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Original Research

The Effect of Ultrasound and Core Stability Exercise on Increasing Lower Back Functionality in Adolescents

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ABSTRACT

Background: *Myogenic low back pain is a disorder characterized by pain in the lower back. Low back pain can have an impact on impaired functional ability. Some of the factors causing functional disorders are physiological factors, poor body posture, and unergonomic work postures. Adolescents are a group that is vulnerable to experiencing functional decline in the lower back due to pain in the lower back as a result of the demands of activity during the learning process, by spending most time sitting, and having busy learning schedules, which make physical activity tend to be low, which can result in decreased lower back functionality. The aim of the study is to determine the effect of ultrasound and core stability exercise on functional abilities in sufferers of myogenic low back pain in adolescents.*

Methods: *The research design was pre-experimental with a one-group pre-and post-test design. From a total population of around 100, after simple random sampling, 57 subjects were obtained with measurements using the Oswestry Disability Index (ODI).*

Results: *The results of the normality test data analysis using the Kolmogorov-Smirnov test, ODI pre-test 0.072, and ODI post-test 0.157, and for hypothesis testing using the paired sample t-test P 0.000, so that there is a significant difference.*

Conclusion: *The clinical implications could be the influence of providing ultrasound and core stability exercises on improving lower back function in adolescents. So the hypothesis is accepted.*

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INTRODUCTION

Low back pain (LBP) is a disease that often arises related to work and activities that are heavily compensated for in the back area for a long time. The complaint that often arises due to this disease is pain; this pain experienced can interfere with functional activities in the lower back (Ozsoy et al., 2019). The pain that occurs comes from work errors/poor work ergonomic positioning that lasts a long time and pain that is felt from the spine, muscles, nerves, and other structures in the back area.

Muscle tension from ergonomics is what causes lower back pain and usually arises in young adulthood, because when you are young, when you are doing learning activities for a long time, sitting for a long time during lectures plus poor positioning can result in prolonged static activity resulting in tissue damage (Kusumaningrum et al., 2021). During the learning process by spending the most time sitting and having a busy learning schedule, which tends to make physical activity low, which can result in decreased lower back function. Myogenic low back pain can be experienced by all ages, including adolescents; this condition can cause one of them to have myofascial syndrome.

Inflammation occurs in the myofascial tissue, resulting in abnormal crosslinks in the muscles. Abnormal crosslinks cause adhesions in the fascia with muscle fibers, resulting in tight band muscles. This band link causes decreased muscle strength, resulting in pain when the muscles experience changes in length and experience hypomobility. Muscle tension from ergonomics (Zahratur and Priatna 2019).

Myogenic low back pain is pain around the lower back that is caused by disorders or abnormalities in the muscle and tendon elements without being accompanied by neurological disorders. Myogenic LBP can cause pain, muscle spasms, and muscle imbalance, resulting in decreased abdominal and lower back muscle stability and limited lumbar mobility, resulting in decreased functional activity (Zahra, Yasya, and Simbolon 2019). The effects caused include spasms; prolonged spasms can cause vasoconstriction of blood vessels, which results in ischemia, so someone who experiences this feeling will limit movement because it can cause pain.

You also need to know that this myogenic LBP can also cause atrophy over a long period of time; there will be a decrease in muscle strength, and a decrease in muscle strength will later cause a decrease in the stability of the lumbar area and ultimately result in a decrease in functional activity in sufferers (Pramita, Pangkahila, and Sugijanto 2015). The physiotherapy approach that can be chosen for functional ability in cases of lower back functional decline due to lower back pain is Ultrasound and Core Stability Exercise. For the first modality, ultrasound can be used.

Ultrasound is a physiotherapy tool that uses mechanical vibrations of longitudinal waves (sound) with an average frequency of 20-20,000 Hz, which aims to reduce muscle stiffness (spasm) as well as reduce pain; besides that, it also has an effect. Thermal, which will provide physiological benefits in the form of increasing tissue temperature, increasing the metabolic activity of blood flow, an analgesic effect on nerves, and increasing the extensibility of collagen tissue (Sulistyawati et al., 2019). The second technical modality is the core stability exercise.

The main core stability exercise is to prevent lumbar lordosis in low back pain (LBP), an exercise that is used by increasing the trunk muscle groups that surround the spine and abdomen in order to control the position and movement of the trunk. Body to produce optimal movement during activities. The method is to activate the core muscles, which are deep muscles in sufferers of myogenic low back pain who experience weakness.

Activating these core muscles will increase the stability of the spine because it will activate intra-abdominal pressure so that an abdominal brace is formed to increase stability in the spine and also increase control of functional activities in the back so that maintenance of corrected positioning in the lumbopelvic is more stable (Wanti Hasmar and Faridah 2022). Based on the theory above, these two modalities are able to reduce pain, so they are good for increasing functional ability in the lower back, especially in

cases of myogenic lower back pain; however, due to the lack of research that proves both modalities are good in reducing pain in cases of myogenic low back pain, there is a lack of information. This makes the author interested in knowing whether the combination of these modalities has an effect on improving lower back function in adolescents.

MATERIALS AND METHOD

This research design used was pre-experimental with one group pre- and post-test design. This research was carried out with 1 group where there was an ultrasound and core stability treatment group. This research was conducted with the aim of finding out the differences in the effect of ultrasound and core stability exercise on improving functional abilities in sufferers of myogenic low back pain in adolescents. With the inclusion criteria, there is myogenic LBP pain with an acute period of 3 months, age 12-25 years, ODI value 5 - 24 moderate degrees, and willingness to be the subject of this research. The exclusion criteria include subjects having cardio disorders, radiating lower back pain, and subjects having malignant tumors.

In the implementation using ultrasound, US frequency is the number of sound waves achieved in one second expressed in megahertz (MHz), which in general the frequencies used in US therapy are 1 and 3 MHz. Intensity is the average energy emitted per unit area and is expressed in watts per square centimeter (W/cm²), while power is the total output of the transducer, expressed in watts (W). There are differences in dosage determination among experts in terms of frequency, intensity, and time.

Ultrasound with a frequency of 3 MHz causes more thermal effects than at a frequency of 1 MHz. When using ultrasound therapy with a high frequency of 3 MHz, the energy required can be absorbed by body tissue to a depth of 1.2 cm below the skin surface, while at a low frequency of 1 MHz, the energy can be absorbed by tissue to a depth of more than 1.2 cm below the skin surface. Meanwhile, to reach an internal tissue temperature of 40°C-45°C with treatment of 5-10 minutes using a continuous method with an intensity varying between 1.0 and 2.0 W/cm².

In general, ultrasound intensity can be divided into three categories, namely: (1) low, namely below 0.3 W/cm²; (2) medium, namely between 0.3 and 1.2 W/cm²; and (3) high, namely between 1.2 and 3.0 W/cm², while determining the dose for the duration of therapy depends on the area of the therapy area and the surface area of the transducer (treatment head) used; 1 cm² of body surface takes 1 minute (Noori et al. 2020). The condition of myogenic low back pain, which is located in the muscle body, which is in layers with a depth of 3 centimeters, will be very effective if using ultrasound with a frequency of 3 MHz with an intensity of 1 W/cm; 20% pulses with a time of 10 minutes will be more easily absorbed because absorption from the thermal effects of ultrasound is more widely

The Mechanism of Core Stability Exercise in Improving Functional Abilities in Low Back Pain Myogenic Core stability exercise has the ability to control position and movement in the center of the body because the main target of this exercise is the muscles located deep in the abdomen, which are connected to the spine, pelvis, and shoulder. Core stability exercises are useful for maintaining lower back health, static stabilization, and trunk dynamics, as well as preventing injury, especially in increasing functional activities. When the core muscles experience weakness or lack of balance (muscle imbalance), what occurs is pain in the lower back area.

The working principle of core stability exercise is to activate the work of the core muscles, which are deep muscles in low back pain sufferers who experience weakness. Activating the core muscles will increase the stability of the spine because active core muscles will increase intra-abdominal pressure, which forms an abdominal brace that will increase the stability of the spine, reduce resistance or load on the paravertebral muscles, improve body posture, prevent further injury, and improve body performance (Zahratur and Priatna., 2019). Core stability exercise movements used for therapy in myogenic low back pain patients include pelvic tilting, bridging, back extension with arms supporting, upper and lower extremity exercise in crawling position, and cat-camel stretch and plank (Coulombe et al., 2017).

With an exercise dose of each movement held for 5 seconds and rest for 5 seconds and repeat 8-10 times (Afriannisyah, Herawati, and Widyawati, 2020). Pre- and post-test measurements with *the Oswestry Disability Index* (ODI). The ODI questionnaire is a form containing 10 question items designed to provide an overview of the functional abilities of low back pain sufferers. Where the first item measures pain intensity and the other 9 items measure the effect of pain on daily activities such as self-care, lifting, walking, standing, sitting, sleeping, sexual activity, social activities, and outings.

Before filling out the questionnaire, an explanation is first given about how to fill out the questionnaire, and the patient must mark (v) in the box provided. Patients are asked to choose one statement that describes their disability in functional activities. Each section is scored on a scale of 0-5, and results can be given on a scale of 0-50. The assessment is a total score (50) x 100% (Zahratur and Priatna, 2019). ODI score interpretations include: (1) No disability (0 - 4), (2) Mild disability (5 - 14), (3) Moderate disability (15 - 24), (4) Severe disability (25 - 34), (5) Completely disabled (35 - 50).

Statistical analysis on the data normality test used the Kolmogorov-Smirnov test because the number of subjects was >50 people (from a total population of around 100, after simple random sampling, 57 subjects). The test results were different from the pre-post-test using the statistical test paired sample t-test because the data was normally distributed with ethical clearance number 4838/B.2/KEPK-FKUMS/V/2023 Health Researcher Ethics Committee Faculty of Medicine of Universitas Muhammadiyah Surakarta.

RESULT S

The research criteria used in this study included age, gender, BMI (body mass index), sitting time per day, and initial condition of the patient functional limitation low back pain with ODI pre- and post-treatment. The subjects in this study were 57 subjects, consisting of 10 men and 47 women. Then the functional ability of the lower back was measured using the Oswestry Disability Index (ODI). At the time of the study, there were no dropouts.

Data results were obtained from a minimum age of 18 years and a maximum of 20 years, with an average of 18 years. Data characteristics based on gender were obtained. There were 10 (16.9%) males and 47 (79.7%) females, with a minimum BMI of 17 and a maximum of 33, with an average of 21.82. From the subject's sitting time per day, the results were a minimum of 4 hours of sitting per day and a maximum of 10 hours per day with an average of 7.40 hours per day. From the initial condition of the patient with a minimum ODI pre-examination of 5 posts 0 maximum ODI pre 24 ODI post 10 with a

mean value of ODI pre 11.19 and ODI max 2.00 with a standard deviation of 6.241 for ODI pre-treatment and 3.059 for ODI post-treatment

The statistical analysis used to test the normality of the data is using the Kolmogorov-Smirnov test because the number of subjects is 57 or >50. with the following results:

Tabel 1. Normality test

Kolmogorov-Smirnov Test	***p***	***Explanation***
Pre ODI	0,072	Normal
Post ODI	0,157	Normal

Tabel 2. Test the effect of US and CSE

Paired sample t – test		
Result	***p***	***Explanation***
Pre – Post ODI	0,000	Hypothesis accepted

DISCUSSION

Based on the results of statistical tests that have been carried out from data characteristics based on age, gender, BMI, length of work, and the initial state of the pre- and post-treatment ODI examination, it states (Andini, 2015):

Age

In terms of age, it turns out that it also has an influence on the functional decline of the lower back due to static back pain. This can be caused by static conditions due to degeneration in the form of tissue damage, tissue replacement into scar tissue, and fluid reduction. This results in reduced bone and muscle stability, resulting in a risk of reduced bone elasticity, which can trigger LBP symptoms.

Gender

The prevalence that women get is higher than men in cases of myogenic LBP; from this, it is clear that gender greatly influences the level of risk of musculoskeletal complaints. This happens physiologically; muscle capacity in women is lower than in men. It is also seen based on other musculoskeletal cases that are currently being experienced.

Body Mass Index

The average results obtained from the WHO 2020 standard scale for research subjects were in the average condition of obesity 2. This is also a serious risk for overweight sufferers because when the body weight is excessive, the spine will receive excessive pressure to work, which can burden the work of the back, so it can damage, and danger to the lumbar vertebral structure can easily occur.

Long duration of sitting

Due to the long duration of the research subjects' activities, their posture was very risky. Repetitive movements and long periods of static will result in muscle weakness, especially in the back; during contraction, the muscles will need oxygen. If the movements are repeated while the muscles are too tight, oxygen has not yet reached the tissues, and the muscles will tire easily. Apart from that, poor positioning/poor ergonomics results in the transfer of energy from the muscles to the skeletal tissue and makes them tired easily (Kusumaningrum et al., 2021).

The effect of ultrasound and core stability exercise with ODI

Ultrasound is a non-invasive treatment modality that can produce thermal and non-thermal effects. The thermal effect can be in the form of increasing skin surface temperature, increasing metabolism, improving blood flow, reducing mild inflammation, reducing muscle spasms, reducing pain, and increasing joint range of motion. Nonthermal mechanical effects from ultrasound can produce micro massage, which will reduce the sensitivity of receptors (mechanoreceptors and muscle spindles) and change muscle viscoelasticity, thereby reducing muscle tension, increasing the range of motion of the senses, and providing a sedative effect on the nerves, so that pain is reduced and functional in the lower back becomes wider in carrying out activities so that providing ultrasound on myogenic LBP has a good effect on improving lower back function (Sulistyawati et al., 2019).

Meanwhile, the effect of providing core stability exercise results in the torso becoming more stable because it is able to control position and movement, where the main target of this exercise is the deep abdominal muscles, where these muscles have connections with the spine, so this CSE is very useful for stabilizing the lower back, both moving or not moving, so it is very effective in preventing further injuries (back area to lower extremities), especially functional activities, because if the core muscles are weak, an imbalance will appear in the muscles (muscle imbalance), and pain will definitely appear in the back area. The presence of CSE will improve the balance of abdominal and prevertebral muscles because muscle coactivity in the lower trunk makes it easier to control movement and shift body weight for functional activities (Pramita and Wahyudi, 2018).

In this case, ultrasound and core stability do have a very good effect on improving the function of the lower back, where when functional capacity increases, it will certainly be accompanied by a decrease in pain spasms with a significance value of $p < 0.05$ from the paired sample t-test. Ultrasound itself can provide effects on cells and soft tissues through thermal and non-thermal effects as well as using heating on deeper tissues, which can provide effects such as stimulating tissue regeneration, soft tissue repair, smoothing blood circulation in cases of chronic soft tissue, protein synthesis, and bone repair and for core stability exercise has the ability to control position and movement in the center of the body, because the main target of this exercise is the muscles located deep in the abdomen that are connected to the spine, pelvis, and shoulders (Bethel, 2020).

After ultrasound and core stability therapy were performed on someone who experienced decreased function due to static work, it did have a good effect after therapy was carried out 3 times a week for 2 consecutive weeks in the form of increased function, especially in adolescents who had lower back pain problems due to lack of activity and poor ergonomic positions, this can actually be caused by many factors, but because the focus of this study was on adolescents who were still in the post-covid recovery phase where activities would return to normal, where during this covid period learning was carried out at home and post-covid it was carried out face-to-face so that activities that returned to normal were required (Raharjo, Wibawa, and Tianing, 2017). One of these normal learning activities is that adolescents who attend lectures must sit for at least 6 hours per day in their daily lives. The static position experienced, at least in previous activities that were not used to it, can also worsen the condition of the lower back to spastic and painful and allow its function to be disrupted (Kotteeswaran, Snigdha, and Alagesan, 2014).

CONCLUSIONS

The results of this research show the effect of providing ultrasound and core stability exercises on improving lower back function in adolescents. So the hypothesis is accepted because the two physiotherapy modalities given both have a good effect. Ultrasound has thermal and non-thermal effects, while CSE has an intra-abdominal stability effect, thereby strengthening the lumbar paravertebral area. These two combinations are very good and effective for myogenic LBP conditions, especially for increasing functional activity.

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