CHAPTER III
MATERIALS AND METHODS

3.1 Subjects

The 137 healthy Thai females aged between 18 and 25 years participating in this study. All of them received subjective examination and were explained about objectives and process of testing. Each subject signed an informed consent. This study was approved by the Ethical Committee, Huachiew Chalermprakiet University, Bangkok, Thailand.

Subjects were screened to exclude those with history of low back pain within three months prior to participating in the study or those having had abdominal or back surgery within the previous year. Subjects, therefore were screened to exclude if they had scoliosis, pregnant or having a baby and ever previously participated in a specific stabilizing exercise intervention.

Inclusion criteria

Subjects were recruited on the basis that:

1. BMI between 18.5-23 kg/m^2
2. Having normal range of motion of spine, hip, knee and ankle joints.
3. No neurological problem.
4. No activities or exercises involved in stability of lumbar spine.

Exclusion criteria

Subjects were excluded from the study if they have the following criteria:

1. History of low back pain within three months prior to participating in the study.
2. Abdominal or back surgery within the previous year.
3. Scoliosis
4. Pregnant or having a baby.
5. Previously participated in a specific stabilizing exercise intervention.
6. Could not understand and follow commands.

3.2 Instrumentation

1. Pressure biofeedback unit (Stabilizer, Chattanooga) consists of an inelastic, three-section air-filled bag of which sections of the cushion communicate with one another. The air-filled bag is inflated to fill the space between target body area and a firm surface. The pressure gauge is marked in increment of 2 mmHg. It is used to read the pressure in the bag for feedback about position as shown in Figure 3.1.

Figure 3.1 Pressure biofeedback unit (Stabilizer).

2. Goniometer
3. Timer
4. Table
5. Mat
6. Pillow
7. Stand and bar

3.3 Procedure

The 157 subjects received the explanation about the detail in every step of the method. Each subject was asked to sign an informed consent. All subjects were tested three times by the same investigator.

The lumbar stabilization exercise program was used for testing. The exercise program was modified from literature review and was tested by the subjects who had similar characteristic to the subjects in the present study[20]. Ordinal level measurement was assigned based on the subject's performance in isometric

contracting the abdominal and back muscles in order to hold pelvic and lower trunk stable. The load was progressively increased by lower extremities movement in more advance levels. A series of six progressive exercises test (Level 1: Abdominal hollowing, Level 2: Unilateral abduction, Level 3: Unilateral knee extend, Level 4: Unilateral knee raise, Level 5: Bilateral knee raise and Level 6: Bilateral knee raise together) was designed orderly by increasing levels of muscular control of the lumbar spine for stability. The exercise is ordered according to the progression of the magnitude of torque at each level.

Initially, all participants started to perform the test from level one to level six. The subject was required to perform the exercise testing without changing the pressure gauge dial. While performing the exercise, subjects were not allowed to have any of these compensations, which included flexion or extension of the neck, elevation of the shoulders from the floor, protrusion of the rectus abdominis, extension of lumbar spine and posterior tilting of the pelvis and elevate rib cage (holding the breath) [9].

The researcher monitored the pressure gauge dial to control the movement of body part of subject from compensation as previously mentioned and to determine whether the subject completed or incompleted exercise level. The subject test's score was the highest-level exercise, which the subject could perform successfully. For example, if subject got a score of 3 on lumbar stabilization exercise program that meant the subject could perform lumbar stabilization exercise program at the third level successfully but incomplete in the fourth level. If the subject got score of 0 on lumbar stabilization exercise program, it meant that subject did not pass the exercise level one. All participants were asked to perform the test up to level six, therefore, they were blinded to which level they could attain.

Training before test

All subject received 10 minutes for training session before the pretest. Training exercise assisted subjects to learn how to use back muscle as well as abdominal muscle to stabilize the lumbar spine before the test. Moreover, this training helped subjects to be accustomed to pressure transducer before the test. The training session before test consisted of abdominal breathing and quadruped abdominal hollowing (Figure 3.2 and 3.3).

A: Abdominal breathing

Subjects were in supine lying with knee bent and feet flat on the floor. The researcher laid the weigh or book approximately 1 kg on the belly and below the navel. Subjects took one hand on the chest and another hand on the abdomen. When subjects inhaled, they kept their chest stable while abdominal expands. When they exhaled, they let abdominal recoil toward the spine and continued this pattern for 5 minutes.

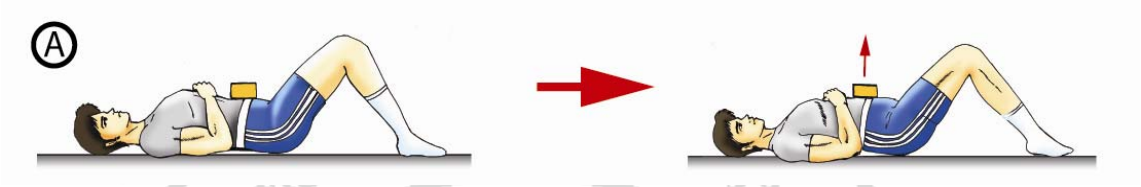

Figure 3.2 Training before test, A: abdominal breathing

B: Quadruped abdominal hollowing

Subjects were in quadruped on the floor with hips and shoulders flexion approximately 90^{o}, spine in neutral position. When subjects inhaled, they permited belly to drop. While they exhaled, they tugged belly to the spine and did not allow spine to move. They continued to breathe in this pattern for 5 minutes.

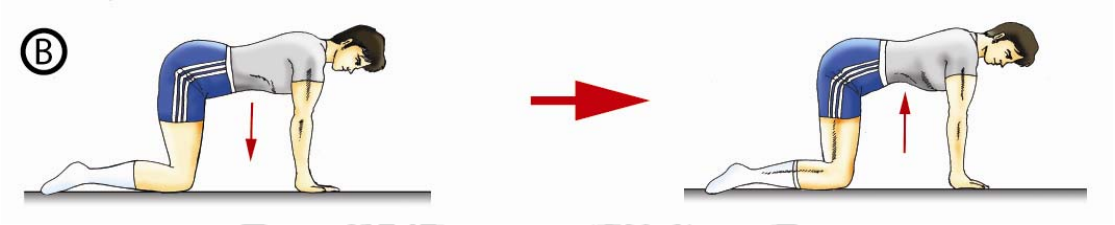

Figure 3.3 Training before test, B: quadruped abdominal hollowing

Subject then performed abdominal hollowing in crook lying position. They practiced the exercise testing with pressure transducer for exercise level 1 to 6 in lumbar stabilization exercise program (Figure 3.4).

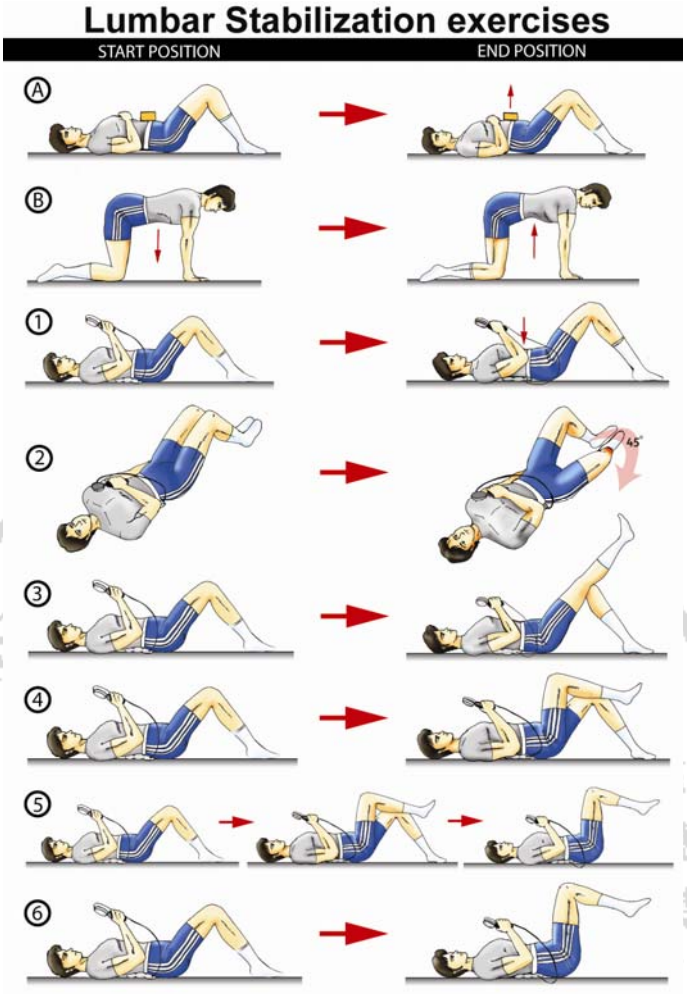

Figure 3.4 Training before test A and B (abdominal breathing and quadruped abdominal hollowing) and exercise levels 1-6

Each subject performed test in a crook lying position (supine with knees flexion approximately 90^{o} and feet flat on the floor). The researcher put pressure transducer under subject's low back by setting the lower rim at S_2, the upper rim at L_1 [53]. The subject was told to relax muscles around pelvis and adjusted the spine into neutral position as shown in Figure 3.5. After that the researcher pumped up the pressure of pressure transducer to 40 mmHg [7].

Figure 3.5 Position of subject and placement of stabilizer when performed the test.

Testing

While the subjects performed level 1, they maintained the pressure at 40 mmHg (± 4 mmHg) [9] which was visible to both subject and the researcher. They sustained that pressure during three cycles of normal breathing without compensation. The subjects who could perform abdominal hollowing and maintain pressure were able to reach this level. After that, they were allowed to continue with exercise level 2 or higher level until level 6, therefore, they were blinded to which level they could attain. The highest exercise level attained that subjects could perform were record. Each level of exercise series test was repeated three times by the same investigator.

At all levels, subjects were asked to maintain the pressure at 40 mmHg (± 4 mmHg) and started to perform the exercises. The degrees of difficulty of the test exercise were as follows:

Level 1: Abdominal hollowing

Subjects were in supine position with knees flexion and feet flat on the floor. They placed their hands on lower abdomen below navel, and felt their muscle contraction. They were asked to imagine the feeling created in abdomen while inhaled. When exhaled, they were asked to imagine to bring belly to the spine (Figure 3.6). Subjects tried to maintain pressure with breathing normally. They performed this exercise for 3 breathing cycles.

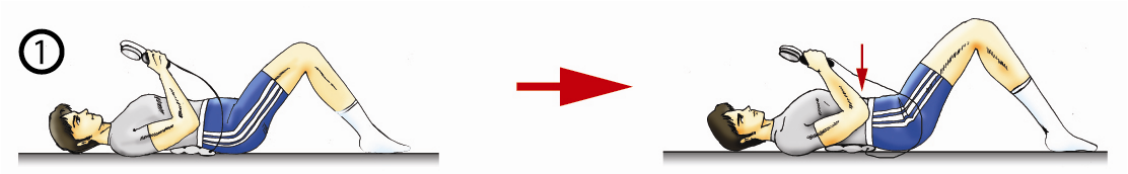

Figure 3.6 Level 1: Abdominal hollowing

Level 2: Unilateral abduction

Subjects were in supine position with knees flexion and feet flat on the floor. They performed the abdominal hollowing by contracted abdominal muscles. While maintaining these contractions, they were advised to abduct their right leg to approximately 45^{o} in relation to the floor during left knee motionless. After that, they put their right leg to the starting position (Figure 3.7). Each subject was asked to continue a normal breathing pattern throughout the exercise. Subjects performed this exercise for 3 breathing cycles.

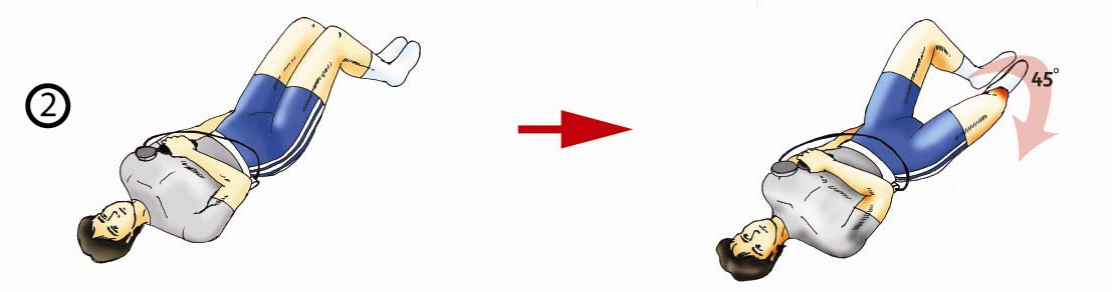

Figure 3.7 Level 2: Unilateral abduction

Level 3: Unilateral knee extend

Subjects performed exercise in supine position with knees flexion and feet flat on the floor. They performed the abdominal hollowing by contracted abdominal muscles. While maintaining the contraction of abdominal muscles, they were asked to extend their right knee joint to zero degree and controlled the thigh in the same level both sides. Then they put their right leg to the starting position (Figure 3.8). Subjects were advised to keep normal breathing throughout the exercise. They performed this exercise for 3 breathing cycles.

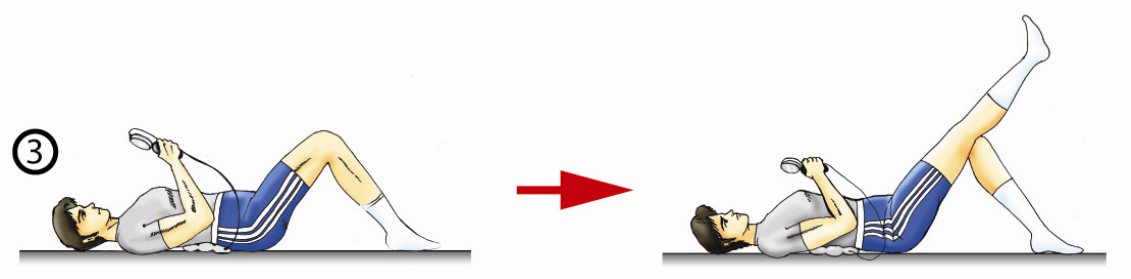

Figure 3.8 Level 3: Unilateral knee extend

Level 4: Unilateral knee raise

Subjects lay in supine position with knees flexion and feet flat on the floor. They performed the abdominal hollowing by contracted abdominal muscles. While the subjects were maintaining these contraction, they were asked to raise their right leg toward chest until it just passed hip flexion approximately 90^{o} and allowed the knee to flex naturally. While subjects performed the lift, they did not allow to move the left leg, head, neck and shoulders. After that, they put their right leg to the starting position (Figure 3.9). Subjects performed this exercise for 3 breathing cycles and breath normally.

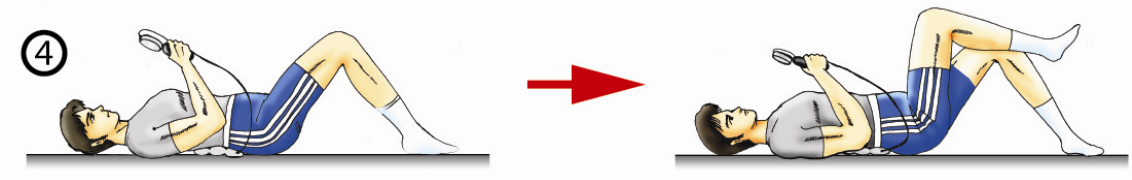

Figure 3.9 Level 4: Unilateral knee raise

Level 5: Bilateral knee raise

Subjects were in supine position with knees flexion and feet flat on the floor. They contracted abdominal muscles. While maintaining these contraction, each subject was asked to raise right leg toward chest until it just passed hip flexion approximately 90^{o} with knee to flexion position. The subjects held their right leg in this position and then raised the left leg in the same manner therefore both legs were elevated. They put their right leg to the starting position followed by left leg (Figure 3.10). Subjects were instructed to breath normally throughout the exercise. Subjects performed this exercise for 3 breathing cycles.

Figure 3.10 Level 5: Bilateral knee raise

Level 6: Bilateral knee raise together

Subjects were in supine position with knees flexion and feet flat on the floor. They recreated the abdominal hollowing by contracted abdominal muscles. While maintaining these contractions, they raised their both legs toward chest until just passed hip flexion approximately 90^{o} with knee flex naturally. Subjects continued to breath normally and did not allow moving head, neck or shoulders. Then, they put their both legs to the starting position together (Figure 3.11). Subjects performed this exercise for 3 breathing cycles.

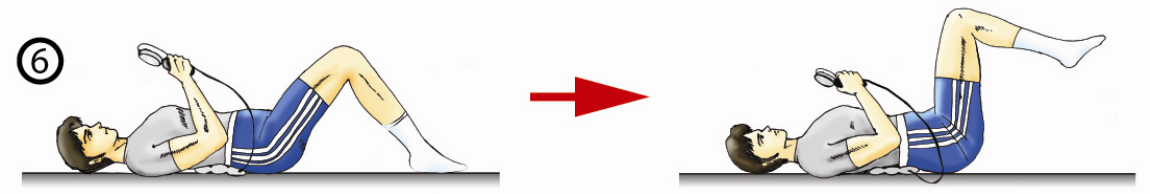

Figure 3.11 Level 6: Bilateral knee raise together

3.4 Data Analysis

The dependent variable was the score on lumbar stabilization exercise program (exercise level attained). The dependent measures ranged from zero to six, which represented the highest level of lumbar stabilization exercise. The highest exercise level attained of each subject were analyzed by using median value and interquartile ranges of exercise level attained.

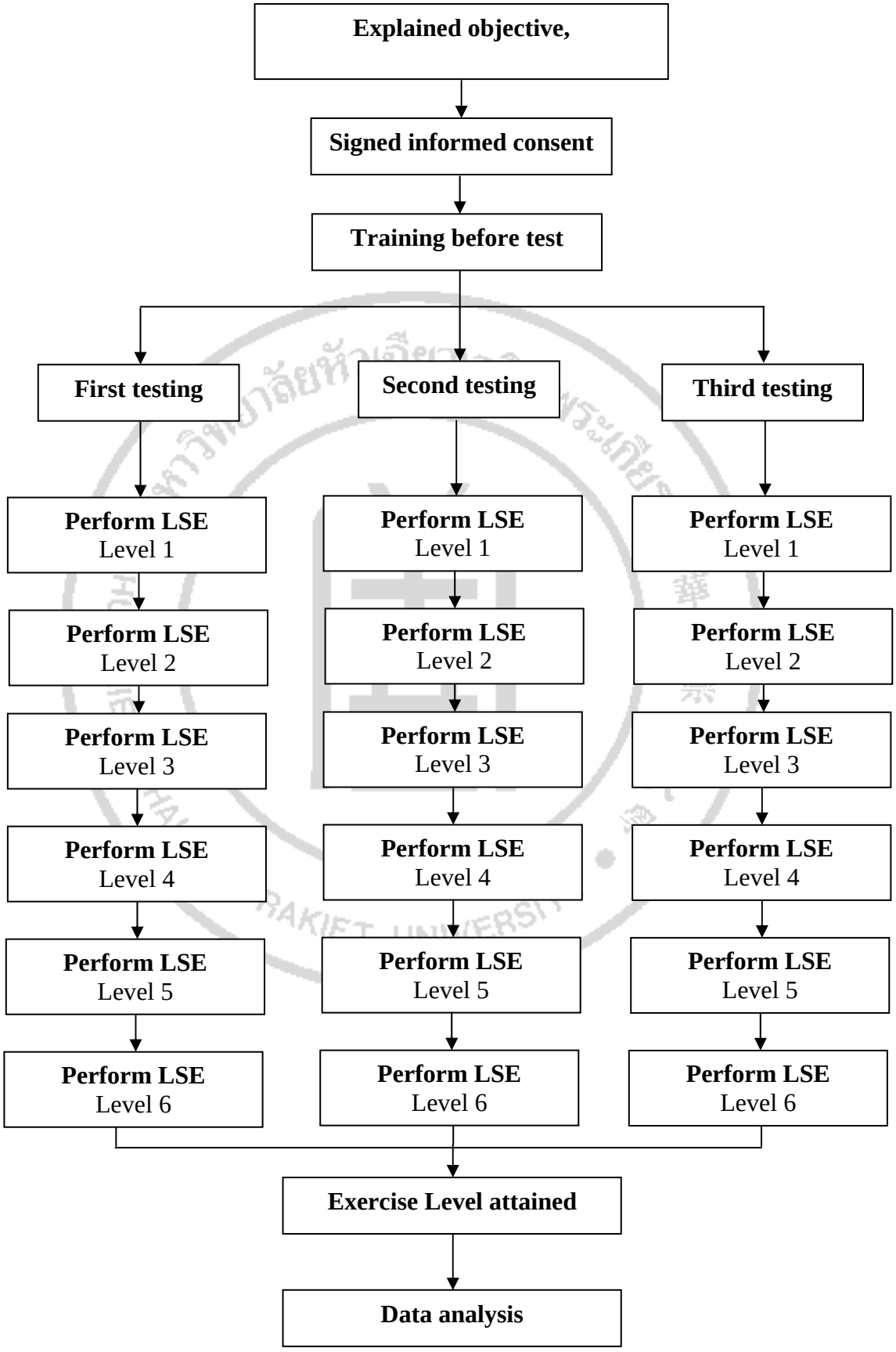

Figure 3.12 Summarized the complete method of the assessment procedure used in this research