Chapter III
METHODOLOGY

This study has been investigated the effects of core Stabilization and Stretching exercises on non specific chronic back pain as a remedy. Third chapter informs about the whole procedure of the study in detail as well as the tools used for this study, their reliability, validity, the variables, exercise programs. This chapter also deals with the proper method to the study, which is experimental in nature, based on the objectives of the study and as per the formulated hypotheses.

3.1 Design of the Study

Design of the study is the plan of the procedures that enables the researcher to move step by step to achieve the all purposes of the study. Actually, all research involves the elements of observation, description, and the analysis of what happens under certain circumstances.

This study is placed at the experimental research class. Experimental design is the blueprint of the procedures that enables the researcher to test hypotheses by reaching valid conclusions about relationships between independent and dependent variables. Selection of a particular design is based on the purposes of the experiment, the type of variables to be manipulated, and the conditions or limiting factors under which it is conducted. The design deals with such practical problems as how subjects are assigned to experimental and control groups, the way independent, dependent and other variables are manipulated and controlled, how observations are made, and the type of statistical analysis is employed in interpreting data relationships. The adequacy of experimental designs is judged by the degree to which they eliminate or minimize threats to experimental validity. Three categories are presented here:

a. Pre –experimental design is the least effective, for the provided either no control group or no way of equating the groups that are used.

b. True experimental design employs randomization to provide for control of the equivalence of groups and exposure to treatment.

c. Quasi-experimental design provides a less satisfactory degree of control, used only when randomization is not feasible.¹

According to these categories, this study has quasi-experimental design. it's consisting of one control group it was chosen from the population; they haven't any kind of back pain, and the two experimental groups were chosen from patients with nonspecific chronic low back pain. One experimental group received core
stabilization exercises, and another experimental group received stretching exercises. Pretest was taken from all groups in the baseline and the posttest was taken from the experimental groups after the intervention (12 weeks). The design is as follows:

\[
\begin{align*}
R_1: & \quad O_1 - X1 - O_2 \\
R_1: & \quad O_3 - X2 - O_4 \\
R_2: & \quad O_5 - C
\end{align*}
\]

- \( R_1 \) is randomization from low back pain patient population.
- \( R_2 \) is randomization from without low back pain population.
- \( X1 \) is stabilization exercises treatment given to one experimental group.
- \( X2 \) is stretching exercises treatment given to another experimental group.
- \( C \) is the healthy group to compare with the experimental group.
- \( O_1, O_3, O_5 \) is before intervention (pretest)
- \( O_2, O_4 \) is after intervention (Posttests)

### 3.2 Population

The Population of this study for experimental groups was consisting of 367 women who have had a medical file in low back pain in physiotherapy clinic and population for control group were 78 referred to the women; they have a medical file in skin clinic, and they didn’t have any kind of back pain.

### 3.3 Sample

From the patient population, we have chosen 157 patients were suffering from non specific chronic LBP. After calling 92 of patients accepted to participate in this research, we selected 34 of them randomly and divided them in two experimental groups. For the control group: after coordinating with the women, we chose 15 women without any kind of low back pain. The Range of age was 30-45 in all the groups.

### 3.4 Including

Criteria for selecting patients are as follows:

- Non-specific low back pain for at least 3 months duration
- Currently seeking care for low back pain
- Aged more than 30, less than 45 years
- Persian speaker
- Clinical assessment indicates that the subject is suitable for active exercises
• Expects to continue residing in the Tehran for study duration

3.5 Excluding
Criteria for rejecting patients are as follows:
• Known or suspected serious spinal pathology (deformity, fracture, metastatic, inflammatory or infective diseases of the spine, cauda equina syndrome/widespread neurological disorder).
• Nerve root compromise (at least 2 of the following signs: weakness/reflex changes/sensation loss, associated with the same spinal nerve)
• Previous spinal surgery or scheduled for major surgery during the treatment follow-up period
• Co-morbid health conditions that would prevent active participation in the exercise programs.
• Pregnancy
• Susceptibility to the gel

3.6 Human resources used
The rehabilitation doctor for choose the appropriate patients and doing ultrasonography. Physical therapist was taken to accompany the researcher for administered the exercise programs for the experimental groups.

3.7 Procedure of the Study
The researcher has to study about all women patients who were suffering of nonspecific chronic back pain and were taking treatment under supervision of doctor in the physiotherapy clinics in Tehran and selected 34 subjects for the present study from 106 patients having nonspecific chronic LBP 30-45 aged. Their name, date of birth, age and history of the pain were noted and confirmed. After taking clearance from doctor regarding exercise programs for the patients, they were divided randomly into two groups and also we chose 15 women without any kind of LBP as a control group. Experimental groups are consisting of 17 (But only 15 women those who attended all sessions from each group were considered as a real sample as others were not present at every session). After discussing with the experts and reviewing literature, the duration and repetitions of each program were fixed and accordingly, the training programs were planned. The study was conducted in three phases;
Phase I: Pretest
Phase II: stabilization exercises and stretching exercises programs of 12 weeks
Phase III: Posttest.
Pretest:
- Functional Disability was assessed by the Oswestry Low Back Pain Disability Questionnaire (ODI), just for experimental groups.
- Pain Intensity was assessed by the visual analogue scale (VAS) just for experimental groups.
- Lumbar Range of Flexion was measured by the Modified-Modified Schober’s test.
- Multifidus Thickness was measured by the Ultrasound Imaging cross-sectional area CSAs of the multifidus muscle.

Treatment programs
Both stabilization group and stretching group have done warm up, main exercise programme and cool down. Sessions were conducted three days a week over 12 weeks. Both programs were given in the afternoon, and they started in the 30 minutes and gradually increased to 45 minutes. In the both programs, initially we used the exercises that were easier for patients and gradually used exercises that were quite difficult.

Posttest:
After the completion of 12 weeks treatment programs, the posttest was performed for experimental groups as the pretest. The data were carefully collected and recorded.

3.8 Variables
Variables are the conditions or characteristics that the experimenter manipulates, controls, or observes. The type of independent variables in this research is treatment variables. Treatment variables are those factors that the experimenter manipulates and to which he or she assigns subjects.¹

3.8.1 Independent Variables
- Core stabilization exercises
- Stretching exercises

3.8.2 Dependent Variables
- Functional Disability
- Pain Intensity
- Lumbar Range of Flexion
- Multifidus Thickness
3.8.3 Confounding Variable

Configure variables are those aspect of a study or sample that might influence the dependent variable (outcome measure) and whose effect may be confused with the effect of the independent variable. In this study, the variables like period of treatment which is taken before the experiment, diet, lifestyle and, etc. were not controllable. Hence, these factors were considered as the confounding variable.

3.9 Measuring tools

- Oswestry Low Back Pain Disability Questionnaire (ODI) was used to evaluate Functional Disability.
- Visual analogue scale (VAS) was used to evaluate Pin Intensity.
- Modified-Modified Schober’s (MMS) test was used to evaluate Lumbar Range of Flexion.
- Ultrasound Imaging was used to evaluate Multifidus Thickness.

3.9.1 Oswestry Low Back Pain Disability Questionnaire (Appendix 1)

The restoration of normal function is considered a key outcome of physical therapy for low back problems. Physical therapists, therefore, need measurement tools that accurately assess function and monitor change over time. Activity limitations are defined in the World Health Organization's International Classification of Functioning, Disability and Health (ICIDH-2) as “difficulties an individual may have in executing activities.” Impairments such as decreased range of movement and reduced straight leg raise can be observed by therapists. However, direct observation of activity limitation is impractical, and physical therapists often rely on clients' self-report to assess the impact of low back pain on daily activities. Physical therapists routinely collect information on activity limitations in the course of their assessments, but the data may not always be collected in a standardized format that yields a measurement with known reliability and validity. Standardized self-report questionnaires provide a convenient method of collecting and synthesizing a large amount of information on activity limitation.

Many questionnaires have been developed to measure activity limitations in people with low back pain, but there is little evidence that physical therapists routinely use these tools. One of the barriers to their widespread clinical use is the proliferation of similar questionnaires.

For this study we search for a questionnaire as having potential clinical utility if it could be self-administered, was brief and easy to complete, was simple to score, and had not been shown to have serious floor or ceiling effects in a general ambulatory
clinical population. We also wanted the questionnaire to have adequate content validity (ie, relevant ICIDH-2 categories were represented) and evidence of credible construct validity and good reliability. M Davidson, PT, JL AND Keating, PT. (2002) compared Five questionnaires met these criteria: the modified Oswestry Disability Questionnaire, the Quebec Back Pain Disability Scale, the Roland-Morris Disability Questionnaire, the Waddell Disability Index, and the physical health scales of the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36). They limited the chose to 5 questionnaires because they estimated that the questionnaires would take up to 30 minutes to complete and they felt this was the most they could expect from respondents. The selected questionnaires have also been identified by other authors as suitable for use in physical therapist practice. Scores have been shown to be correlated with related variables such as pain intensity and physical impairments and have also been demonstrated to detect change in functioning over time.

They concluded Measurements obtained with the modified Oswestry Disability Questionnaire, the SF-36 Physical Functioning scale, and the Quebec Back Pain Disability Scale were the most reliable and had sufficient width scale to reliably detect improvement or worsening in most subjects. The reliability of measurements obtained with the Waddell Disability Index was moderate, but the scale appeared to be insufficient to recommend it for clinical application. The Roland-Morris Disability Questionnaire and the Role Limitations–Physical and Bodily Pain scales of the SF-36 appeared to lack sufficient reliability and scale width for clinical application.\(^7\)

High test-retest reliability coefficients have generally been reported for the scores obtained with the 5 questionnaires. For the original Oswestry questionnaire, values of \( r = .99 \) over 24 hours\(^8\) and ICC=.94 over 1 to 14 days\(^9\) are typical. Baker et al\(^10\) reported a reliability coefficient of \( r = .89 \) for a same-day test-retest of the modified Oswestry questionnaire.

The Oswestry was originally described in 1980.\(^11\) In Iran Mousavi (2006)\(^12\) in their research, to cross-culturally translate the Oswestry Disability Index (ODI), Roland-Morris Disability Questionnaire (RDQ), and Quebec Back Pain Disability Scale (QDS) into Persian, and then investigate the psychometric properties of the Persian versions produced. The ODI, RDQ, and QDS showed excellent test-retest reliability (interclass correlation coefficient =0.91, 0.86, and 0.86, respectively) (P< 0.01).

**Scoring instructions**

This comprises of 10 sections that ask questions about difficulty with lifting, walking, sitting, etc. and the effect these difficulties have on activities of daily living and social life. Each section is scored on a six-point scale (0-5), with 0 representing
no limitation and 5 representing maximal limitation. The subscales together add up to a total score of 50. The score is then doubled and interpreted as a percentage of the patient-perceived disability where the higher the score, the greater the disability. The test-retest reliability of the modified ODI has been shown to be high (ICC = .90).\textsuperscript{13}

**Interpretation of scores**

The score is calculated by the addition of the values assigned for each of the 10 individual questions and is used to categorize disability as: mild or no disability (0 to 20%); moderate disability (21% to 40%); severe disability (41% to 60%); incapacity (61% to 80%); restricted to bed (81% to 100%).\textsuperscript{14}

### 3.9.2 Visual analogue scale

According to the definition of the International Association of pain, "the pain is an emotional experience and unpleasant feeling that is in connection with injury and damage tissues"\textsuperscript{15} and has various aspects, such as intensity, perception, quality, location, duration, and acute or chronic.\textsuperscript{16} In this study we evaluated the intensity of the pain by visual analogue scale.

The visual analogue scale (VAS) is a simple and frequently used method for the assessment of variations in intensity of pain. In clinical practice the percentage of pain relief, assessed by VAS, is often considered as a measure of the efficacy of treatment.\textsuperscript{17} They are generally completed by patients themselves but are sometimes used to elicit opinions from health professionals. VAS are more sensitive to small changes than are simple descriptive ordinal scales in which symptoms are rated, for example, as mild or slight, moderate, or severe to agonizing.

The simplest VAS is a straight horizontal line of fixed length, usually 100 mm. The ends are defined as the extreme limits of the parameter to be measured (symptom, pain, health) orientated from the left (worst) to the right (best). In some studies, horizontal scales are orientated from right to left, and many investigators use vertical VAS. Scott and Huskisson reported no difference between horizontal and vertical VAS in a survey involving 100 subjects, but other authors have suggested that the two orientations differ with regard to the number of possible angles of view. Reproducibility has been shown to vary along a vertical 100-mm VAS (9) and along a horizontal VAS. The choice of terms to define the anchors of a scale has also been described as important.

VAS can be presented in a number of ways, including the following: scales with a middle point, graduations or numbers (numerical rating scales), meter-shaped scales (curvilinear analogue scales), "box-scales," scales consisting of circles equidistant
from each other (one of which the subject has to mark), and scales with descriptive terms at intervals along a line (graphic rating scales or Liker scales).

Numerical rating scales or number scales consist of numbers without a line, although the term is also sometimes used to refer to graphic rating scales. Comparisons of measurements usually show good correlations between types of scale (7, 10-14). One study analyzing the preferences of subjects for 12 different scales failed to find any universal favorite but observed that numerical rating scales with descriptive terms were preferred with regard to ease of use and accuracy of representation.

Other than in a paper by Cline et al., no recommendations have been drawn in the literature about the effect of the presentation of a VAS on its metric properties or about the consequences of choosing a particular type.18

When using this scale, the health care provider describes the meaning of pain to the patient (e.g., significant feeling of unpleasantness, distress, and significant of the experience for the individual).19

Patients were asked to rate the intensity of their pain during the last week on a visual analogue scale (VAS) consisting of a 100-mm line anchored with the words ‘no pain’ at one end and ‘unbearable pain’ at the other.20 It is a responsive pain scale that yields reliable and valid data (Figure 3.1).21

![Fig 3.1 Visual analogue scale](image-url)
3.9.3 Modified-Modified Schober’s test

In the rehabilitation of patients with prolonged back pain, the physical impairment should be assessed. As LBP has been shown to alter lumbar range of motion (ROM), there is a need to identify reliable methods for assessing lumbar ROM in patients. Lumbar ROM is often used to evaluate spinal function, select appropriate treatments, and monitor the patient's progress. It is difficult to accurately measure spinal movement because bony landmarks are often difficult to palpate due to excess soft tissue, normal curves of the spine vary from individual to individual, and the presence of hip motion may confound the spinal movement measurement. One method of measuring spinal ROM is with the use of a tape measure. The test was first described in 1937 by Dr Paul, a German physician. This technique involves using a tape measure held directly over the spine between points 10 cm above the lumbosacral junction with the patient in the neutral standing position. When the patient moves into full lumbar flexion, the increase in distance between the marks gives an estimate of spinal flexion ROM.22

After that in 1969, the modified Schober described by Macrae and Wright23 has achieved more common clinical usage. Macrae and Wright modified the original Schober method by marking a point 5 cm below and 10 cm superior to the lumbosacral junction. The rationale for this modification was an observation that on forward flexion, both the lumbosacral and 10-cm superior skin marks tended to move superiorly relative to the spinous processes and the skin was more firmly tethered at the point 5 cm lower on the sacrum. In addition, they suggested that the effect of inaccurate identification of the lumbosacral junction was minimized by adding the landmark 5 cm below the lumbosacral function. These investigators attempted to validate this method by comparing the lumbar flexion measurements of the Schober and modified Schober techniques with radiographic lumbar flexion measurements obtained from 11 subjects with and without spinal disease. One radiograph was taken while the subject was in the standing position, and the second radiograph was taken with the subject's lumbar spine flexed. Pearson Product-Moment Correlation Coefficients of .97 and .90 were found for the modified Schober and the original Schober techniques, respectively. Reliability was not addressed.

Modified Schober changed by van Adrichem JAM, van der Korst JK in 197324 and after that by Williams R, Binkley J, Bloch R, Goldsmith CH and Minuk T. in 1993.25 It's same Modified-Modified Shober Test getting covered all off the lumbar vertebral and all of the motions of lumbar region (figure 3.2).
Technique

The examiner knelt behind the standing subject and identified the posterior superior iliac spines (PSISs) by marking the inferior margins of the subject's PSISs his or her thumbs. An ink mark was drawn along the midline of the lumbar spines horizontal to the PSISs. Another ink mark was made 15 cm above the original mark. The tape measure was then lined up between the skin markings. With the tape measure pressed firmly against the subject's skin and while holding the tape measure with his or her fingertips, the therapist instructed the subject to bend forward. When the subject bent forward into full lumbar flexion, the new distance between the superior and inferior skin markings was measured. The distance between these marks after trunk flexion was measured, and the change in the difference between the marks was used to indicate the amount of lumbar flexion. Each therapist recorded measurements to the nearest 1 mm, the difference in the initial length between skin markings (15 cm) and the length measured in forward lumbar flexion. After each measurement, all skin marks were removed with rubbing alcohol.

In this method, the skin over the spine is marked at a level corresponding to the posterior superior iliac spines, and another mark is made 15 cm above. Participants were asked to stand with knees locked and to bend. Then the new distance between skin marks was measured.
3.9.4 Ultrasonography

Ultrasound has been used in medical practice since the early 1950s, when Wild and colleagues discovered the ability of high-frequency ultrasonic waves to visualize living tissues. Since then, the technique of ultrasound has rapidly evolved, leading to its widespread use in almost all fields of medicine because of its non-invasive nature and real-time display. In 1980 it was first discovered that diseased muscles showed a different ultrasound appearance compared to healthy muscles.

Muscle ultrasound is a convenient technique to visualize normal and pathological muscle tissue as it is non-invasive and real-time. Neuromuscular disorders give rise to structural muscle changes that can be visualized with ultrasound: atrophy can be objectified by measuring muscle thickness, while infiltration of fat and fibrous tissue increase muscle echo intensity, i.e. the muscles become whiter on the ultrasound image. Muscle echo intensity need to be quantified to correct for age-related increase in echo intensity and differences between individual muscles. This can be done by gray scale analysis, a method that can be easily applied in daily clinical practice. Using this technique it is possible to detect neuromuscular disorders with predictive values of 90 percent. Only in young children and metabolic myopathies the sensitivity is lower. Ultrasound is a dynamic technique and therefore capable of visualizing normal and pathological muscle movements. Fasciculations can easily be differentiated from other muscle movements. Ultrasound appeared to be even more sensitive in detecting fasciculations compared to EMG and clinical observations, because it can visualize a large muscle area and deeper located muscles. With improving resolution and frame rate it has recently become clear that also smaller
scale spontaneous muscle activity such as fibrillations can be detected by ultrasound. This opens the way to a broader use of muscle ultrasound in the diagnosis of peripheral nerve and muscle disorders. Diagnostic Musculoskeletal Ultrasonography is a useful way to detect problems for muscle, tendon and ligament pain. Ultrasound images are captured in real time, so they can often show movement, function and anatomy, further enabling the diagnoses of a variety of musculoskeletal conditions and assessment for damage to soft tissues after an injury or illness. Ultrasonography involves the sending of sound waves through the body. Those sound waves are reflected off the internal tissues. Special instruments interpret the reflections and create an image of anatomic parts. No ionizing radiation (x-ray) is involved in ultrasound imaging.29

In physics, the term "ultrasound" applies to all sound waves with a frequency above the audible range of human hearing, about 20 kHz. The frequencies used in diagnostic ultrasound are typically between 2 and 18 MHz.30

What does the equipment look like?

Ultrasound scanners consist of a console containing a computer and electronics, a video display screen and a transducer that is used to do the scanning. The transducer is a small hand-held device that resembles a microphone, attached to the scanner by a cord. The transducer sends out inaudible high frequency sound waves into the body and then listens for the returning echoes from the tissues in the body. The principles are similar to sonar used by boats and submarines (Figure 3.4).31
The ultrasound image is immediately visible on a video display screen that looks like a computer or television monitor. The image is created based on the amplitude (strength), frequency and time it takes for the sound signal to return from the area of the patient being examined to the transducer and the type of body structure the sound travels through.31

**How does the procedure work?**

Ultrasound imaging is based on the same principles involved in the sonar used by bats, ships, fishermen and the weather service. When a sound wave strikes an object, it bounces back, or echoes. By measuring these echo waves, it is possible to determine how far away the object is and its size, shape and consistency (whether the object is solid, filled with fluid, or both). In medicine, ultrasound is used to detect changes in appearance of organs, tissues, and vessels or detect abnormal masses, such as tumors.31

In an ultrasound examination, a transducer both sends the sound waves and receives/records the echoing waves. When the transducer is pressed against the skin, it directs small pulses of inaudible, high-frequency sound waves into the body. As the sound waves bounce off of internal organs, fluids and tissues, the sensitive microphone in the transducer records tiny changes in the sound's pitch and direction. These signature waves are instantly measured and displayed by a computer, which in turn creates a real-time picture on the monitor. One or more frames of the moving pictures are typically captured as still images. Small loops of the moving “real time” images may also be saved.31

**How is the procedure performed?**

For most ultrasound exams, the patient is positioned lying face-up or face down on an examination table that can be tilted or moved. A clear water-based gel is applied to the area of the body being studied to help the transducer make secure contact with the body and eliminate air pockets between the transducer and the skin that can block the sound waves from passing into your body. The sonographer (ultrasound technologist) or radiologist then presses the transducer firmly against the skin in various locations, sweeping over the area of interest or angling the sound beam from a farther location to better see an area of concern.

When the examination is complete, the patient may be asked to dress and wait while the ultrasound images are reviewed.31
What are the benefits vs. risks?

Benefits

- Most ultrasound scanning is noninvasive (no needles or injections) and is usually painless.
- Ultrasound is widely available, easy-to-use and less expensive than other imaging methods.
- Ultrasound imaging does not use any ionizing radiation.
- Ultrasound scanning gives a clear picture of soft tissues that do not show up well on x-ray images.
- Ultrasound is the preferred imaging modality for the diagnosis and monitoring of pregnant women and their unborn babies.
- Ultrasound provides real-time imaging, making it a good tool for guiding minimally invasive procedures such as needle biopsies and needle aspiration.\(^\text{31}\)

Risks

- For standard diagnostic ultrasound there are no known harmful effects on humans.\(^\text{31}\)

In this research ultrasound imaging cross-sectional area (CSAs) of the multifidus muscle was measured between L5 – S1 vertebral. Multifidus muscle thickness were assessed using a 7.5 MHz B-mode transducer ultrasound (Sonoline Adara; Siemens Medical System, Inc; Issaquah, WA, USA)\(^\text{32}\) which a high resolution for muscle examination can be achieved.\(^\text{33}\) Reliability of performing these measures has been previously reported\(^\text{34}\) and previous clinical trials have shown the highly trained assessor in the present study to be repeatable and reliable with ultrasound measurements of the multifidus muscle.\(^\text{35}\) The validity of measurements obtained using ultrasound imaging has also been demonstrated by comparison with MRI measurements.\(^\text{36}\)
3.10 Statistical tools

Data analysis was performed using SPSS version 18. Paired t-tests were used for comparison between pretest and posttest in experimental groups. Furthermore, for comparing groups before intervention and after intervention was used ANOVA followed by Post Hoc Tests. A p-value lower than 0.05 was accepted as being statistically difference.

3.11 Treatment programs

3.11.1 Core Stabilization program (appendix 2)

Core Stabilization exercise program consisted of three parts. In the first part, the patients have done some exercises with stabilizer tool, and it was including the resistance exercises. The main aim of this part was enhancing the endurance and strength of the core muscles. The second part of the core stabilization program was including the Static Floor Exercises. The main aim of this part was enhancing the cooperating of the muscles for maintenance of the core stability of the back structure in static position. And the third part was consisted of Dynamic Floor Exercises. The main aim of this part was enhancing the balance of the back muscles to protect of the back structure in dynamic position.
Part one: Exercises with stabilizer tool

The stabilizer was designed by physical therapists to detect spinal movements during exercise. It is very similar to a blood pressure monitor where the pressure is measured in the blue air-filled bag that is attached to a gauge and pump. Core stability is about re-teaching the transverse abdominis and lumbar multifidus muscles to contract together to provide support to the lumbar spine (Figure 3.6).  

![Stabilizer tool](image1.png)

Fig 3.6 stabilizer tool

The stabilizer is a simple device used to provide feedback to ensure quality, and precision in exercise performance and testing. Monitors position of the low back and provides feedback when the abdominal muscles are not actively or effectively protecting the spine. The Stabilizer is principally used for exercises that focus on the protection and stabilization of joints. Research has shown these types of exercise are especially important for the prevention and treatment of low back and neck pain (of various pathologies). The exercise techniques involve slow and controlled body movement. The Stabilizer is used to monitor and provide feedback on this body movement during exercise. This promotes effective exercise to improve back and neck pain. The deep muscle system in the lumbar spine and pelvic region is directly responsible for stabilizing vertebral segments and sacroiliac joints. The larger, more superficial muscles are underactive in low back pain and the more superficial muscles are often overactive. In order to retrain the deep muscles, specific exercise and overactive testing with the stabilizer is needed.
Exercises with stabilizer:
- Lying on back
- Lying on abdomen
- Sitting Upright
- Lying on back (controlled leg movement)
- Lying on side

**Lying on back**

a) Place the three-chamber pressure cell under the lumbar spine and inflate to a baseline of 40 mmHg (orange band).
b) Draw in the abdominal wall without moving the spine or pelvis.
c) Pressure should remain at 40 mmHg (i.e. no movement of the spine).
d) Hold for 10-15 seconds; breathe normally.
e) Perform 10 repetitions.

Attention: this exercise Training the Corset Action of Transversus Abdominis in Supine (Figure 3.7).

**Fig 3.7 lying on back**

**Lying on abdomen**

a) Place the three-chamber pressure cell under the abdomen and inflate to a baseline of 70 mmHg. (Brown band)
b) Draw abdominal wall up and in without moving the spine or pelvis.
c) Pressure should decrease 6-10 mmHg.
d) Hold 10-15 seconds, breathe normally.
e) Perform 10 repetitions.
Attention: this exercise for Transversus Abdominis and Internal Oblique (Figure 3.8).³⁹

**Fig 3.8 lying on abdomen**

**Sitting Upright**

a) Place the three-chamber pressure cell behind the lumbar spine and inflate to baseline of 40 mmHg. (Orange band)
b) Draw in abdominal wall without thoracic or pelvic movement.
c) Pressure should increase 8-10 mmHg.
d) Lift one leg slowly to test position with the other leg unsupported (i.e., no stool). Pressure should remain constant at 48-50 mmHg.
e) Hold for 5 seconds.
f) Perform 10 repetitions.

Attention: this exercise improves the strength of Iliopsoas muscle (Figure 3.9).³⁹
Fig 3.9 Sitting Upright

Lying on back (controlled leg movement)

a) Place the three-chamber pressure cell behind the lumbar.

b) Spine and inflate to baseline of 40 mmHg (orange band).

c) Draw in the abdominal wall without moving the spine or Pelvis.

d) Pressure should remain at 40 mmHg (i.e. no movement of the spine) while leg lifts.

e) Hold for 10-15 seconds; breathe normally.

f) Repeat 10 times with each leg.

Attention: this exercise Training the Corset Action of Transversus Abdominis in Supine (Figure 3.10).39

Fig 3.10 Lying on back (controlled leg movement)
Lying on side
a) Have patient lying on their side.
b) Place pressure cell between lateral trunk (lumbar spine level) and supporting surface.
c) Inflate pressure cell to 40 mmHg. (orange band)
d) Maintain lumbo-pelvic stability by maintaining pressure at 40 mmHg during the stretching maneuvers.

Attention: this exercise Training the Lower Trapezius (Figure 3.11)\textsuperscript{39}

Fig 3.11 Lying on side

Part two: Static floor exercises

The points should note when doing core stability exercises:

- Do not let your whole stomach tense up. If your upper abdominable muscles “bulge” outwards it means you have cheated by using the large rectus abdominus (six pack) instead of the transverses abdominus (lower abdominals).
- Do not brace your lower abdominals too hard; a gentle contraction will suffice. You are trying to improve endurance rather than maximum strength. Only clench them about 50%.
- Do not hold your breath as this is a signal that you are not relaxed. You must learn to breathe normally.\textsuperscript{40}

Static floor exercises:

- Abdominal Hollowing
- Lying on back
- Lying on abdomen
- Sitting Upright
- Lying on back (controlled leg movement)
- Lying on side
**Abdominal Hollowing**

a) Lie flat on the floor with your knees bent.

b) Using your abdominal muscles, draw your belly button straight backwards approximately 2 inches toward your spine.

Attention: Abdominal Hollowing-This is the basis for many core strengthening exercises. It is important not to just suck your stomach in, this does nothing. When you do it, if you push on your abdominal muscles you should feel them tightening. Hold this for a few seconds and relax. Repeat this 10 times and do 3 sets (Figure 3.12).

![Abdominal Hollowing](image)

**Fig 3.12 Abdominal Hollowing**

**Lying on back**

a) Lie on your back with your legs together and your arms by your sides.

b) Keeping your legs straight, lift your heels approximately 4 inches off the floor.

c) Hold for 1 minute

Attention: Do not allow your back to arch. The small of your back should be flat on the floor (Figure 3.13).

![Lying on back](image)

**Fig 3.13 Lying on back**
Lying on back (controlled leg movement)
a) Lie with your back flat on the floor and your legs raised above your hips.
b) Lower your legs for 30 seconds until the heels are about 4 inches from the floor. Without allowing your heels to touch down, raise them for another 30 seconds.

Attention: Keep your legs straight and do not allow your back to arch. Try not to move too quickly (Figure 3.14).40

Hamstring Raises
a) Start in a quadruped position (on your hands and knees).
b) Tighten your core and contract your abs to stabilize the spine.
c) Focus on contracting the left glute. You may need to place your hand on your glute to be sure it contracts.
d) Slowly lift the left leg up while keeping a 90-degree bend at the knee.
e) The left thigh should be nearly parallel with the ground.
f) Slowly lower to the start position and repeat 10 reps per side.
g) To increase the intensity of this exercise, place a small dumbbell behind your knee or add an ankle weight.
h) Return the leg to the floor and repeat.40

Attention: this exercise to wake up your glutes, use the hip extension exercise. In order to isolate the glutes and reduce hamstring involvement,42 Complete 15 repetitions one one leg, and the repeat on the other leg (Figure 3.15).
Fig 3.15 Hamstring Raises

**Hundreds**

a) Lie on your back with your arms by your sides. Raise your legs and bend them so that you form a right angle at your hips and knees.

b) Keeping your arms straight and lifting your hands no more than a few inches, gently tap the floor 100 times.

Attention: Focus on keeping your hips and legs completely still and your back flat (Figure 3.16). ⁴⁰
Hip Bridge (superman)

a) Balance on the floor on your hands and knees. Your back should be flat and hips parallel to the floor.
b) Raise your right arm out in front of you and raise your left leg out behind you, keeping it straight.
c) Hold for 30 seconds and then repeat on the other side.

Attention: Concentrate on keeping completely still with your hips square and your back flat (Figure3.17).40

Back Plank

a) Assume a front-support position resting on your fore-arms with your shoulders directly over your elbows.
b) Straighten your legs out behind you and lift up your hips to form a dead-straight line from your shoulders to your ankles. You should be balanced on your fore-arms and toes, with your lower abdomen and back working to keep your body straight. Hold for 1 minute.

Attention: Aim to be able to hold this position for 3 x 1 minute (Figure3.18).40
Side Plank

a) On your side, balance on your right fore-arm with your shoulder above your elbow.

b) With your legs out straight to the left, lift your pelvis so that you are balanced on your fore arm and feet. Your body should form a straight line and you should feel the oblique muscles down the side of your trunk working to maintain the position.

c) Hold for 1 minute then repeat on other side.

Attention: You may find it easier to balance if you hold your free arm out. This will also make the exercise a bit easier by altering the distribution of your weight (Figure 3.19).

![Fig 3.19 Side Plank](image)

Part three: Dynamic floor exercises

Dynamic floor exercises:
- Side lying hip abduction
- Oblique crunch
- Dynamic Leg and Back
- Leg Extensions
- Lying windscreen wipers

Side lying hip abduction

a) While lying on your side keep both knees bent and flex the hips to 30 degrees.

b) While keeping your heels touching and pelvis still, open your knees by contracting your glute medius. This is a very slow, small and targeted movement.
c) Place your hand on your gluteus medius (just below and behind your hip) to ensure that it is firing during the movement.

d) Repeat the movement slowly 10 to 15 times and switch sides.

Attention: this exercise for glute activation specifically targets the gluteus-maximus, the prime mover during hip extension (Figure 3.20). 43

Fig 3.20 Side lying hip abduction

**Oblique crunch**

a) Lie on your back. Raise your legs and bend them so that you form a right angle at your hips and your knees. Place your hands gently on the side of your head.

b) Lift your shoulders off the floor and twist, reaching your right elbow towards your left leg.

c) Return to the floor then repeat, twisting in the opposite direction. Take care not to rock. Your hips and legs should stay as still as possible, allowing your trunk to do all of the work.
Attention: Aim to complete 3 x 30 crunches (15 on each side per set) with 30 seconds of recovery between sets (Figure 3.2).

Fig 3.21 Oblique crunch

**Dynamic Leg and Back**

a) Assume the same position as for the “Static leg and back”.

b) Lower your pelvis but do not allow it to tilt or touch the floor. This should be a slow, controlled movement.

c) Return to the original position, restoring the straight line from shoulders to toe.

Attention: Aim to complete 10 on each leg. Stop if you feel your hamstring tighten (Figure 3.22).
**Fig 3.22 Dynamic Leg and Back**

**Leg Extensions**

a) Lie on your back. Raise your legs and bend them so that you form a right angle at your hips and knees.

b) Keeping your hips completely still, lower and straighten out one leg so that your heel is about 4 inches from the floor. The movement should be slow and controlled.

c) Return to the original position and repeat on the other leg.

Attention: Aim to complete 10 on each leg. Breathing normal and keep your stability along with the movement (Figure3.23).  

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**Fig 3.23 Leg Extensions**

**Lying windscreen wipers**

a) Lie on the ground with your arms outstretched to your sides.

b) Bring your knees to your chest.
c) Beginners can keep their knees bent, advanced should straighten their legs out.

d) With a slow and controlled motion, lower your legs to one side of your torso until your thigh reaches the floor.

e) Then raise your legs back up to center and then down to the opposite side.
   Repeat 10-20 times to each side.

f) Exhale as you lift your legs, inhale as you lower them.

Attention: You can put any amount of bend in your knees depending on how hard you want to work. The more bend, the easier (Figure 3.24).44

Fig 3.24 Lying windscreen wipers

3.11.2 Stretching program

Stretching exercises should focus on achieving flexibility and elasticity in the disc, muscles, ligaments, and tendons. Additionally, it is important to activate and strengthen muscles not directly involved with the injured area. For example, the hamstring muscles play a role in lower back pain, as it is clear that hamstring tightness limits motion in the pelvis and can place it in a position that increases stress across the low back. Any form of inactivity, especially where an injured back is involved, is usually associated with some progressive stiffness. Therefore, it is necessary to push the range of motion as far as can be tolerated (in a controlled manner). Patients with chronic pain may find it takes weeks or months of stretching to mobilize the spine and soft tissues, but will find that the increase in motion provides meaningful and sustained relief of their back pain.45

With regard to this point the exercises of stretching program have done in for four parts of the body waist, back, hip and thighs.
Part one: Back stretching exercises

A strong lower back keeps us upright against the force of gravity and also functions as a shock absorber, softening the impact when our feet hit the ground. Both prolonged sitting and standing can tighten and stiffen the lower back muscles. These stretches will improve suppleness and relieve muscle stiffness. If you experience discomfort when performing a stretch, come out of it immediately.

Back stretching exercises:

- Seated head curl
- Knees to chest
- Hamstring with crossed arm
- Crossover reach back

Seated head curl

a) Sit slightly forward on a chair, your feet flat on the floor. Sit up straight, tighten your abdominals, and grasp the backs of your thighs.

b) Tuck your chin into your chest, rotating your head down as if an imaginary axis runs through your ears. Round your back, caving your chest, and gently pull with your arms to curl your head toward your knees. Pull your navel into your spine and hold for 2 breath cycles. Slowly uncurl to the upright sitting position.

Attention: This is a good basic back stretch that you can do anywhere there’s a chair. Curve your back by pulling your navel into your spine as you roll your head toward your knees. Think of your pelvis anchoring down into the seat and the crown of your head reaching up and over a fence to help you to round your back (Figure 3.25).46

Fig 3.25 Seated head curl
Knees to chest

a) Lie on your back with your knees bent. Tighten your abdominals and lift your thighs toward your chest. Gently press your lower back into the floor as you reach forward and grasp your thighs.

b) Exhale and gently tuck your chin into your chest as you take hold of your shins and curl your head forward. Bring your shoulders toward your heels, and hold for 2 breath cycles, and then relax down.

Attention: Another basic back stretch, the key again is to tuck your chin into your chest as you curl up and pull your abdominals in. Imagine making yourself into a perfectly round ball. You might want to place a folded towel or pillow under your shoulders to make this stretch more comfortable (Figure 3.26).

Fig 3.26 Knees to chest

Hamstring with crossed arm

a) Pull your navel into your spine, lift your pelvic floor, and exhale as you tuck your chin into your chest and roll down to a comfortable position.

b) Cross your arms and hold onto your upper arms or elbows, round your back, so that you are looking at your navel.

Attention: Don’t allow yourself to tip forward. Hold for 2 breath cycles, and then slowly roll back up (Figure 3.27).
Crossover reach back

a) Stand with your feet about hip width apart. Exhale as you tuck your chin into your chest, bend your knees slightly, and roll your spine down to a comfortable position. Reach down with your arms. Be sure to keep your abdominals tucked in.

b) Reach across and grasp your right ankle with your left hand as you reach your right hand behind you toward the floor. Press down with your left hand to help support your hanging body weight. Hold for 2 breath cycles, and then use your hands to help you to roll back up to upright. Repeat the stretch on the other side.

Attention: This advanced stretch opens both the lower back and the deep muscles of the pelvis. Be sure to hold your abdominals firmly into the spine and to
keep the groin lifted for support throughout the whole stretch. Come out of the stretch immediately if you experience any dizziness or if you feel light-headed (Figure 3.28).  

![Crossover reach back](image)

**Fig 3.28 Crossover reach back**

**Part two: Waist exercise stretching**

The corset-like muscles of the waist protect the vital organs, support the spine, and connect the upper and lower bodies. The waist is the malleable part of the torso that enables the bony structures of the ribcage and pelvis to twist in different directions. The waist has a tendency to slump and collapse; regular stretching can help to lengthen the muscles so that they can be properly strengthened.

**Waist stretching exercises:**

- Standing waist twist
- Seated waist stretch
- Lying waist twist

**Standing waist twist**

a) Stand with feet about hip-width apart. Place your right hand, fingers pointing down, firmly on the right side of your lower back.

b) Pull your navel into your spine and, leading with your left hand, twist diagonally up and around to the right.

c) Repeat, twisting to the other side.
Attention: Feel a good stretch in the left side of your waist and up the body. Hold for 2 breath cycles, then release (Figure 3.29).

**Seated waist stretch**

a) Sit slightly forward on a chair, feet flat on the floor. Reach up with your right hand; hold onto the chair with your left hand.

b) Press down on the chair with your left hand as you stretch your right hand up and over your head. Imagine that your back is flat against a wall. Hold for 2 breathe Cycles and then release. Repeat on the other side.

Attention: To get the full benefit of this stretch, elongate both sides of the torso as you reach up. Focus on stretching up and then over as you reach to the side. Gaze ahead and hold yourself back to keep from leaning forward (Figure 3.30).
Lying waist twist

a) Lie on your back. Extend your arms at your sides, and hold your abdominals firms as you cross your right knee over toward the floor on your left side. Bend your left leg slightly. Press your right knee toward the floor while pushing your right hip forward. Hold for 2 breath cycles, then gently release.

b) Repeat on the other side (Figure 3.31).
Part three: HIP stretching exercises
The muscles surrounding the hip joints and pelvis are dense due to the fact that they must bear the weight of the entire upper body. We have both deep hip flexors, muscles that run from the front of the spine to the top inner thigh, and superficial hip flexors, which run from the hip bone to the knee.46

The Hip stretching exercises:
- Front hip stretch
- Side Hip stretch
- Leg-cross hip stretch

Front hip stretch
a) Place you hands on your hips, and step forward with your left foot. Stand with one leg forward, both knees slightly bent.
b) Tuck your pelvis under and lift your back, right heel, bending your leg slightly. Lean back on to the toes of your right foot to isolate the muscles at the front of the hip. Hold for 3 breath cycles, then release and repeat on the other side.

Attention: This stretch targets both the deep and the superficial hip flexors. Feel it by tucking your pelvis under (Fig 3.32).46
Side hip stretch

a) Stand with your left leg crossed in front of your right, the toes of your left foot touching the floor. Raise your right arm up, and place your left hand on the left side of your pelvis.

b) Tighten your abdominals and stretch over to the left as you push in with your left hand. Feel the stretch in the right side of your pelvis. Hold for 4 breath cycles, then release and repeat on the other side (Figure 3.33).

Leg-cross hip stretch

a) Sit comfortably with your legs crossed so that your right ankle is on your left thigh.

b) Pull your right ankle toward your left shoulder. Feel the stretch on the outside of your right hip and hold for 4 breath cycles and then release. Repeat on the other side.

Attention: This stretch targets the muscles around the hip joints. It helps to improve flexibility and strength necessary for hip stability (Figure 3.34).
Part four: Thighs stretching exercises

The large muscles on the tops of the thighs, the quadriceps (quads), are called the bully of the body because they tend to dominate leg movements. Tight quads can cause painful knees, while the hamstrings in the backs of the thighs tend to cause lower back problems if they are not stretched. The inner thighs help to support the spine; it is essential that they are stretched and equally balanced too.

The Thighs stretching exercises:

- Standing quad stretch
- Outer thigh stretch
- Supported hamstring
- Lying hamstring stretch

Standing quad stretch

a) Standing, bend your right leg and reach back with your right hand to grasp your right foot. Gently pull your right heel in toward your buttock.

b) Tuck your pelvis under and line up your knees. Reach up with your left arm and balance for 3 breath cycles. Repeat on the other side.

Attention: This is the basic quad stretch. Keep your bent knee aligned under your pelvis, and be careful not to let it veer to the side. As you stretch, avoid pulling too hard on the foot. You should not experience any knee pain. If you have difficulty balancing, rest your free hand on a wall or chair for support (Figure 3.35).
Outer thigh stretch
a) Sit comfortably with your legs crossed. If you can, line your knees up on top of each other. Firmly grasp a foot in each hand. Be sure to cross your legs only as far as is comfortable.

b) Gently pull up and back on your feet, and bend your head slightly forward, if you can. Feel a strong stretch along the side of your top leg. Hold for 4 breath cycles. Repeat with your legs crossed the other way. (Figure 3.36).
**Fig 3.36 Outer thigh stretch**

**Support hamstring stretch**

a) Stand on your left foot and place your right heel on a support that is ideally no higher than mid thigh. The knee of your raised leg should be comfortable for this advanced stretch.

b) Place your hands on your right thigh, lengthen your torso, and lean forward over your propped up leg. Hold for 4 breath cycles and Release. Repeat on the other side (Figure 3.37).  

**Fig 3.37 Support hamstring stretch**
Lying hamstring stretch

a) Lie down and gently pull your right leg toward you with your left leg slightly bent on the floor. Tuck your chin into your chest to help support your neck and spine, and flatten your abdominals, pulling them in. If performing just this step of the stretch, hold for 4 breath cycles, then release.

b) Repeat on the other leg.

Attention: provides a simple and effective hamstring stretch and can be performed on its own, if preferred (Figure 3.38).46

![Fig 3.38 Lying hamstring stretch](image-url)
Reference


