

Effectiveness of Core Stability Exercise in Physiotherapy Approach to Improve Cardiorespiratory Fitness in College Students

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ABSTRACT

Introduction: Physical fitness, especially cardiorespiratory fitness, is an important factor in supporting students' health and academic performance. However, an increase in sedentary lifestyles has led to a decrease in physical fitness levels in university students. This study evaluates the effectiveness of the Core Stability Exercise (CSE) program in improving the cardiorespiratory fitness of university students, using a combination of bicycle crunch and mountain climber as the main exercises. This exercise is one of the physiotherapy exercise methods that focuses on strengthening core muscles, which not only improves body stability but also contributes to improving cardiorespiratory capacity through diaphragm activation and postural control. This study aimed to evaluate the effectiveness of CSE in improving the physical fitness of university students using a one-group pre-post-test quasi-experimental design. **Methods:** A total of 27 students underwent the bicycle crunch and mountain climber exercise program for eight weeks with a frequency of three times a week. Cardiorespiratory fitness was measured using the Harvard Step Test, and the results of statistical analysis with the Wilcoxon test showed a significant increase ($p < 0.05$) after the intervention. **Results:** The results of this study indicate that Core Stability Exercise is an effective exercise method in improving the cardiorespiratory fitness of college students. **Conclusion:** Therefore, this exercise is recommended as part of a preventive physiotherapy program to improve the health and fitness of students in the academic environment.

Keywords: *Core Stability Exercise, physical fitness, Harvard Step Test, preventive physiotherapy*

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INTRODUCTION

A person's physical fitness greatly affects their physical ability to carry out daily activities, where better fitness will increase work productivity. In addition to reflecting physical condition, physical fitness has various functions, such as supporting athlete performance, employee work efficiency, and student learning success. Fitness is also important for rehabilitation for people with disabilities, helping pregnant women prepare for childbirth, and supporting children's growth and maintaining the health of the elderly to stay fit and avoid disease (Arifin, 2018). Physical fitness in adolescents is needed to prepare for productive age, but the condition of physical fitness in Indonesian adolescents is indicated to be lacking. According to Fadhillah (2022) stated that

the results of the survey of the Physical Fitness Center Depdiknas were categorized as 10.7% in a very poor state, 45.9% inadequate, 37.7% moderate, and 5.7% in a good state (Adriani & Fadilah, 2023). Physical fitness factors have a positive correlation with adolescent physical activity levels (Alamsyah et al., 2017). A Brazilian study of 879 adolescents (14-19 years old) measured cardiorespiratory fitness using the *modified Canadian aerobic fitness test* (mCAFT) and analyzed four risk factors: physical inactivity, sedentary behavior, unhealthy diet, and excess body fat. As a result, low levels of physical activity or low-intensity activity are not sufficient to reach the thresholds required for cardiovascular adaptation and cardiorespiratory fitness. Thus, low aerobic fitness and overweight increase the risk of

arterial stiffness and atherosclerosis from childhood (Gonçalves & Santos Silva, 2019).

In Padhan (2023), the World Health Organization (WHO) emphasizes that physical inactivity is one of the major risk factors for global mortality, causing 3.2 million deaths annually. Physiotherapy currently has a role in all levels of prevention from emergency to rehabilitation. In addition, it is proven that physical activity is one of the preventive measures for non-communicable diseases. Providing gradually progressive physical activity for individuals, assessing, designing safe exercise protocols, and providing education to overcome non-communicable diseases makes the role of the physiotherapy profession very important (Padhan & Mohapatra, 2023).

Core stability exercise is one of the physiotherapy management in the form of exercises that are often applied to various conditions. Core stability exercise (CSE) targets the muscles in the spine through sustained isometric contractions, with the aim of progressively improving muscle coordination and function. This exercise is effective in strengthening the trunk muscles, supporting spinal stability, and activating the deep abdominal muscles without the risk of injury (Luberto et al., 2023). Research sourced from Pradita (2024) which provides a comparison of the therapeutic effects of physiotherapy management of core stability exercise on low back pain has a positive value (Pradita & Halimah, 2024). Similar research explains the positive effect of core stability exercise on the case of dynamic balance of soccer players aged 12-15 years due to the dynamic stabilizing effect of the entire kinetic chain during functional movements and provides proximal movement stability for efficient lower limb movement (Rozaq et al., 2022). The provision of core stability exercise intervention shows the results of a direct effect of VO 2Max on Core Stability exercise (Azka et al., 2024).

Based on the researcher's observation, the level of fitness and the risk of fatigue in university students is increasing from year to year. This is likely due to an increase in sedentary lifestyles, such as excessive use of technology and lack of physical activity will cause various health problems. In addition, the context of core stability

exercise has been widely studied although in the context of athletics and rehabilitation. There is a need to evaluate the approach of core stability exercise method in improving physical fitness among university students. This research is important because there are not many studies that approach the effectiveness of CSE in the scope of preventive application of physiotherapy in the context of higher education.

METHODS

This study used a quasi-experimental design with a *one-group pre-posttest* to evaluate the effect of *Core Stability Exercise (CSE)* on students' physical fitness.

Population and Sample

The study population was physiotherapy students of ITSK RS. dr. Soepraen Malang. The sample was randomly selected using simple random sampling technique, as many as 30 students, who met the inclusion and exclusion criteria. Three respondents *dropped out* because they did not complete the exercise program, so the final number of samples was 27 students.

Inclusion criteria: Students aged 19-25 years, no cardiovascular disease, and willing to participate in the exercise program. Exclusion criteria: Students with a history of cardiorespiratory disease, musculoskeletal injury, or medical conditions that inhibit physical activity.

Intervention Design

The Core Stability Exercise (CSE) program was conducted for eight weeks with a frequency of three times a week. The exercise consisted of combining two techniques, namely the bicycle crunch and mountain climber, which were performed alternately in one training session. Each session lasted 45 minutes, with the following breakdown: warm-up (5 minutes), main exercise (35 minutes, consisting of bicycle crunch and mountain climber in an interval pattern), and cool-down (5 minutes). These techniques were chosen because they synergistically target the core muscles and support the improvement of cardiorespiratory fitness through the mechanisms of postural stabilization and respiratory muscle activation.



- *Bicycle Crunch*: On your back with your hands behind your head, raise your legs 45 degrees, and then perform a criss-cross motion between your elbows and knees.
- *Mountain Climber*: Plank position with arms straight, knees pulled to the chest alternately.
- Reps and Sets: Each movement is performed for 15 reps per set, with 4 sets of the exercise and a 1-minute break between sets.

Measurements and Instruments

The Harvard Step Test is used to measure cardiorespiratory fitness, with the calculation of a fitness index:

$$\text{index harvard} = \frac{100 \times \text{durasi (detik)}}{2 \times \text{jumlah denyut nadi recovery}}$$

Fitness categories: Excellent (>90), good (80-89), fair (65-79), poor (55-64), very poor (<55). The validity and reliability of the Harvard Step Test has been tested in various previous studies with ICC values > 0.85, making it a reliable measurement tool in assessing cardiorespiratory fitness.

Data Analysis

Data were analyzed using the Wilcoxon test in SPSS 26.0 software to compare pre-test and post-test scores. This test was chosen because the data was not normally distributed based on the Shapiro-Wilk test.

RESULTS

Table 1. General characteristics

Characteristics	N	Percentiles
Male	13	48%
Female	14	52%
Total	27	100%

Table 1 shows that the dominance of respondents is female, and can be seen in 27 (52%) respondents.

Table 2. Hypothesis Test

Category	N	Median (Min-Max)	P-value
Pre CSE	27	34 (16-79)	0,000
Post CSE	27	65 (13-109)	

Wilcoxon test results showed that the combination of *bicycle crunch* and *mountain climber* exercises significantly improved the cardiorespiratory fitness index of university students ($p < 0.05$). Although both methods contributed to the fitness improvement, further analysis showed that *mountain climber* had a greater effect than *bicycle crunch* in improving the fitness index based on the *Harvard Step Test*.

The figure below illustrates the improvement in cardiorespiratory fitness index after the intervention.

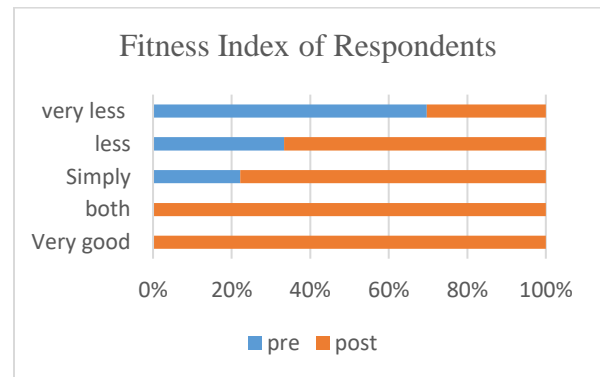


Figure 1. Respondents Fitness Indicators

Based on the fitness change diagram, there is a significant difference in the fitness index before and after the Core Stability Exercise intervention. Before the intervention, most of the respondents were in the fair to poor category based on the Harvard Step Test scale. However, after the eight-week exercise program, the majority of respondents experienced an improvement in fitness as indicated by a move to the fair to good category. These results suggest that the CSE Program combined bicycle crunch and mountain climber exercises contribute to the improvement of cardiorespiratory fitness through the mechanism of strengthening core muscles that play a role in postural stabilization and respiratory efficiency. In addition, the significant difference in the median fitness index (from 34 to 65) indicates the effectiveness of the intervention in improving the cardiorespiratory capacity of university students. Overall, the results of this study support the use of Core Stability Exercise as part of preventive physiotherapy strategies to

improve physical fitness in the university student population.

DISCUSSION

Based on the results of this study, women are more dominant than men, in Indri's study (2023) that the effect of gender on adolescent fitness is related to the body's homeostasis which causes the factor of lack of activity to reduce the cardiovascular system. The tendency of men to have better fitness is also due to the size and strength of their muscles (Indri Sagita et al., 2023). Differences in muscle size and strength in men are influenced by hormonal factors that cause increased synthesis and preparation of actin and myosin so that naturally the muscle mass of men is greater (Adriani & Fadilah, 2023). In addition, the ease of technology and the negative stigma of women about sports cause a lack of women to exercise, on the contrary, positive perceptions of women such as disease prevention and ideal body building cause sports to also be in great demand (Distya Pratiwi, 2023). Today, women's increasing awareness of body ideals is spurring interest in more physical activity.

Based on the diagram, it can be seen that the dominance of the moderate category is seen, this is attributed to Zheng's study (2020) showing that adolescents' sedentary lifestyle is caused by a less active lifestyle, including the use of gadgets, laptops, and watching television for a longer time (Zheng et al., 2020). Sholihah's (2019) research shows that adolescents aged 8-18 years spend more than 7 hours a day using electronic devices for entertainment (Sholihah et al., 2019). In addition, changes in online learning methods have increased teenagers' sitting time from an average of 5 hours to 8 hours per day. The impact of this lifestyle includes decreased academic ability and cardiovascular fitness, which may increase the risk of cardiovascular disease in later life (Indri Sagita et al., 2023). The decline in fitness is complemented by the ease of technology that can gradually affect the immunity of adolescents, causing cardiovascular decline in adolescents.

Diagram 1 also shows a shift to the fair to good category. It can be explained that optimal

physical fitness is the main capital for a person to carry out physical activities or daily work efficiently and for a long duration without experiencing excessive fatigue, so that they can still enjoy leisure time. This condition can be achieved through physical exercise that is carried out properly, structured, and with intensity that is not excessive (Arifin, 2018). The provision of core stability exercise in this study has a positive effect, in line with a study conducted by Rizki (2023) which proves that the core stability exercise program can increase core muscle strength in firefighter personnel. This exercise focuses on strengthening the muscles of the middle body regularly, which aims to stimulate the functions of postural stability and mobility. A core training program includes several aspects, such as core muscular endurance, core stability, and core muscular strength. Each component has a specific function, including the ability to maintain a position or perform many repetitions, the capacity of the system to maintain the spinal neutral zone within physiological limits, and the strength of the core muscles in generating power through contraction and intra-abdominal pressure (Rizki et al., 2023). Physiologically, improvements in cardiovascular fitness occur through adaptation of the heart and lungs to physical activity, where the cardiovascular system increases cardiac output and blood pressure to meet the oxygen demand of active skeletal muscles. Regular physical exercise also increases the efficiency of the cardiovascular system in pumping blood and delivering oxygen to the muscles used during exercise (Alamsyah et al., 2017). In core stability exercise, especially abdominal crunch exercises aim to increase the strength of the rectus abdominis muscle and the external oblique muscle, which functions as an auxiliary muscle in breathing, especially during expiration. The increased strength of the abdominal muscles has a positive impact on the value of chest expansion (Wahyudi et al., 2018). Based on this, the provision of core stability exercise can optimize adolescent physical fitness through the activation of core muscles that have an effect on the concept of cardiovascular adaptation.



This study showed a significant difference in the median fitness index (from 34 to 65) indicating the effectiveness of the intervention in improving the cardiorespiratory capacity of university students. The study conducted by Wahyudi (2018) showed that after 4 weeks of abdominal crunch training, lung function and chest expansion had a significant increase. This proves a positive relationship between abdominal crunch exercise, lung function, and chest expansion. Increased abdominal muscle strength is directly related to increased chest expansion, in line with the results of previous studies showing that pulmonary resistance training and core training can also increase chest expansion (Wahyudi et al., 2018). A study comparing core muscles and taichi chuan exercise on improving the musculoskeletal and cardiopulmonary systems showed positive results. That these two interventions both have an effect on adult cardiopulmonary improvement (Jia et al., 2018). Oktaviyani's research (2021) shows that core stability training is effective for increasing the physical fitness value A in Brigif 15 Kujang II Cimahi soldiers. As a result of this exercise has an effect on the ability to control the arms, trunk, pelvis and legs to increase optimal motion production (Oktaviyani & Arifin, 2021). The use of a combination of bicycle crunch and mountain climber in the CSE program aims to optimize core muscle activation and improve the efficiency of the cardiorespiratory system. The bicycle crunch focuses on strengthening the rectus abdominis and obliquus externus muscles through dynamic cross movements, while the mountain climber involves more complex core stabilization activation through dynamic plank positions. The combination of these two methods allows for more overall fitness improvement than using either method in isolation.

Overall, the results of this study indicate that Core Stability Exercise is an effective exercise method in improving cardiorespiratory fitness of university students and can be implemented in preventive physiotherapy programs to reduce the risk of cardiovascular disorders due to sedentary lifestyle. Although this study showed positive results, there are some limitations that need to be considered. One of

them is the one-group pre-post test design, which does not have a control group, so the effect of exercise cannot be compared with other factors such as diet or lifestyle. In addition, the level of adherence of respondents to the exercise protocol may affect the results obtained.

For future research, it is recommended to use a randomized controlled trial (RCT) design in order to evaluate the effects of Core Stability Exercise more objectively. In addition, it is necessary to take additional measurements such as VO2max or spirometry to obtain more in-depth data on improving cardiorespiratory capacity.

CONCLUSIONS

The results of this study showed that Core Stability Exercise (CSE) was effective in improving the cardiorespiratory fitness of university students, as evidenced by the significant improvement in the Harvard Step Test results after the eight-week intervention. The bicycle crunch and mountain climber exercise methods were shown to improve core stability, which contributed to improved respiratory efficiency and aerobic capacity.

Overall, CSE is a simple, effective, and implementable exercise method in preventive physiotherapy programs to improve cardiorespiratory fitness of university students and reduce the risk of cardiovascular disorders due to sedentary lifestyle.

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