.06	4.5	4.64	4.68	4.73

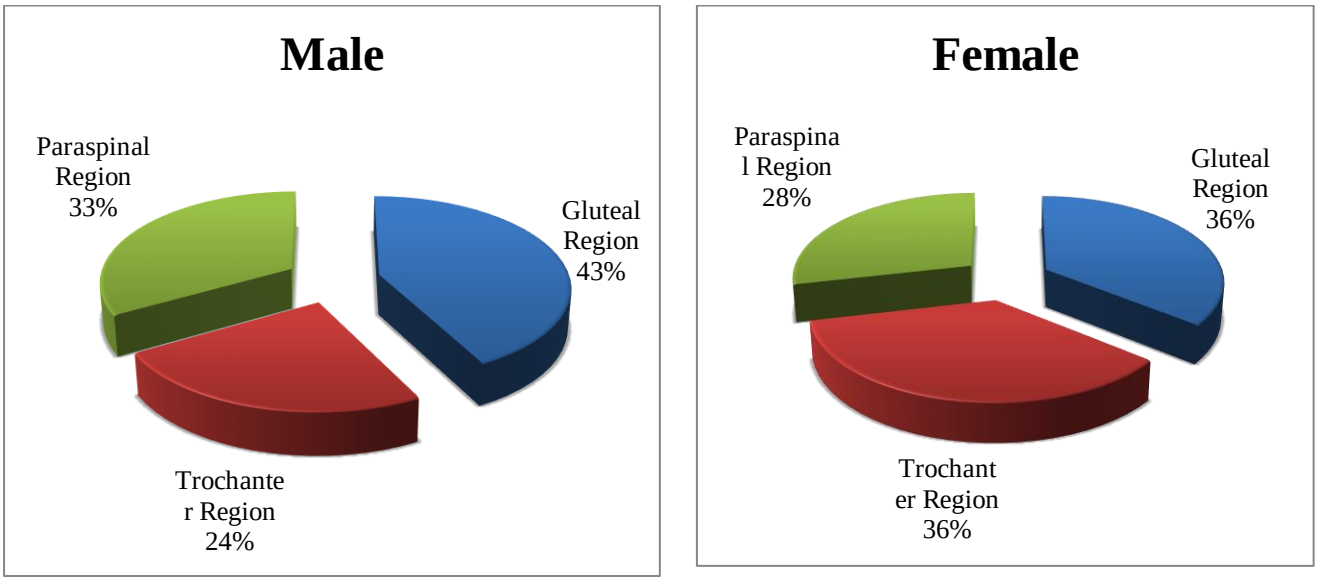
Graph 1: Comparative analysis of Muscle Strength of Affected and Un affected side

On analyzing the strength of muscles of affected and unaffected side, few interesting things has been highlighted. Such as overall analysis says that Gluteal Medius muscle strength has been affected compaired to gluteus Gluteus Maximus and tensor facia lata as mentioned in Table-4 and Graph-1. Further we found the strength Gluteus medius of male (3.42±0.5) were more severely affected, as compare to females(4±0.85). Similarly strength of Gluteus Maximus is least affected in females (4.33±0.9)as compare to males(3.79±0.71). but in case of tensor fascia late its lease difference between affected and unaffected side.

C. Tenderness

Table-5	Site of Tenderness		
	Gluteal Region	Trochanter region	Paraspinal Region
Male	14	8	11
Female	10	10	8
Total	24	18	19

Table 5: Site of Tenderness



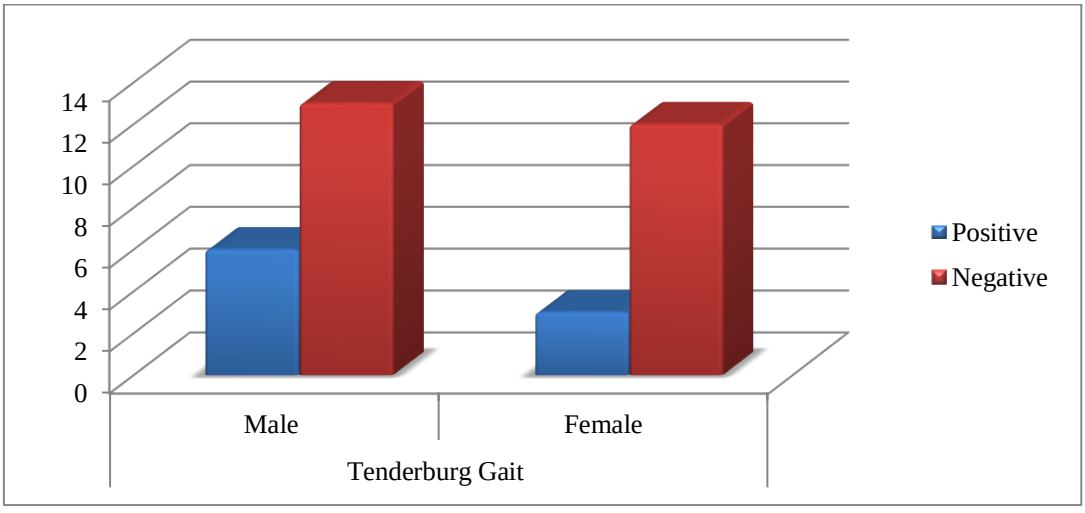
Graph 2: Comparative analysis among gender On tenderness area

On analyzing from Table-5 and Graph-2, overall our sample population complain mainly gluteal tenderness(66.67%) along with chronic mechanical low back pain, as compare to Trochantric region(we found the comparation between male and female. It's a interesting fact that majority of male complain tenderness point on Gluteal region (43%) as compare to Paraspinal region (33%) and trochanter region(24%). Where as females complains equal distribution on tenderness viz gluteal region (36%), Trochanceric region(36%) and paraspinal region(28%)

D. Tenderburg Gait

Table-6	No. of positive Tenderburg Gait Sign	
	Male	Female
Positive	6	3
Negative	13	12

Table 6: No. of positive Tenderburg Gait Sign



Graph 3: Comparison of Tenderburg Gate Sign on Gender basis

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Based on Graph-3 and Table -6, based on our sample, found that Positive sign of tenderburg gate among males (46.15%) was more as compare to female (25%)

To analyze second hypothesis we divided the available sample into two group, balancing equal number of gender. This was purposeful for trying to neutralizing the impact of gender on exercise protocol.

The Group -1: Having seventeen participants(10 male & 7 female) and they were given Stabilization exercise protocol.

The Group-2: Having seventeen participants (8 female & 9 male) and they were given Gluteus Medius Strengthening Protocol.

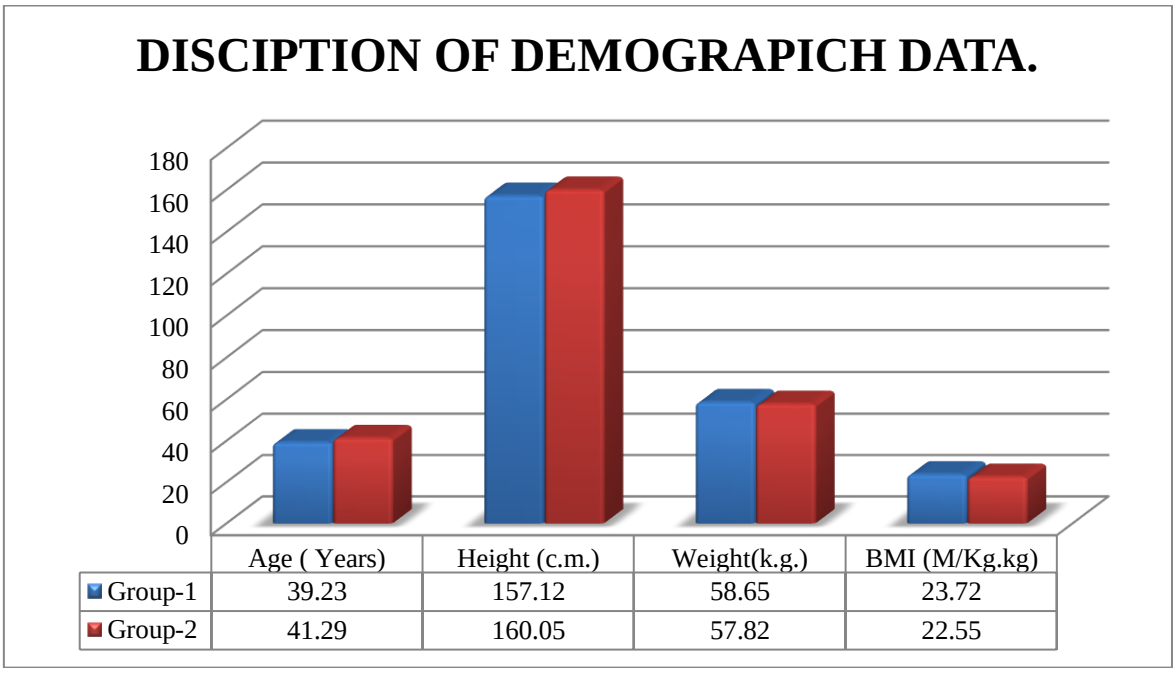
We have tried to analyze five different parameters.

- They are muscles strength (Gluteus Medius, Gluteus Maximus, Tensor Facia lata) by Manual Muscle testing.
- Pain intensity by Visual Analog Scale. (10 point scale – 1 is least and 10 is maximal experienced),
- Quantify the disability due to Low back pain was analysed, Oswestry Low Back Disability quesnionnairs were used.
- Psychological aspect, scales such as SF-36 and FABQ questionnaires were used. to analysis the
- functional strength assessment – Active hip abduction test, single limb squat test and five times sit to stand test were used.

E. THE DEMOGRAPHIC DISTRIBUTION AMONG GROUPS

Table-7	Group-1	Group-2
Sample size	17	17
Age	39.23±6.29	41.29±9.65
Height	157.12±7.96	160.05±10.48
Weight	58.65±7.66	57.82±10.95
BMI	23.72±2.4	22.55±3.81

Table 7: The demographic distribution among groups



Graph 4: DISCIPTION OF DEMOGRAPICH DATA

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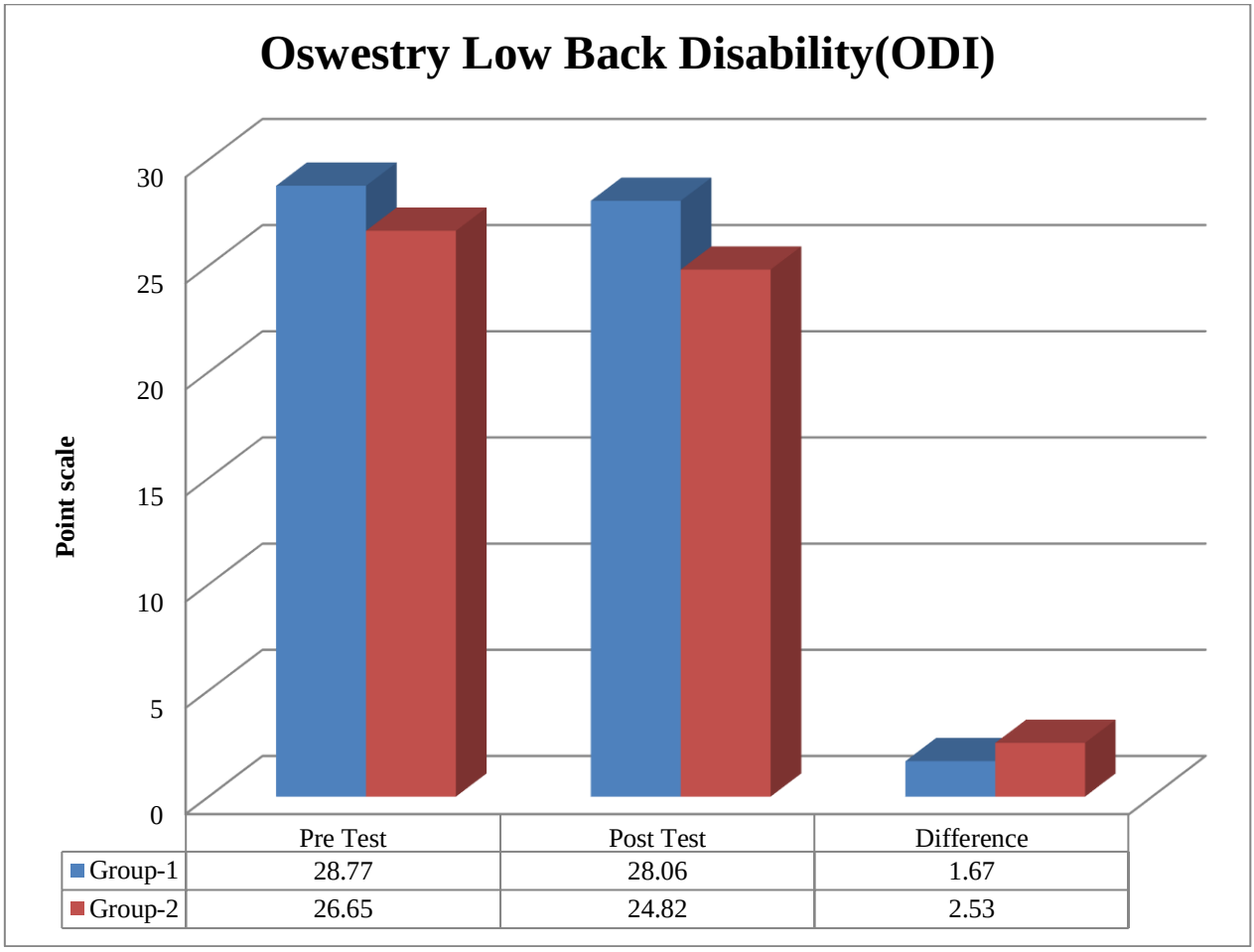
The table No-7 and Graph No-4, compared the demographic data distribution. On comparing Group-1 to Group-2 the age(39.23±6.29, 41.29±9.65) in years, Height(157±7.96, 160.05±10.48) in centimeter, weight(58.65±7.66) in kilogram and BMI (23.72±2.4, 22.55±3.81) in M/Kg^2 respectively, almost matched.

F. OSWESTRY LOW BACK DISABILITY INDEX (OLBDI)

Oswestry Low Back Disability(ODI							
Pre		Post		Chage		Significance	Stastical
Group-1	Group-2	Group-1	Group-2	Group-1	Group-2	P ≥0.05	Students T-test
28.77±12.94	26.65±4.04	28.06±9.05	24.82±4.14	1.67±2.26	2.53±2.07	0.1251	Not-significant

Table 8: Comparison of oswestry low back pain disability index between groups



Graph 5: Comparison of oswestry low back pain disability index between groups

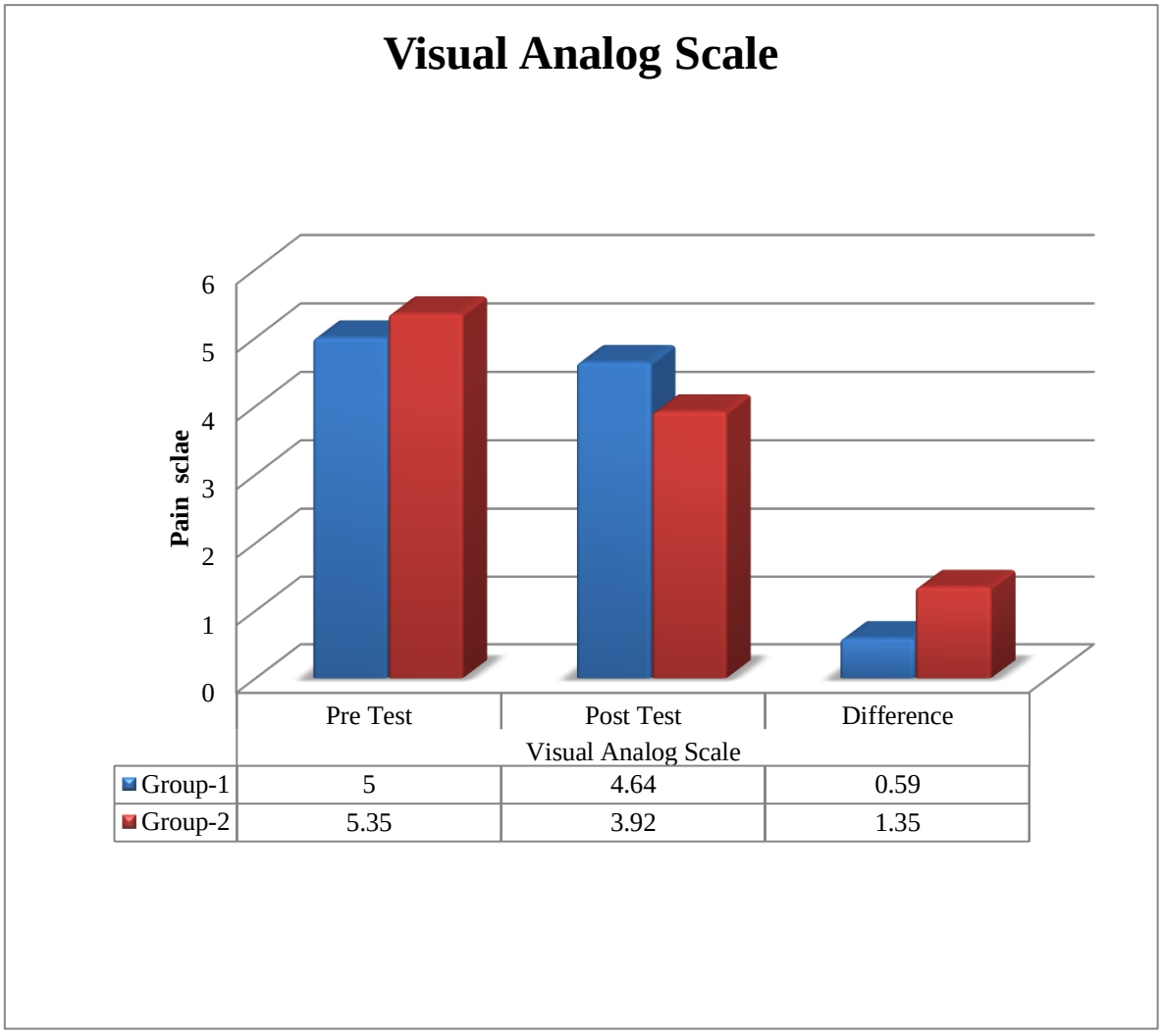
On analyzing the back pain disability,(Table-8, Graph-5) Oswestry low back disability scale were used. In Group-1, pretest was 28.77±12.94 and post test was 28.06±9.05, thus there was a marginal change of 1.67±0.26, were as Group-2 was, as pre test 26.65±4.04 and 24.82±4.14, and change was 2.53±2.07 which was marginally high.

ISSN No:-2456-2165

G. PAIN INTENSITY

Pain scale (VAS)							
Pre		Post		Change		Significance	Stastical method used
Group-1	Group-2	Group-1	Group-2	Group-1	Group-2	p≥0.05	Student T-test
5±0.63	5.35±0.7	4.64±0.24	3.92±0.79	0.59±0.62	1.35±0.93	0.0026	Significant

Table 9: Comparison of Visual analog scale (Pain Intensity) between groups



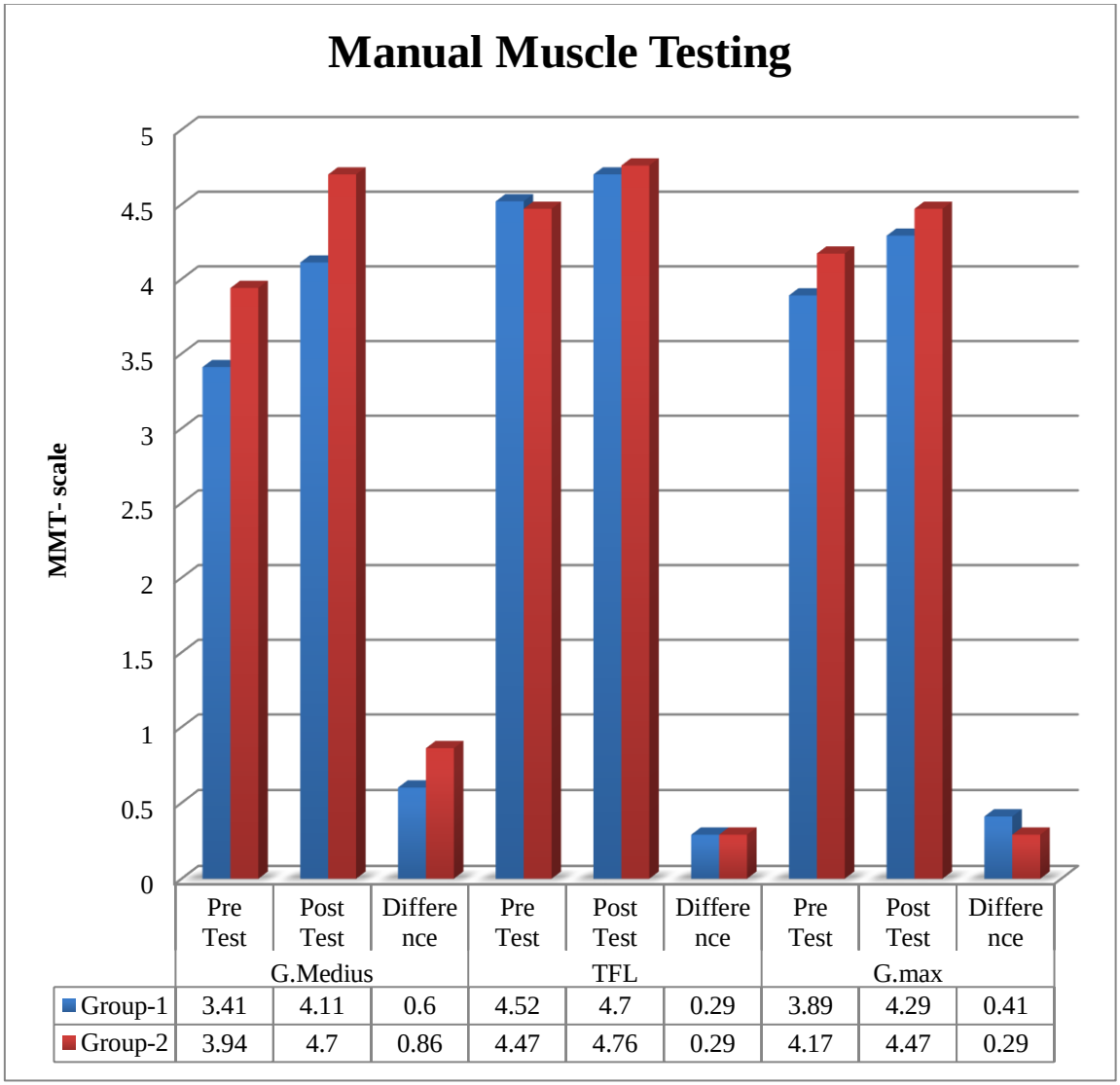
Graph 6: Comparison of Visual analog scale (Pain Intensity) between groups

The Pain component was analysed on Visual analog scale grading. The mean value for Group-1 was 5±0.63 and after eight week of intervention it was subsided to 4.64±0.24 and a marginal change of 0.59±0.62 was noted, on other hand the Group-2 Pain intensity was measeure was 5.35±0.7 which was subsided upto 3.92±0.79 and vast change of 1.35±0.93 recorded.

H. Muscle strength

Table-10 Comparison of Muscle Strength of hip abductors by manual muscle testing(MMT)								
	Pre		Post		Change		Significance	Stastical method
components	Group-1	Group-2	Group-1	Group-2	Group-1	Group-2	p≥0.05	Student T- Test
Gluteus Medius	3.41±0.61	3.94±0.75	4.11±0.6	4.7±0.22	0.6±0.46	0.86±0.66	0.0918	Significant
Tensor Facia Lata	4.52±0.51	4.47±0.51	4.7±0.47	4.76±0.43	0.29±0.46	0.29±0.27	0.5	Significant
Gluteus Maximus	3.89±0.073	4.17±0.81	4.29±0.22	4.47±0.51	0.41±0.5	0.29±0.47	0.2358	Significant

Table 10: Comparison of Muscle Strength of hip abductors by manual muscle testing(MMT)



Graph 7: Comparison of Muscle Strength of hip abductors by manual muscle testing(MMT)

On comparing the strength of muscle of Gluteus medius, Tensor facia Lata and Gluteus Maximus on different group, we found few interesting thing to be noted. Both the exercises have shown their positive impact, the Table-10 and Graph-7 described in details.

I. Tensor Facia Lata

In Group-1, it was 4.52±0.51and after exercise it was noted 4.7±0.47 were as in Group-2, it was 4.47±0.51 after eight week of exercises it went upto 4.76±0.43. Comparing the improvement Group-1, and Group-2 had similar positive change of 0.29±0.46 and 0.29±0.27 respectively.

J. Gluteus Medius

In Group-1, it was 3.41±0.61 and after exercise it was noted 4.11±0.6. were as in Group-2, it was 3.94±0.75 after eight week of exercises it went upto 4.7±0.22. Comparing the improvement Group-1, had marginal positive change of 0.6±0.46 where as Group-2, there was a significant positive change of 0.86±0.66.

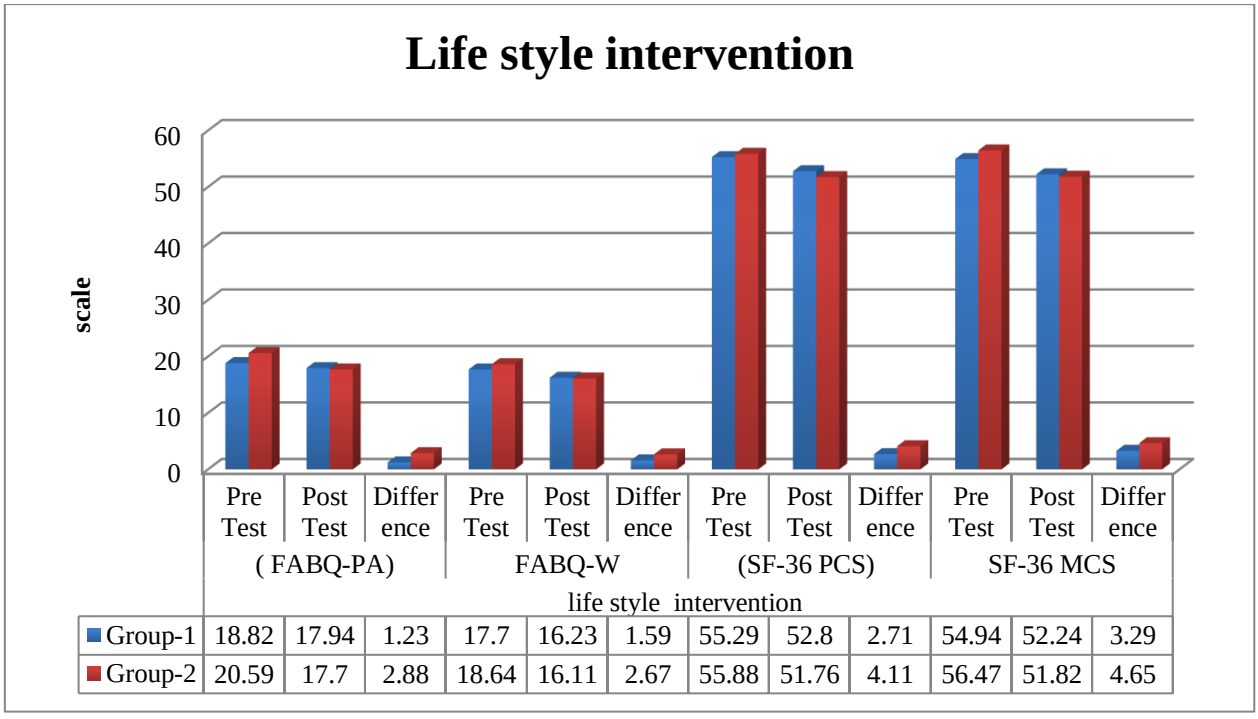
K. Gluteus Maximus

In Group-1, it was 3.89±0.73 and after exercise it was noted 4.29±0.22 were as in Group-2, it was 4.17±0.81 after eight week of exercises it went upto 4.7±0.51. Comparing the improvement Group-1, had marginal positive change of 0.41±0.5 and Group-2, there was a slight positive change of 0.29±0.47

L. QUALITY OF LIFE

	Pre		Post		Chage		Significance	Stastical
components	Group-1	Group-2	Group-1	Group-2	Group-1	Group-2	P≥0.05	Students T-Test
FABQ-PA	18.82±2.67	20.59±1.66	17.94±2.14	17.7±1.82	1.23±1.14	2.88±1.69	0.0001	Significant
FABQ-W	17.7±4.97	18.64±2.08	16.23±2.19	16.11±1.96	1.59±1.18	2.67±1.16	0.0036	Significant
(SF-36 PCS)	55.29±3.99	55.88±4.12	52.8±3.13	51.76±3.32	2.71±2.44	4.11±1.99	0.0336	Significant
SF-36 MCS	54.94±6.24	56.47±5.14	52.24±6.95	51.82±5.31	3.29±2.66	4.65±2.57	0.0793	Significant

Table 11: Comparative analysis of Quality of life among groups



Graph 7: Comparative analysis of Quality of life among groups

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On psychonalysis we have tried to assess few components among both the groups.

SF-36 MCS
On analysing Group-1 its scores 54.94±6.24 as pre test and after intervention it was 52.24±6.95 where as Group-2, pre test was 56.47±5.14 and post test it was 51.82±5.31 only. In both group it's a marginal changes. In both groups, it's a notable change as Group -1 it was only 3.29±2.66 but Group-2 has a notable betterment with 4.65±2.57

SF-36 PCS
On analysing Group-1 its scores 55.29±3.99 as pre test and after intervention it was 52.8±3.13 where as Group-2, pre test was 55.88±4.12 and post test it was 51.76±3.32 only. In both group it's a marginal changes. As Group -1 it was only 2.71±2.44 but Group-2 has a notable betterment with 4.11±1.99

FABQ-PA
On analysing Group-1 its scores 18.82±2.67 as pre test and after intervention it was 17.94±2.14 where as Group-2, pre test was 20.59±1.66 and post test it was 17.7±1.82 only. In both group it's a marginal changes. As Group -1 it was only 1.23±1.14 and even in Group-2 there was a slight betterment with 2.88±1.69 .

FABQ-W
On analysing Group-1 its scores 17.7±4.97 as pre test and after intervention it was 16.23±2.19 where as Group-2, pre test was 18.64±2.08 and post test it was 16.11±1.96only. In both group it's a marginal changes. As Group -1 it was only 1.59±1.18 and Group-2 there was a slight improvement with 2.67±1.16.

M. FUNCTIONAL STRENGTH ASSESSMENTS

		Pre test		Post test	
		Group-1	Group-2	Group-1	Group-2
	Grade	No. of clients	No. of clients	No. of clients	No. of clients
Active Hip Abduction Test	0	1	4	3	6
	1	7	3	7	7
	2	6	8	4	3
	3	3	2	1	1
Single Limb Squat Test	1	1	0	1	1
	2	6	6	11	10
	3	10	11	5	6

Table 12: Comparative analysis of Functional Strength Assessments among groups

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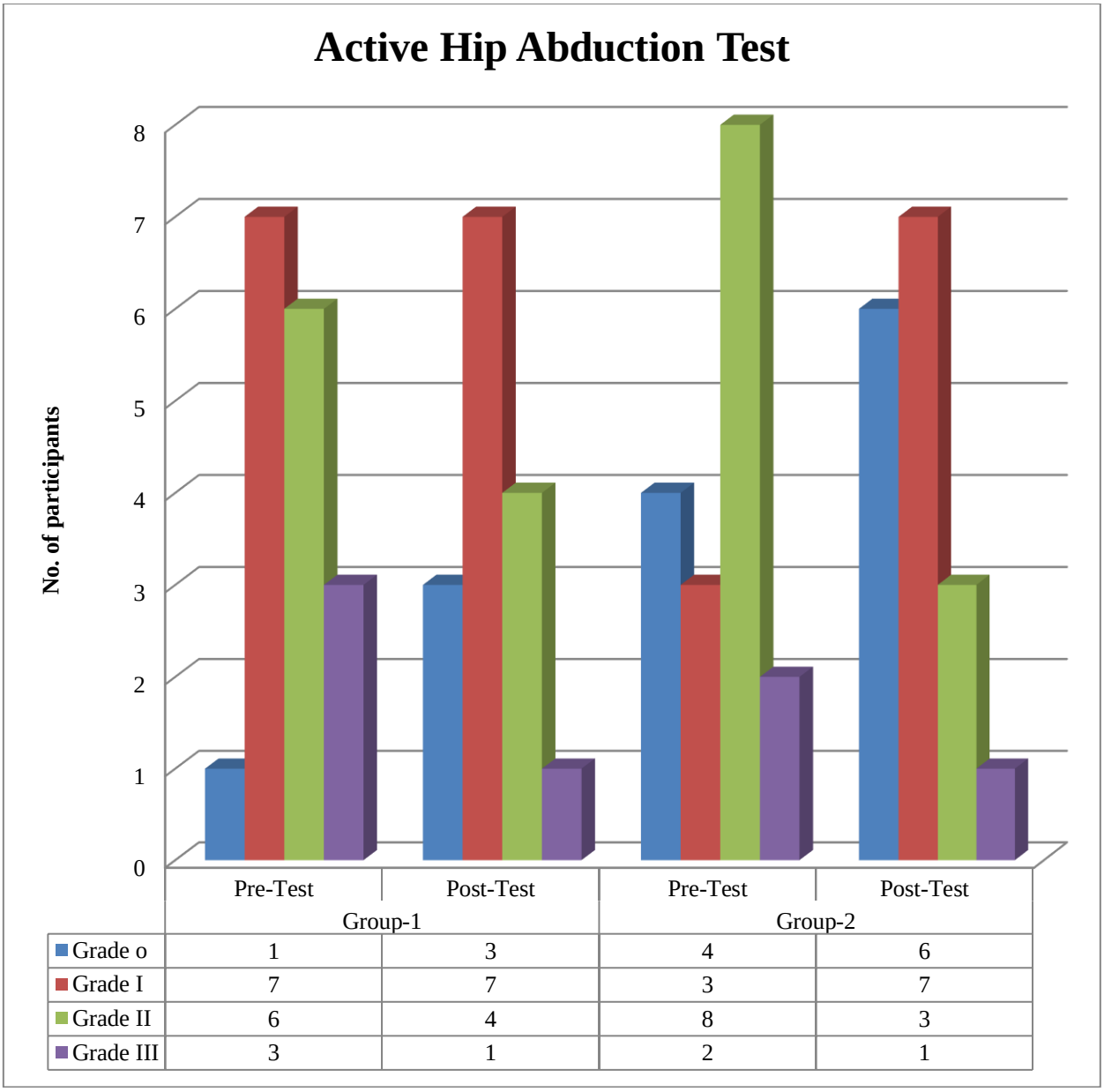

Graph 8: Comparative analysis of Functional Strength Assessments among groups

The graph-9 and table-11 shows a positive outcome of exercises. On compilation of Grade -3 and Grade -2, in Group-1 it was 9 members were there in pre-test, where as in post test it was only 5 members, it means 44.44% participants were able to perform Active hip abduction. were as in Group-2 there were 10 members but after exercise intervention only 4 members were there in this category, it means 66.66% members were improved.

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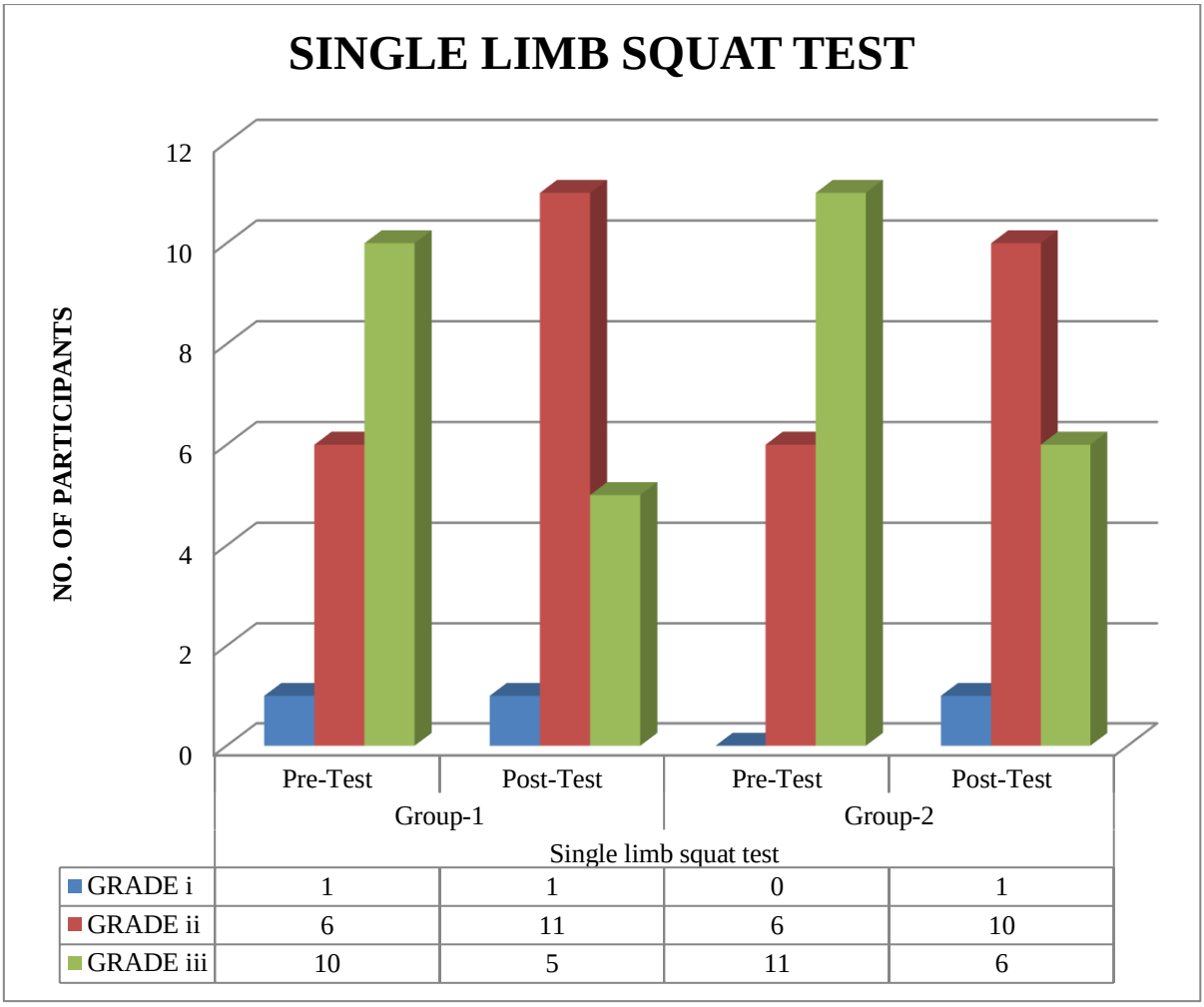

Graph 9: Comparative analysis of single limb test among groups

Analyzing the functional activity by single limb squat test a major change was noted in both group. Majority of the participants were in Grade –III but after eight week of exercise training the maximum participants were in group-II. But on comparing we didn't found such difference.

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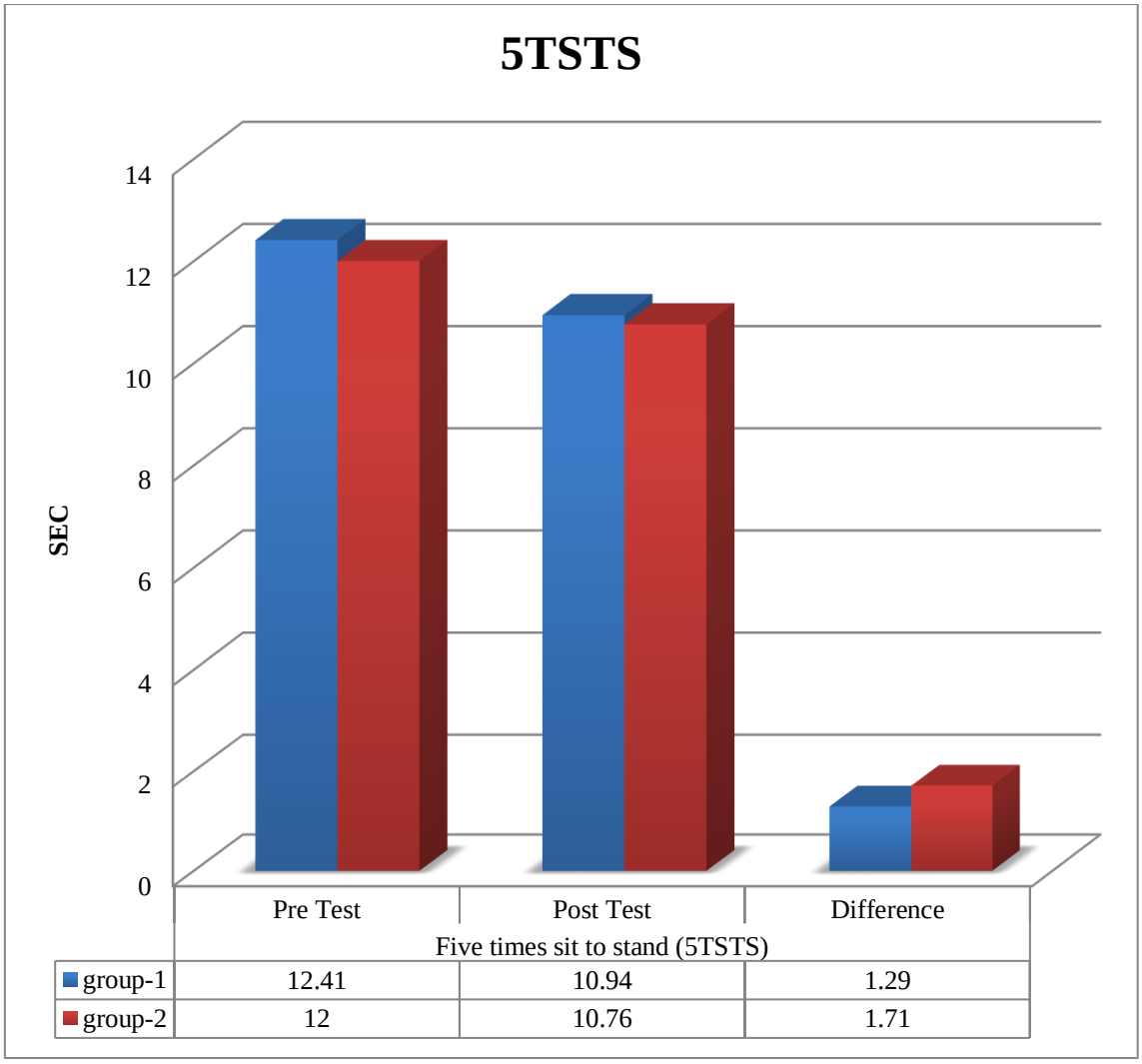

Graph 10: Comparative analysis of **5 TIMES SIT TO STAND TEST**Among groups

5TSTS							
Pre		Post		Change		Significance	Stastical method used
Group-1	Group-2	Group-1	Group-2	Group-1	Group-2	P≥0.05	
12.41±1.08	12±1.96	10.94±1.71	10.76±1.39	1.29±1.31	1.71±1.4	0.1841	Student T-test

Table 13: Comparative analysis of **5 TIMES SIT TO STAND TEST**among groups

Based on table …….., it's was a positive sign majority of participant reported as reduce in time duration for five times sit to stand, though it varies from participants to other participant. In Group-1, the pre test reaction time was 12.41±1.08, but post test it was 10.94±1.71.In Group-2 the pre test for reaction time was 12.0±1.96 sec and post test it was recorded as 10.76±1.39 sec . In both Group there was slight reduction in reaction time. In Group-1, it was 1.29±1.31 which is a marginal but in Group-2 it was 1.71±1.4 sec which we can account in record. The detail comparation have been expressed in Graph……

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N. Analysis

Inter-Rater Reliability of Evaluators

Team of four physiotherapists evaluated one hundred thirty five clients. All therapists assess the patients ~~in~~ independently. To evaluate the inter-rated reliability among the therapist, randomly ten volunteer were examined by all therapist. The therapists were kept blind about their evaluation. The reliability to assess the tenderness points and Trendelenburg sign is perfect (=1), where as MMT is purely subjective thus reliability is odd (= 0.87)

O. Analysis

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CHAPTER 6

DISCUSSION

The current study was done on residential of Ziro Valley of Lower Subansiris district of Arunachal Pradesh. The target sub-population was chronic mechanical / non-specific low back pain patients with having signs of gluteal tenderness, gluteus muscle weakness and trendelenburg sign. Further this study tries to determine the treatment of gluteus medius weakness and tenderness on has any positive effect on low back pain.

Our research accept the study done by Arab A et al.(2010) and Kendall KD et al. (2010) about showing the weakness of hip abductor muscles as associated with low back pain. [2,37,] These studies had shown effect on combination of gluteus medius and Tensor fascia late. But till dated we didn't found any study worked only on gluteus medius and minimizing tensor facia lata. This current study was designed to analyse on gluteus medius with minimizing the TFL's functional influences. From our university Physiotherapy department overall 135 (63 male, 72 female) patients got cured with lower back pain, of different causes. Out of theses, as per study criteria we got only 83 (32 male, 51 female) patients, and only 34 (19 male, 15 female) clients interested to participate our study. While evaluating theses participants we found comparative difference between affected and unaffected side muscles strength. The affected side strength of glutes medius was 3.68±0.72 as compared to 4.64±0.48 of unaffected side. But we didn't found such major changes among glutes maximus and TFL strength. Our results demonstrated no difference in TFL strength between unaffected and the affected side of participants with LBP, but significant weakness in the gluteus medius in participants with LBP. Thus, the current study suggests gluteus medius muscle weakness contributes to the presentation of chronic non-specific LBP. The muscle strength assessment done by dynamometry would be given much better quantitative strength assessment. In general, majority of the participants had gluteus medius weakness and can be taken potential prediction for low back pain. Supporting the current research data, several author such as Simons and travel (1983) suggested as gluteus medius muscle reffered pain as one of the component of low back pain. [68] , whereas Nadler and collegues (2002) concluded as female athletes are more prone to low back pain as due to disproportion of hip abductor strength.[46] On analyzing the tenderness points our study shows that along with the mechanical low back pain, 43% male complain tender point on gluteal region whereas only one third of female complain the same.

After finding such studies it is clear that weakness of gluteus medius has significant role in chronic low back pain but, patho-physiology or any other mechanism is unclear. The existing scenario, most of the Indian physiotherapist, try to manage the low back pain based on Mechanical Diagnosis and Treatment (MDT) system, where as we tried on treatment based classification system, which was tried to implement to our participants with the interventions that leads to best outcome, though such system generally focused on acute cases but not for chronic conditions. [1,16]Fairbank J et al (2011) quoted that, in general for chronic back pain conditions McKenzie and movement impairment classification system shown maximum effectiveness and reliable. [22]. Till dated there was no classification system which can directs the intervention and predict the outcome. Van Middelkoop M et al.(2011) expressed that majority of the exercise prescribed for chronic low back pain are effective. [77] The recent meta analysis conducted by Fritz JM et al.(2007) found that exercise prescription for low back pain consist of strengthening and stabilization exercises protocol. These exercises promotes functional movement and reduces pain. [29]

Till dated we didn't found any proper exercises protocol intervention. Even Hayden JA et al.(2005) expressed that there was lack of literatures in exercise protocol and its intervention.[29]and thus the current study tried to frame well-described targeted exercises program.

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In our study we believed that patient with chronic non-specific LBP with gluteus medius weakness and associated tenderness may be benefited but the amount of benefit will represent specific treatment sub group. A pilot study was conducted by Kendall KD et al.(2010) on 10 people with mechanical low back pain, were treated with hip abductor strengthening exercises program, but the outcome was not significant. [37] Thus this study focused on more clinically, on gluteus medius strengthening protocol compared to traditional protocol which is practiced generally in physiotherapy clinic.

The existing study confirmed a difference in the strength between affected and unaffected side. Overall the data suggest that the strength of gluteus medius was 3.68 on affected side as compare to 4.64 on unaffected side. But it is negligible in terms of gluteus maximus, i.e. 4.06 on affected side and 4.68 on unaffected side, similarly strength of tensor facia lata is noted as 4.5 on affected side and 4.73 on unaffected side. The strength were evaluated by manual muscle testing, thought the dynamometer were better option but there were several limitation in this study. The samples collected were from IGTAMSU physiotherapy unit which is a part of IGTAMSU- Naturopathy, yoga, physiotherapy and life style intervention center. The clients of our clinic is different from other clinical center seen in general medical practices. Although our control were matched by age, gender and BMI. Our sample have been divided into two group and tried to distribute equally based on disability level.

During entire session of treatment routine~~ly~~ clinical assessments were done, with specified objectivity. The inter-rater reliability for tenderness and tendelenburg sign were high may represent as highly experiences but the MMT has lower inter-rated reliability as chance of subjective biasness is higher, and similar report seen in earlier studies. Krause DA et al (2014)found that to quantify the strength of muscles, dynamometer can be used and to quantify the pain threshold pressure algometry can be used. [39] Further electromyography can be used in examine the muscle activation pattern which is a limitation for this study, and suggest to be used in further study which can be given data validity. The study has been limited only in Ziro city based population, thus sample size is smaller. Further study should be done in bigger sample size to generalize the treatment protocol.

Due to ~~less dense~~thin population and lack of awareness of therapeutic exercise among the available sample population, the size of the sample population was too small for study, and it's a challenge for researcher, to justify the clinical population who need the physical therapy intervention for chronic low back pain in future. For study the researcher tried to manage with the available sample population. The thirty four subjects were divided into two groups as traditional group and gluteal medius strengthening exercises group.

A. Resemblance of Exercise Interventions

Few of the studies suggested that treatment classification schemes have no additional benefits with chronic low back pain. Apeldoorn and colleagues (2012) found that the treatment based classification scheme had limited effective in chronic low back pain as compare to traditional practiced therapies used by physical therapy. [1] Henry and colleagues (2014) studied on chronic low back pain and less impressive with outcome by using treatment based classification and movement system impairment schemes. [31] Van Dillen LR and colleagues (2016) had a annual follow-up of chronic low back pain on classification based treatment but didn't find any significance difference.[76] Several studies such as Cairns MC et al.(2006), Ferreira ML et al.(2007), Hayden JA et al.(2005), Macedo LG et al.(2012) and Unsgaard-Tondel M et al. (2010) had failed to demonstrate the outcome of superior interventions.[8,23,29,41,75] Saragiotto BT et.al (2004) and colleagues found that motor control exercises had similar effect to other traditional exercises during interventions in chronic low back pain. [65] Likewise, Wieland LS et.al,(2015) concluded that pilates and yoga were found same out come as other exercises for caring chronic low back pain. [82] This is to defy the current thoughts in physical therapy for chronic low back pain management.

B. Sample Representativeness

The present study was based on Ziro population having chronic low back pain. Overall Ziro has a thin population and mainly the dweller are farmers. Due to extensive exclusive criteria and the sample were recruited from community based, thus we had only handful of sample population which may not generalized clinical population.

We analyzed many pain intensity, low-back pain related disability, fear –aviodance scale, quality of life, and functional assessment test. The sample received were nearly homogeneous but cannot be generalized.

The sample recruited for this study had a pain intensity of maximum 6/10 on VAS pain rating scale and a inclusion criteria. Overall in our Stabilization exercise protocol was 5±0.63 and Gluteus Medius Strengthening Protocol was 5.35±0.7 as pre test mean data. Though other studies such as Hicks and colleagues (2005) reported mean pain ratings of 4.5±2.4 for their study sample. However they suggested the outcome will be seen better with higher pain rating scale. [32]

In support of Hick et.al, Rabin and colleague worked on (20020 pain rating of 4.9±1.7 and 5.3±1.7 in their study.[24] Similarly Costa and colleague (2009) used pain rating scale of 6.8±2.1 and 6.6±2.0 in a clinical sample. [14] used for stabilization intervention for low back pain. Supporting to above literature we found positive result. Our study shows similar result as was predicted by earlier researchers. In our group-1 the pre test pain intensity was 5±0.63 and post test we got a result as pain reduced to 4.64±0.24 and had a change of 0.59±0.62 on VAS pain rating scale . similarly for group-2 the pre test pain was 5.35±0.7 but after intervention of exercises we found the pain reduces to 3.92±0.79 and had a remarkable change of 1.35±0.93 on VAS pain rating scale.

The next parameter analyzed was Oswestry Low back Disability Index (ODI) . Despite pain the ODI for group-1 was 28.77±12.94 as pre test data and post test it was 28.06±9.05 and the change was recorded as 1.67±2.26 improvement which is marginal. In Group-2 the ODI was 26.65±4.04 as pre-test data and 24.82±4.14 as post test data. The change was 2.53±2.07 which is not such a significant improvement. The similar baseline was noted as 29.7±13.7 in one of a study done by Hick and colleagues[37]. In one of the study done by Henry and colleague found relatively lower ODI score: 20.6 and 18.7 for their group and suggested that community – recruited sample is lower than that seen in clinical population and most of the words are agreeable in this present study.

The next component assed was Fear- avoidance beliefs scores. Over all it assess includes ADL's, behavior, functional mobility, general health, life participation, mental health, motivation, occupational performance, pain, personality, wuality of life , self efficiency, stress and coping. For Hick and colleague (2005) reported FABQ- PA score of 14.6±5.9 and FABQ-W scores of 13.9±12.0 [32] similarly Rabin and colleagues(2014) reported even higher scores as FABQ-PA was 16.2±4.4 and 15.1±4.9 and FABQ-W was 18.1±9.9 and 19.4±10.3 for the for each treatment group.[60] Comparing to our study Henry and colleagues found lower scores in their community-recruited sample as FABQ-PA score was 13.4 and 13.0 and FABQ-W score was 10.7 and 10.5 for the for each group.[31] Whereas our findings for FABQ-PA were 18.82±2.67 and 20.59±1.66 as pre test score and even the score were marginal subsided as 17.94±2.14 and 17.7±1.82 respectively. Even in FABQ-W score was 17.7±4.97 and 18.64±2.08 as pre test and post test it was subsided as 16.23±2.19 and 16.11±1.96 respectively.

The SF – 36 is tries to analze the domain such as limitation in physical activity, social activity, general role activities, body pain, general mental health, emptional problem, vitality and general health perceptions. Henry and colleagues 92014) in their community sample reported as 46.7 and 48.9 for the **SF-36** PCS and 52.8 and 52.6 for the SF-36 MCS.[31] even our data mimics same as above as 55.29±3.99 and 55.88±4.12 as pre test data and 52.8±3.13 and 51.76±3.32 for post test data for SF-36 PCS. Likewise SF-36 MCS score were 54.94±6.24 and 56.47±5.14 as pre test and 52.24±6.95 and 51.82±5.31 as post-test respectively. In

present study the exercises intervention has negligible effect on quality of life. more over this data suggest that normal quality of life in spite of their chronic pain.

The last component assed was functional strength and assessment. An interesting study evaluated by Simmons,(1998) who reported as five times sit-to-stand test on chronic low back pain recruited from orthopedic clinic and was found 12.75±7.36 seconds to complete the test, on reevaluation it was 11.54±5.78 seconds. [69] and later Novy DM et al,(1999) analyzed on gender-wise they found that women needs 11.03±4.42 seconds, whereas men need 12.75±8.67 seconds [55] On visiting by Lee CE et al(2001) in the orthopedic and spine clinic the average testing time noted as 14.05±7.93 seconds [40] Progressively Novy DM et al(2002) visited orthopedic and physiotherapy clinic tested the clients evaluated with same functional test and recorded as 13.00±6.29 seconds to finish the test. [54] Latter study done by Simmonds MJ(1998) compared with healthy people without back pain and reported times of 7.36±1.42 seconds and again on retest after a week it was only 6.95±1.37 seconds. [69]

In our study we have found 12.41±1.08 seconds and 12±1.96 seconds as pre-test data of both group and after exercises protocol the post test data was 10.94±1.71 seconds and 10.76±1.39 seconds respectively. We have found the improvement in both the group but, more effective with gluteus medius exercise protocol group. It was believed that exercise can show a big change in time duration but it was not as per expected, may be due to majority of the participants were farmer by occupation and older age may be the other factors.

As per our search we didn't got any such literature data on active hip abduction test and single limb squat test but our finding suggest that majority of the participant improved. On comparing the groups we found that Gluteus Medius Strengthening Protocol shown better outcome Stabilization exercise protocol group. Similarly on single limb squat test majority of the members were improvised but not with perfection. The age can be a big factor as the participants are unable to improvised with perfection but able to recover better than before as professionally majority are farmers and physically they are active as per our observation. On evaluating strength assessment for current study kendall's manual muscle testing had been used though using dynamometer data were superior, which is a limitation of this study. Our study found that Gluteus Medius Strengthening Protocol had shown better improvement as compared to Stabilization exercise protocol group. The improvement gluteus medius strength of 0.86±0.66 have been recorded with Gluteus Medius Strengthening Protocol against 0.6±0.46 had been found in Stabilization exercise protocol group. we believe it is a big improvement for age group which were participated for this present study. Other than gluteus medius, we didn't found any improvement in gluteus maximus and tensor facia lata.

C. Exercise observance

The participants were dedicated to their work out as per given protocol and they are under supervised by physical therapist assistant and senior students of physical therapy department. Though Mannion AF et al (1881-91) and Beinart NA and colleagues (2013) had already stated about the several factors which inter-fears the devotion for exercise such as self- efficacy, locus of control, supervision, participation in exercise self motivation .[3,42,]

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CHAPTER 7

CONCLUSIONS

Our first hypothesis was weakness of gluteus medius and tenderness in gluteus region occurs in the majority of people chronic non-specific low back pain. We found that weakness of gluteus muscles issignificantly low on symptomatic side as compared to asymptomatic side. Similarly tenderness was noted on belly of gluteal region in majority of the cases. Thus we can state that gluteus weakness is one of the strong predictive of low back pain.

The second hypothesis was, strengthening of gluteus medius is more effective than a standard exercise program for people with chronic non-specific low back pain with gluteus medius weakness and gluteus tenderness. The present study was done by distributing the sample population into two sub group. unbiased research show the superior result in favor of gluteus medius strengthening as compared to stabilization exercises protocol.

Further, researcher suggests that ~~further~~ more study should be done on large sample population and should compare between community populations with clinical populations. The present study was done on inhabitants of Ziro, were majority were farmers and middle age. It is suggested the research should be done on chronic low back pain along with other lifestyle and age group. In this study we used manual muscle testing to analyze the muscle strength, but we believe utilization of dynamometer and surface electromyogram might have given further better result and analysis in dept. This sample for study was collected from single source, thus thread to internal validity can be a question, but it will be better if same project was done in multiple setting to avoid biasness.

REFERENCES

[1.] Apeldoorn AT, Ostelo RW, van Helvoirt H, et al. A randomized controlled trial on the effectiveness of a classification-based system for subacute and chronic low back pain. *Spine.* 2012;37(16):1347-1356.
[2.] Arab A, Nourbakhsh M. The relationship between hip abductor muscle strength and iliotibial band tightness in individuals with low back pain. *Chiropr Osteopat.* 2010;18(1):1.
[3.] Beinart NA, Goodchild CE, Weinman JA, Ayis S, Godfrey EL. Individual and intervention-related factors associated with adherence to home exercise in chronic low back pain: a systematic review. *Spine J.* 2013;13(12):1940-1950.
[4.] Ben-Galim P, Ben-Galim T, Rand N, et al. Hip-spine syndrome: the effect of total hip replacement surgery on low back pain in severe osteoarthritis of the hip. *Spine.* 2007;32(19):2099-2102.
[5.] Bewyer DC, Bewyer KJ. Rationale for treatment of hip abductor pain syndrome.*Iowa Orthop J.* 2003;23:57-60.
[6.] Bewyer KJ, Bewyer DC, Messenger D, Kennedy CM. Pilot data: association between gluteus medius weakness and low back pain during pregnancy. *Iowa Orthop J.* 2009;29:97-99.
[7.] Bohannon RW. Reference values for extremity muscle strength obtained by handheld dynamometry from adults aged 20 to 79 years. *Arch Phys Med Rehabil.*1997;78(1):26-32.
[8.] Cairns MC, Foster NE, Wright C. Randomized controlled trial of specific spinal stabilization exercises and conventional physiotherapy for recurrent low back pain. *Spine (Phila Pa 1976).* 2006;31(19):E670-681.
[9.] Chapman JR, Norvell DC, Hermsmeyer JT, et al. Evaluating common outcomes for measuring treatment success for chronic low back pain. *Spine.* 2011;36(21 Suppl):S54-68.
[10.] Chesworth BM, Padfield BJ, Helewa A, Stitt LW. A comparison of hip mobility in patients with low back pain and matched healthy subjects. *Physiother Can.* 1994;46(4):267-274.
[11.] Cibulka MT, Sinacore DR, Cromer GS, Delitto A. Unilateral hip rotation range of motion asymmetry in patients with sacroiliac joint regional pain. *Spine.* 1998;23(9):1009-1015.
[12.] Collee G, Dijkmans BA, Vandenbroucke JP, Rozing PM, Cats A. A clinical epidemiological study in low back pain. Description of two clinical syndromes. *British journal of rheumatology.* 1990;29(5):354-357.
[13.] Collee G, Dijkmans BA, Vandenbroucke JP, Cats A. Greater trochanteric pain syndrome (trochanteric bursitis) in low back pain. *Scandinavian journal of rheumatology.* 1991;20(4):262-266.
[14.] Costa LO, Maher CG, Latimer J, et al. Motor control exercise for chronic low back pain: a randomized placebo-controlled trial. *Phys Ther.* 2009;89(12):1275- 1286
[15.] Delitto A, Erhard RE, Bowling RW. A treatment-based classification approach to low back syndrome: identifying and staging patients for conservative treatment. *Phys Ther.* 1995;75(6):470-485; discussion 485-479.
[16.] Delitto A, George SZ, Van Dillen LR, et al. Low back pain. *J Orthop Sports Phys Ther.* 2012;42(4):A1-57.
[17.] Deyo RA, Dworkin SF, Amtmann D, et al. Report of the NIH Task Force on Research Standards for Chronic Low Back Pain. *J Pain.* 2014.
[18.] Deyo RA, Rainville J, Kent DL. What can the history and physical examination tell us about low back pain? *JAMA.* 1992;268(6):760-765.
[19.] Dionne CE, Dunn KM, Croft PR, et al. A consensus approach toward the standardization of back pain definitions for use in prevalence studies. *Spine.* 2008;33(1):95-103.
[20.] Ellison JB, Rose SJ, Sahrmann SA. Patterns of hip rotation range of motion: a comparison between healthy subjects and patients with low back pain. *Phys Ther.* 1990;70(9):537-541.
[21.] Fairbank JC, Couper J, Davies JB, O'Brien JP. The Oswestry low back pain disability questionnaire. *Physiotherapy.* 1980;66(8):271-273.
[22.] Fairbank J, Gwilym SE, France JC, et al. The role of classification of chronic low back pain. *Spine.* 2011;36(21 Suppl):S19-42.

[23.] Ferreira ML, Ferreira PH, Latimer J, et al. Comparison of general exercise, motor control exercise and spinal manipulative therapy for chronic low back pain: A randomized trial. *Pain.* 2007;131(1-2):31-37.
[24.] Flynn T, Fritz J, Whitman J, et al. A clinical prediction rule for classifying patients with low back pain who demonstrate short-term improvement with spinal manipulation. *Spine.* 2002;27(24):2835-2843.
[25.] Frese E, Brown M, Norton BJ. Clinical reliability of manual muscle testing. Middle trapezius and gluteus medius muscles. *Phys Ther.* 1987;67(7):1072-1076.
[26.] Fritz JM, Cleland JA, Childs JD. Subgrouping patients with low back pain: evolution of a classification approach to physical therapy. *J Orthop Sports Phys Ther.* 2007;37(6):290-302.
[27.] Hardcastle P, Nade S. The significance of the Trendelenburg test. *The Journal of bone and joint surgery British volume.* 1985;67(5):741-746.
[28.] Harris-Hayes M, Sahrmann SA, Van Dillen LR. Relationship between the hip and low back pain in athletes who participate in rotation-related sports. *J Sport Rehabil.* 2009;18(1):60-75.
[29.] Hayden JA, van Tulder MW, Malmivaara A, Koes BW. Exercise therapy for treatment of non-specific low back pain. *The Cochrane database of systematic reviews.* 2005(3):CD000335.
[30.] Hefford C. McKenzie classification of mechanical spinal pain: profile of syndromes and directions of preference. *Manual therapy.* 2008;13(1):75-81.
[31.] Henry SM, Van Dillen LR, Ouellette-Morton RH, et al. Outcomes are not different for patient-matched versus nonmatched treatment in subjects with chronic recurrent low back pain: a randomized clinical trial. *Spine J.* 2014.
[32.] Hicks GE, Fritz JM, Delitto A, McGill SM. Preliminary development of a clinical prediction rule for determining which patients with low back pain will respond to a stabilization exercise program. *Arch Phys Med Rehabil.* 2005;86(9):1753-1762.
[33.] Hislop HJ, Montgomery J. *Daniels and Worthingham's muscle testing : techniques of manual examination.* 7th ed. Philadelphia: W.B. Saunders; 2002.
[34.] Jaramillo J, Worrell TW, Ingersoll CD. Hip isometric strength following knee surgery. *J Orthop Sports Phys Ther.* 1994;20(3):160-165.
[35.] Karayannis NV, Jull GA, Hodges PW. Physiotherapy movement based classification approaches to low back pain: comparison of subgroups through review and developer/expert survey. *BMC Musculoskelet Disord.* 2012;13:24.
[36.] Kendall KD, Patel C, Wiley JP, Pohl MB, Emery CA, Ferber R. Steps toward the validation of the Trendelenburg test: the effect of experimentally reduced hip abductor muscle function on frontal plane mechanics. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine.* 2013;23(1):45-51.
[37.] Kendall KD, Schmidt C, Ferber R. The relationship between hip-abductor strength and the magnitude of pelvic drop in patients with low back pain. *J Sport Rehabil.* 2010;19(4):422-435.
[38.] Kramer JF, Vaz MD, Vandervoort AA. Reliability of isometric hip abductor torques during examiner- and belt-resisted tests. *Journal of gerontology.* 1991;46(2):M47-51.
[39.] Krause DA, Neuger MD, Lambert KA, Johnson AE, DeVinny HA, Hollman JH. Effects of examiner strength on reliability of hip-strength testing using a handheld dynamometer. *J Sport Rehabil.* 2014;23(1):56-64.
[40.] Lee CE, Simmonds MJ, Novy DM, Jones S. Self-reports and clinician-measured physical function among patients with low back pain: a comparison. *Arch Phys Med Rehabil.* 2001;82(2):227-231.
[41.] Macedo LG, Latimer J, Maher CG, et al. Effect of motor control exercises versus graded activity in patients with chronic nonspecific low back pain: a randomized controlled trial. *Phys Ther.* 2012;92(3):363-377.
[42.] Mannion AF, Helbling D, Pulkovski N, Sprott H. Spinal segmental stabilization exercises for chronic low back pain: programme adherence and its influence on clinical outcome. *Eur Spine J.* 2009;18(12):1881-1891.
[43.] Matsuyama Y, Hasegawa Y, Yoshihara H, et al. Hip-spine syndrome: total sagittal alignment of the spine and clinical symptoms in patients with bilateral congenital hip dislocation. *Spine.* 2004;29(21):2432-2437.

[44.] Mellin G. Correlations of hip mobility with degree of back pain and lumbar spinal mobility in chronic low-back pain patients. *Spine.* 1988;13(6):668-670.
[45.] Nadler SF, Malanga GA, Feinberg JH, Prybicien M, Stitik TP, DePrince M. Relationship between hip muscle imbalance and occurrence of low back pain in collegiate athletes: a prospective study. *American journal of physical medicine & rehabilitation / Association of Academic Physiatrists.* 2001;80(8):572-577.
[46.] Nadler SF, Malanga GA, Bartoli LA, Feinberg JH, Prybicien M, Deprince M. Hip muscle imbalance and low back pain in athletes: influence of core strengthening. *Med Sci Sports Exerc.* 2002;34(1):9-16.
[47.] Nadler SF, Malanga GA, DePrince M, Stitik TP, Feinberg JH. The relationship between lower extremity injury, low back pain, and hip muscle strength in male and female collegiate athletes. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine.* 2000;10(2):89-97.
[48.] Nelson-Wong E, Gregory DE, Winter DA, Callaghan JP. Gluteus medius muscle activation patterns as a predictor of low back pain during standing. *Clin Biomech.* 2008;23(5):545-553.
[49.] Nelson-Wong E, Flynn T, Callaghan JP. Development of active hip abduction as a screening test for identifying occupational low back pain. *J Orthop Sports Phys Ther.* 2009;39(9):649-657.
[50.] Nelson-Wong E, Callaghan JP. Is muscle co-activation a predisposing factor for low back pain development during standing? A multifactorial approach for early identification of at-risk individuals. *J Electromyogr Kinesiol.* 2010;20(2):256-263.
[51.] Nelson-Wong E, Callaghan JP. Transient low back pain development during standing predicts future clinical low back pain in previously asymptomatic individuals. *Spine.* 2014;39(6):E379-383.
[52.] Njoo KH, Van der Does E. The occurrence and inter-rater reliability of myofascial trigger points in the quadratus lumborum and gluteus medius: a prospective study in non-specific low back pain patients and controls in general practice. *Pain.* 1994;58(3):317-323.
[53.] Nourbakhsh MR, Arab AM. Relationship between mechanical factors and incidence of low back pain. *J Orthop Sports Phys Ther.* 2002;32(9):447-460.
[54.] Novy DM, Simmonds MJ, Lee CE. Physical performance tasks: what are the underlying constructs? *Arch Phys Med Rehabil.* 2002;83(1):44-47.
[55.] Novy DM, Simmonds MJ, Olson SL, Lee CE, Jones SC. Physical performance: differences in men and women with and without low back pain. *Arch Phys Med Rehabil.* 1999;80(2):195-198.
[56.] Offierski CM, MacNab I. Hip-spine syndrome. *Spine.* 1983;8(3):316-321.
[57.] O'Sullivan P. Diagnosis and classification of chronic low back pain disorders: maladaptive movement and motor control impairments as underlying mechanism. *Manual therapy.* 2005;10(4):242-255.
[58.] Pengel LH, Herbert RD, Maher CG, Refshauge KM. Acute low back pain: systematic review of its prognosis. *Bmj.* 2003;327(7410):323.
[59.] Petersen T, Olsen S, Laslett M, et al. Inter-tester reliability of a new diagnostic classification system for patients with non-specific low back pain. *Aust Physiother.* 2004;50(2):85-94.
[60.] Rabin A, Shashua A, Pizem K, Dickstein R, Dar G. A clinical prediction rule to identify patients with low back pain who are likely to experience short-term success following lumbar stabilization exercises: a randomized controlled validation study. *J Orthop Sports Phys Ther.* 2014;44(1):6-B13.
[61.] Radcliff KE, Orozco F, Molby N, et al. Is pelvic obliquity related to degenerative scoliosis? *Orthopaedic surgery.* 2013;5(3):171-176.
[62.] Radloff LS. The CES-D Scale: A Self-Report Depression Scale for Research in the General Population. *Appl Psychol Meas.* 1977;1(3):385-401.
[63.] Roland M, Morris R. A study of the natural history of back pain. Part I: development of a reliable and sensitive measure of disability in low-back pain. *Spine.* 1983;8(2):141-144.
[64.] Sahrmann S. *Diagnosis and treatment of movement impairment syndromes.* St. Louis, Mo.: Mosby; 2002.
[65.] Saragiotto BT, Maher CG, Yamato TP, et al. Motor control exercise for chronic non-specific low-back pain. *The Cochrane database of systematic reviews.* 2016(1):CD012004.

[66.] Sayegh F, Potoupnis M, Kapetanos G. Greater trochanter bursitis pain syndrome in females with chronic low back pain and sciatica. *Acta orthopaedica Belgica.* 2004;70(5):423-428
[67.] Sembrano JN, Polly DW, Jr. How often is low back pain not coming from the back? *Spine (Phila Pa 1976).* 2009;34(1):E27-32.
[68.] Simons DG, Travell JG. Myofascial origins of low back pain. 3. Pelvic and lower extremity muscles. *Postgrad Med.* 1983;73(2):99-105, 108.
[69.] Simmonds MJ, Olson SL, Jones S, et al. Psychometric characteristics and clinical usefulness of physical performance tests in patients with low back pain. *Spine.* 1998;23(22):2412-2421.
[70.] Sullivan MJL, Bishop SR, Pivik J. The Pain Catastrophizing Scale: Development and validation. *Psychol Assess.* 1995;7(4):524-532.
[71.] Sutherlin MA, Hart JM. Hip-abduction torque and muscle activation in people with low back pain. *J Sport Rehabil.* 2015;24(1):51-61.
[72.] Swezey RL. Pseudo-radiculopathy in subacute trochanteric bursitis of the subgluteus maximus bursa. *Arch Phys Med Rehabil.* 1976;57(8):387-390.
[73.] Tortolani PJ, Carbone JJ, Quartararo LG. Greater trochanteric pain syndrome in patients referred to orthopedic spine specialists. *Spine J.* 2002;2(4):251-254.
[74.] Trendelenburg F. Trendelenburg's test: 1895. *Clin Orthop Relat Res.* 1998(355):3-7.
[75.] Unsgaard-Tondel M, Fladmark AM, Salvesen O, Vasseljen O. Motor control exercises, sling exercises, and general exercises for patients with chronic low back pain: a randomized controlled trial with 1-year follow-up. *Phys Ther.* 2010;90(10):1426-1440.
[76.] Van Dillen LR, Norton BJ, Sahrmann SA, et al. Efficacy of classification-specific treatment and adherence on outcomes in people with chronic low back pain. A one-year follow-up, prospective, randomized, controlled clinical trial. *Manual therapy.* 2016;24:52-64
[77.] van Middelkoop M, Rubinstein SM, Kuijpers T, et al. A systematic review on the effectiveness of physical and rehabilitation interventions for chronic non-specific low back pain. *Eur Spine J.* 2011;20(1):19-39.
[78.] Vlaeyen JW, Kole-Snijders AM, Boeren RG, van Eek H. Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. *Pain.* 1995;62(3):363-372.
[79.] Walker BF. The prevalence of low back pain: a systematic review of the literature from 1966 to 1998. *Journal of spinal disorders.* 2000;13(3):205-217.
[80.] Waddell G, Newton M, Henderson I, Somerville D, Main CJ. A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. *Pain.* 1993;52(2):157-168.
[81.] Wieland LS, Skoetz N, Pilkington K, Vempati R, D'Adamo CR, Berman BM. Yoga treatment for chronic non-specific low back pain. *The Cochrane database of systematic reviews.* 2017;1:CD010671.
[82.] Yamato TP, Maher CG, Saragiotto BT, et al. Pilates for low back pain. *The Cochrane database of systematic reviews.* 2015(7):CD010265.
[83.] Yoshimoto H, Sato S, Masuda T, et al. Spinopelvic alignment in patients with osteoarthrosis of the hip: a radiographic comparison to patients with low back pain. *Spine.* 2005;30(14):1650-1657.
[84.] Youdas JW, Madson TJ, Hollman JH. Usefulness of the Trendelenburg test for identification of patients with hip joint osteoarthritis. *Physiother Theory Pract.* 2010;26(3):184-194.
[85.] Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta psychiatrica Scandinavica.* 1983;67(6):361-370.

ISSN No:-2456-2165

APPENDIX A:
OSWESTRY DISABILITY INDEX

Could you please complete this questionnaire it is designed to give us information as to how your back (or leg) trouble has affected your ability to manage in everyday life. Please answer every section. Mark **one box only** in each section that most closely describes you **today.**

Score	Components
Pain Intensity	
6	¨ I can tolerate the pain I have without having to use pain medication.
5	¨ The pain is bad, but I can manage without having to take pain medication.
4	¨ Pain medication provides me with complete relief from pain.
3	¨ Pain medication provides me with moderate relief from pain.
2	¨ Pain medication provides me with little relief from pain.
1	¨ Pain medication has no effect on my pain.
Personal Care (e.g. Washing, Dressing)	
6	¨ I can take care of myself normally without causing increased pain.
5	¨ I can take care of myself normally but it increases my pain.
4	¨ It is painful to take care of myself and I am slow and careful.
3	¨ I need help but I am able to manage most of my personal care.
2	¨ I need help every day in most aspects of my care.
1	¨ I do not get dressed, wash with difficulty and stay in bed.
Lifting	
6	¨ I can lift heavy weights without increased pain.
5	¨ I can lift heavy weights but it causes increased pain.
4	¨ Pain prevents me from lifting heavy weights off the floor, but I can manage if the weights are conveniently positioned (e.g. on a table).
3	¨ Pain prevents me from lifting heavy weights but I can manage light to medium weights if they are conveniently positioned
2	¨ I can lift only very light weights.

ISSN No:-2456-2165

1	¨ I cannot lift or carry anything at all
Walking	
6	¨ Pain does not prevent me walking any distance.
5	¨ Pain prevents me walking more than 1 mile
4	¨ Pain prevents me walking more than . mile.
3	¨ Pain prevents me walking more than . mile.
2	¨ I can only walk with crutches or a cane.
1	I am in bed most of the time and have to crawl to the toilet.
Sitting	
6	¨ I can sit in any chair as long as I like.
5	¨ I can sit in my favorite chair as long as I like
4	¨ Pain prevents me from sitting for more than 1 hour.
3	¨ Pain prevents me from sitting for more than . hour.
2	¨ Pain prevents me from sitting for more than 10 minutes.
1	¨ Pain prevents me from sitting at all
Standing	
6	¨ I can stand as long as I want without increased pain.
5	¨ I can stand as long as I want but it increases my pain.
4	¨ Pain prevents me from standing more than 1 hour.
3	¨ Pain prevents me from standing more than . hour.
2	¨ Pain prevents me from standing more than 10 minutes.
1	¨ Pain prevents me from standing at all.
Sleeping	
6	¨ Pain does not prevent me from sleeping well.
5	¨ I can sleep well only by using pain medication.
4	¨ Even when I take pain medication, I sleep less than 6 hours.
3	¨ Even when I take pain medication, I sleep less than 4 hours.
2	¨ Even when I take pain medication, I sleep less than 2 hours.
1	¨ Pain prevents me from sleeping at all.
Social Life	
6	¨ My social life is normal and does not increase my pain.
5	¨ My social life is normal, but it increases my pain.
4	¨ Pain prevents me from participating in more energetic interests (e.g. sports, dancing).
3	¨ Pain prevents me from going out often.
2	¨ Pain has restricted my social life to my home.
1	¨ I have hardly any social life because of my pain.
Traveling	

ISSN No:-2456-2165

6	¨ I can travel anywhere without increased pain.
5	¨ I can travel anywhere but it increases my pain.
4	¨ My pain restricts my travel over 2 hours.
3	¨ My pain restricts my travel over 1 hour.
2	¨ My pain restricts my travel to short necessary journeys under . hour.
1	¨ My pain prevents all travel except for visits to the physician/therapist or hospital
Employment/Homemaking	
6	¨ My normal homemaking/job activities do not cause pain.
5	¨ My normal homemaking/job activities increase my pain, but I can still perform all that is requires of me.
4	¨ I can perform most of my homemaking/job duties, but pain prevents me from performing more physically stressful activities (ex. lifting, vacuuming).
3	¨ Pain prevents me from doing anything but light duties.
2	¨ Pain prevents me from doing even light duties.
1	¨ Pain prevents me from performing any job or homemaking chores

ISSN No:-2456-2165

APPENDIX B:
FEAR-AVOIDANCE BELIEFSQUESTIONNAIRE

Here are some of the things which other patients have told us about their pain. For each statement please circle any number from 0 to 6 to say how much physical activities such as bending, lifting, walking or driving affect or would affect your back pain. Completely Disagree Unsure Completely Agree

		Completely Disagree			Unsure			Completely Agree
		0	1	2	3	4	5	6
1	My pain was caused by physical activity							
2	Physical activity makes my pain worse							
3	Physical activity might harm my back							
4	I should not do physical activities which (might) make my pain worse							
5	I cannot do physical activities which (might) make my pain worse							

The following statements are about how your normal work affects or would affect your back pain.

		Completely Disagree			Unsure			Completely Agree
		0	1	2	3	4	5	6
6	My pain was caused by my work or by an accident at work							
7	My work aggravated my pain							
8	I have a claim for compensation for my pain							
9	My work is too heavy for me							
10	My work makes or would make my pain worse							
11	My work might harm my back							
12	I should not do my normal work with my present pain							
13	I cannot do my normal work with my present pain							
14	I cannot do my normal work until my pain is tolerated							
15	I do not think that I will be back to my normal work within 3 months							
16	I do not think that I will ever be able to go back to that work							

ISSN No:-2456-2165

APPENDIX C:
SF-36

1. In general, would you say your health is:

1	Excellent
2	Very good
3	Good
4	Fair
5	Poor

2. **Compared to one year ago**, how would you rate your health in general **now**?

1	Much better now than one year ago
2	Somewhat better now than one year ago
3	About the same
4	Somewhat worse now than one year ago
5	Much worse now than one year ago

The following items are about activities you might do during a typical day. Does **your health now limit you** in these activities? If so, how much?

Sl.no.		Yes, Limited a Lot	Yes, Limited a Little	No, Not limited at All
3	**Vigorous activities**, such as running, lifting heavy objects, participating in strenuous sports	1	2	3
4	**Moderate activities**, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	1	2	3
5	Lifting or carrying groceries	1	2	3
6	Climbing **several** flights of stairs	1	2	3
7	Climbing **one** flight of stairs	1	2	3
8	Bending, kneeling, or stooping	1	2	3
9	Walking **more than a mile**	1	2	3
10	Walking **several blocks**	1	2	3
11	Walking **one block**	1	2	3
12	Bathing or dressing yourself	1	2	3

During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a result of your physical health**?

Sl.no	Questionnaires	Yes	No
13	Cut down the amount of time you spent on work or other activities	1	2
14	**Accomplished less** than you would like	1	2
15	Were limited in the **kind** of work or other activities	1	2
16	Had **difficulty** performing the work or other activities (for example, it took extra effort)	1	2
		1	2

ISSN No:-2456-2165

During the **past 4 weeks,** have you had any of the following problems with your work or other regular daily activities **as a result of any emotional problems** (such as feeling depressed or anxious)?

Sl.no	Questionnaires	Yes	No
17	Cut down the **amount of time** you spent on work or other activities	1	2
18	**Accomplished less** than you would like	1	2
19	Didn't do work or other activities as **carefully** as usual	1	2

20. During the **past 4 weeks,** to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

Score	Component
1	Not at all
2	Slightly
3	Moderately
4	Quite a bit
5	Extremely

21. How much **bodily** pain have you had during the **past 4 weeks**?

Score	Component
1	None
2	Very mild
3	Mild
4	Moderate
5	Severe
6	Very severe

22. During the **past 4 weeks,** how much did **pain** interfere with your normal work (including both work outside the home and housework)?

Score	Component
1	Not at all
2	Slightly
3	Moderately
4	Quite a bit
5	Extremely

These questions are about how you feel and how things have been with you **during the past 4 weeks**. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the **past 4 weeks** . . .

ISSN No:-2456-2165

Sl.no	Component	All of the Time	Most of the Time	A Good Bit of the Time	Some of the Time	A Little of the Time	None of the Time
23	Did you feel full of pep?	1	2	3	4	5	6
24	Have you been a very nervous person?	1	2	3	4	5	6
25	Have you felt so down in the dumps that nothing could cheer you up?	1	2	3	4	5	6
26	Have you felt calm and peaceful?	1	2	3	4	5	6
27	Did you have a lot of energy?	1	2	3	4	5	6
28	Have you felt downhearted and blue?	1	2	3	4	5	6
29	Did you feel worn out?	1	2	3	4	5	6
30	Have you been a happy person?	1	2	3	4	5	6
31	Did you feel tired?	1	2	3	4	5	6

32. During the **past 4 weeks,** how much of the time has your **physical health or emotional problems** interfered with your social activities (like visiting with friends, relatives, etc.)?
(Circle One Number)

Score	**Component**
1	All of the time
2	Most of the time
3	Some of the time
4	A little of the time
5	None of the time

How TRUE or FALSE is each of the following statements for you.
(Circle One Number on Each Line)

Sl.no	components	Definitely True	Mostly True	Don't Know	Mostly False	Definitely False
33	I seem to get sick a little easier than other people	1	2	3	4	5
34	I am as healthy as anybody I know	1	2	3	4	5
35	I expect my health to get worse	1	2	3	4	5
36	My health is excellent	1	2	3	4	5

ISSN No:-2456-2165

APPENDIX D:
MANUAL OF OPERATIONS

(adapted from……)

Screening

Screening Questions	Open screening database in RedCAP. Ask and record the answers to the following questions
	"How old are you?"
	"Do you have low back pain?"
	"Have you had low back pain for more than three months?"
	"Has your low back pain been bothersome on more than half of the days of the past six months?"
	"Have you been diagnosed with any specific back condition other than low back pain?"
	"Do you have a history of any fractures in the back or legs?"
	"Have you had any surgeries of the trunk or legs?"
	"Have you had any injuries or do you have any conditions that affect your back or legs?"
If they do not meet inclusion/exclusion criteria:	"Thanks for your interest in our study, however you do not meet our criteria."
If they DO meet criteria thus far:	"You meet our criteria and we'd like to invite you to participate in our study."
Consent	Give the potential participant a copy of the informed consent document and ask them to read through the document.
	"This is the informed consent document. It describes the project and the associated risks and benefits. Please take a few minutes to read through is. Please ask if you have any questions or do not understand anything." Sign and date both copies of the informed consent document. Give one copy to the participant and retain the other for our records.
Screening Physical Exam	"We need to check a few other things to make sure you meet all of the criteria for our study. I'm going to perform a neurological examination of your legs, press over the muscles and bones in your low back, and look at the strength in a couple of the muscles that cross your hips."
	Have the participant sit on the exam table and remove their shoes.
	"Have a seat on the exam table and take off your shoes.
	First we're going to look at the strength in several muscles in your legs. Pull your big toes up to the ceiling. Hold them up there."
Demonstrate the desired motion by	Test hallux extension on both sides. Grade and score this in RedCAP.

ISSN No:-2456-2165

lifting your thumbs to the ceiling.	
	"Pull your feet up. Hold them up there."
Demonstrate the desired motion	Test ankle dorsiflexion. Grade and record this in RedCAP.
	"Straighten out your [right or left] knee all the way."
Demonstrate the desired motion.	Observe for any signs of discomfort.
	"Bend your knee just a little bit." With the knee unlocked, test knee extension strength. Grade and record this in RedCAP
	"Straighten out your other knee all the way"
Observe for signs of discomfort	Bend your knee just a little bit."
	With the knee unlocked, test knee extension strength. Grade and record this in RedCAP.
	"Lift your [right or left] knee up like you're marching."
Demonstrate the desired movement.	Test hip flexion strength. Grade and record this in RedCAP.
	"Lift your other knee."
	Test hip flexion strength. Grade and record this in RedCAP
"Next we're going to look at the sensation in both of your legs	. I'm going to touch both sides. Let me know if they feel different side to side or if either feels numb or tingly. How does it feel here?"
Stoke the anterior thigh, over the L2 dermatome, bilaterally.	"How about here?"
Stroke the anterior knee, over the L3 dermatome, bilaterally.	"And here?"
Stroke the lateral calf ,over the L5 dermatome, bilaterally	"How about in your feet, here?"
Stroke the medial aspect of the first	"Or here?"

ISSN No:-2456-2165

MTP joint over the L4 dermatome bilaterally.	
Stroke the dorsal first web space, over the L5 dermatome, bilaterally	"What about out here?"
Stroke the lateral aspect of the foot along the fifth metatarsal, over the S1 dermatome, bilaterally.	"And how about back here?"
Stroke the central posterior calf, over the S1 dermatome, bilaterally.	Record the results of the sensory screening in RedCAP
. Position the subject in supine on the exam table.	"Go ahead and lay down on you back on the table. First I'm going to lift your legs one at a time. I want you to relax and let me do the lifting. Tell me when we need to stop."
Lift one lower extremity, flexing at the hip and keeping the knee extended and ankle dorsiflexed.	Observe for signs of distress Feel for resistance to hip flexion. Prompt the participant at any sign of distress or hamstring tension limiting continued flexion. .
	"What are you feeling? Is there pain in the back or down into the leg? Or does it just pull in the back of the thigh?"
Lower the limb and repeat on the other side	"We're going to do the same thing over here. Let me do the lifting."
Lift the other lower extremity, flexing at the hip and keeping the knee extended and ankle dorsiflexed.	Observe for signs of distress. Feel for resistance to hip flexion. Prompt the participant at any sign of distress or hamstring tension limiting continued flexion.
	"What are you feeling? Is there pain in the back or down into the leg? Or does it just pull in the back of the thigh?"
Position the participant in sideling	The participant is positioned side lying with hips and knees extended and aligned with their trunk. The pelvis is in the frontal plane, perpendicular to the table. Direct the subject to

ISSN No:-2456-2165

	abduct the top leg maintaining alignment in the frontal plane:
Active Hip Abduction Test	Score the test 0-3 based on the criteria
	"Please keep your knee straight and raise your top thigh and leg towards the ceiling, keeping them in line with your body, and try not to let your pelvis tip forwards or backwards."
Single Limb Squat Test	The participant stands on one leg on a 20cm box with arms crossed over their chest. Direct the participant to squat down as far as possible and return to standing without losing their balance. Squats should be performed at a rate of about one squat per two seconds. They may take up to three practice attempts. For the test they will perform five squats consecutively. Observe their movement a score the squat as "good," "fair," or "poor" based on the following criteria:
Five Times Sit to Stand Test	Position participant in a 16-inch high, armless chair with their arms crossed over their chest. Instruct them to "Stand up and sit down as quickly as possible five times, keeping your arms folded across your chest. I'll be timing you with a stopwatch. After the test I will ask you to rate your pain on a zero to ten scale where zero is no pain and ten is the worst pain imaginable. We will do three trials of this test."

ISSN No:-2456-2165

APPENDIX E

Active Hip Abduction Test

Score the test 0-3 based on the criteria:

Score	Criteria (Nelson-Wong et al, 2009)	Criteria (Davis et al, 2011)
0: **No loss** of pelvis frontal plane 0, Able to **maintain position** of pelvis in the frontal plane	-Participant **smoothly** and **easily** performs the movement -Lower extremities, pelvis, trunk, and shoulders **remain aligned** in the frontal plane	-**Smoothly** and **easily** performs movement; lower extremities, pelvis, trunk, and shoulders **remain aligned** in frontal plane.
1: **Minimal loss** of pelvis frontal plane 1, **Minimal loss** of pelvis position in the frontal plane	-Participant may demonstrate a **slight wobble** at initiation of the movement, but quickly regains control. -Movement may be performed with **noticeable effort** or with a slight **ratcheting** of the moving limb.	-**Slight wobble** at initiation or throughout movement; may show **noticeable effort** or **"ratcheting"** of moving limb.
2: **Moderate loss** of pelvis frontal plane 2, **Moderate loss** of pelvis position in the frontal plane	-Participant has a **noticeable wobble**, **tipping of the pelvis**, **rotation of the shoulders or trunk**, **hip flexion**, and/or **internal rotation** of the abducting limb. -Movement may be performed **too rapidly**, and participant may or may not be able to regain control of the movement once it has been lost.	-Has **at least 2** of the following: **noticeable wobble** through movement; **tipping of pelvis, trunk, or shoulder rotation**; increased **hip flexion** and/or **rotation** of the moving limb; **rapid or uncontrolled** movement.
3: **Severe loss** of pelvis frontal plane 3, **Severe loss** of pelvis position in the frontal plane	-Participant demonstrates the same patterns as in a test score of 2, with **greater severity**. -Participant is **unable to regain control** of the movement and may have to use a **hand or arm on the table** to maintain balance.	-Has **more than 3** of the above characteristics and/or **unable to regain control** of movement once lost or **may lose balance** (has to place hand on table)

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ISSN No:-2456-2165

APPENDIX F
SINGLE LIMB SQUAT TEST

Criterion	Requirements for Good Rating
Overall Performance Criterion	
Balance	No loss of balance
Perturbations	Smooth performance
Squat depth	To at least 60deg knee flexion
Squat speed	Rate of 1 squat/2 seconds
Trunk Posture Criterion	
Trunk lateral deviation	No trunk lateral deviation
Trunk rotation	No trunk rotation
Trunk lateral flexion	No trunk lateral flexion
Trunk flexion	No trunk flexion
Pelvis Position Criterion	
Pelvic lateral deviation	No pelvis lateral deviation
Pelvic rotation	No pelvis rotation
Pelvic tilt	No pelvis tilt
Hip Joint Criterion	
Hip adduction	No hip adduction
Hip internal rotation	No hip internal rotation
Knee Joint Criterion	
Knee valgus	No knee valgus
Knee position	Knee remains over foot

Participants are rated “Good” if they meet all of the requirements for 4/5 of the criteria.
Participants are rated “Fair” if they meet all the requirements of at least one of the criteria.
Participants are rated “Poor” if they fail to meet all of the requirements for at least one of the criteria.

ISSN No:-2456-2165

APPENDIX G
Five Times Sit to Stand Test

Position participant in a 16-inch high, armless chair with their arms crossed over their chest.

Instruct them to
"Stand up and sit down as quickly as possible five times, keeping your arms folded across your chest. I'll be timing you with a stopwatch. After the test I will ask you to rate your pain on a zero to ten scale where zero is no pain and ten is the worst pain imaginable. We will do three trials of this test."

Begin timing as soon as the participant initiates the first transition to standing. Count each stand aloud so that the participant remains oriented. Stop the test when the participant achieves the standing position on the fifth repetition. Prompt the participant to rate their pain during the test:

"How bad was your pain during the test on a zero to ten scale?"
Record the time to complete the five sit-to-stand transfers and their pain during the test.

Allow a brief pause before repeating the test.

Record the time to complete the five sit-to-stand transfers and their pain during the second test.

Allow a brief pause before repeating the test.

Record the time to complete the five sit-to-stand transfers and their pain during the third test.

ISSN No:-2456-2165

APPENDIX H
STABILIZATION EXERCISE PROTOCOL

Procedure:-

Physical Therapy Visit One:
The first visit will consist of training the participant in the abdominal drawing-in maneuver (ADIM) in different positions. No further progression is attempted on the first visit.

Exercises in stage one are:
- ADIM in quadruped
- ADIM in supine
- ADIM in standing

Sidelying isometrics are not performed in stage one of the protocol.

Subsequent Physical Therapy Visits:
- ✓ Each exercise progression is assessed.
- ✓ The exercise prescribed at the last visit is assessed first.
  - If the participant meets the failure criteria, that exercise is prescribed.
  - If a participant meets the progression criteria the next exercise in the progression is attempted.
  - If they meet failure criteria, that exercise is prescribed; if they meet progression criteria, the next exercise is attempted.
  - This is repeated until failure criteria are reached.
  - If a participant progresses to the final exercise in the progression, that exercise is prescribed.

Exercise	**Progression Criterion**
Quadruped Progression	
ADIM in quadruped	30 reps with 8 sec hold
ADIM in quadruped, UE lifts	30 reps with 8 sec hold, both sides
ADIM in quadruped LE lifts	30 reps with 8 sec hold
ADIM in quadruped UE & LE lifts	30 reps with 8 sec hold
ADIM in quadruped, dynamic UE & LE lifts	
Supine Progression	
ADIM in supine	30 reps with 8 sec hold
ADIM in supine heel slides	20 reps with 4 sec hold, both sides
ADIM in supine LE lift	20 reps with 4 sec hold, both sides
ADIM in supine bridge	30 reps with 8 sec hold
ADIM in supine SLS bridge	30 reps with 8 sec hold, both sides
ADIM in supine curl up, elbows at sides	30 reps with 8 sec hold
ADIM in supine curl up, elbows elevated	30 reps with 8 sec hold
ADIM in supine, curl up, hands at head	
Sidelying Progression	
ADIM in sidelying	30 reps with 8 sec hold
ADIM in sidelying, side plank, knees bent	30 reps with 8 sec hold, both sides
ADIM in sidelying , side plank, knee extended	30 reps with 8 sec hold, both sides
ADIM in sidelying, side plank with tilt	30 reps with 4 tilts A/P, both sides
ADIM in sidelying, side plank with roll	

ISSN No:-2456-2165

Standing Progression	
ADIM in standing	30 reps with 8 sec hold
ADIM in standing row	30 reps with 8 sec hold
ADIM in standing, walking	

ISSN No:-2456-2165

APPENDIX I
GLUTEUS MEDIUS STRENGTHENING EXERCISE PROTOCOL

Procedure:

Physical Therapy Visits:
Each exercise progression is assessed.
The exercise prescribed at the last visit is assessed first.
If the participant meets the failure criteria, that exercise is prescribed.
If a participant meets the progression criteria the next exercise in the progression is attempted.
If they meet failure criteria, that exercise is prescribed; if they meet progression criteria, the next exercise is attempted.
This is repeated until failure criteria are reached.
If a participant progresses to the final exercise in the progression, that exercise is prescribed.

Supine Progression	
Bridge	30 reps with 8 sec hold
Bridge with Arms Crossed	30 reps with 8 sec hold
Bridge with Arms Crossed & Feet Together	30 reps with 8 sec hold
SLS Bridge	
Sidelying Progression	
Clam at 45 degrees	30 reps with 8 sec hold
Sidelying hip abduction, knees extended	30 reps with 8 sec hold
Side plank, knees bent	30 reps with 8 sec hold
Side plank, knees extended	30 reps with 8 sec hold
Squat Progression	
Squat	30 reps
SLS mini squat	30 reps
SLS squat	
Standing Progression 1	
Standing abduction	30 reps
Standing abduction, yellow band	30 reps
Standing abduction, red band	30 reps
Standing abduction, green band	30 reps
Standing abduction, blue band	30 reps
Standing abduction, black band	
Standing Progression 2	
Standing abduction with extension	30 reps
Standing abduction with extension, yellow band	30 reps
Standing abduction with extension, red band	30 reps
Standing abduction with extension, green band	30 reps
Standing abduction with extension, blue band	30 reps
Standing abduction with extension, black band	