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The Effect of Swiss Ball Exercise on Trunk Flexibility in Adolescents Aged 17-21 Years

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Abstract

These activities are mostly spent in a long sitting position while studying, work in front of laptop, or reading where students have to sit for more than 2 hours. Long sitting will result in continuous muscle overuse and body posture imbalance. The high tension of the lower back muscles can cause limited range of motion (ROM) of the vertebrae, resulting in decreased flexibility. In addition, lack of physical activity, especially sports activities that involved the trunk and lumbar will also affect muscle flexibility. This study aims to find the effect of swiss ball exercise on trunk flexibility in teenagers aged 17-21 years old. A one group pre and post test design was conducted on 19 students of Airlangga University's Vocational School aged 17–21 years old. Meanwhile, sit and reach test was used to evaluate the trunk flexibility. Comparison analysis was done by using paired t-test on EZR (Easy R) application. Analysis of comparison between pre and posttest by using paired t-test revealed p = 0,001 (4,91e-08) with p <0.05 which means that there was a significant difference of sit and reach test before and after treatment. The average of pretest is 30,82±6,91 and posttest is 37,94±5,08. There was a significant effect of the Swiss Ball exercises on trunk flexibility in adolescent aged 17–21 years.

Keywords: swiss ball exercise, trunk flexibility, sit and reach test

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Introduction

Adolescents are individuals in the transitional phase between childhood and adulthood, as described by the WHO. In Indonesia, according to the Ministry of Health of the Republic of Indonesia (2009), the late adolescence period ranges from 17 to 25 years. Between the ages of 17 and 21, most adolescents are students or university students, with their primary activity being learning. The typical schedule for regular university students generally runs from 08:00 to 15:00, with a one-hour break from 12:00 to 13:00. This schedule means that most of the students' time is spent sitting for hours, especially since a single class session typically lasts for two hours. This habit can trigger the risk of lower back pain (LBP), particularly if the sitting posture used is not ergonomic (Wulandari, 2010).

Sitting for prolonged periods of 15–20 minutes with poor posture can cause the back muscles to become fatigued, leading to muscle tension. This tension can trigger the body's protective mechanism, where the spinal muscles work harder to maintain balance. This often results in overuse of certain muscles, which in the long term can cause postural imbalances. Research shows that individuals with a slouched sitting posture are 2.58 times more likely to experience LBP compared to those who sit upright. Additionally, sitting for too long can also lead to spasms or tension in the lower back muscles, which affects the range of motion (ROM) of the vertebrae and reduces flexibility (Padmiswari et al., 2017).

Flexibility is the ability of muscles and joints to move freely within the maximum range of motion. Factors that affect flexibility include muscle elasticity, joint condition, and lifestyle. A sedentary lifestyle can lead to muscle shortening, stiffness, and dysfunction of tendons, ligaments, and joints. A decline in flexibility can increase the risk of poor posture, vertebral injury, and difficulties in performing daily activities (Rahmawati et al., 2015). Furthermore, the decline in flexibility is often caused by structural changes in the musculoskeletal system that occur with age (Pulcheria et al., 2016).

To measure an individual's flexibility, various methods have been developed, one of which is the sit and reach test. This test is designed to measure the flexibility of the back muscles, hamstrings, and vertebral joints. The equipment used in this test is quite simple, consisting of a bench with a ruler in centimeters. The sit and reach test is commonly used because it is easy to perform and provides reliable results (Alter, 2004).

Various types of physical exercises can be used to improve trunk flexibility, such as active or passive stretching, Swiss ball exercises, Proprioceptive Neuromuscular Facilitation (PNF), Slow Active Stretching (SAS), yoga, and Pilates. One of the effective methods is Swiss ball exercise. This exercise utilizes a special ball with a specific diameter, adjusted to the individual's height (for example, a 55 cm diameter ball for individuals with a height of 150–172 cm). Swiss ball exercises fall under the category of core stability exercises, where the use of the ball functions to enhance spinal stability and train the flexibility of the back and shoulder muscles (Aagaard, 2011).

Swiss ball exercises are performed for four weeks with a frequency of three times a week, with a two-day rest interval. Each exercise session lasts approximately 45 minutes, starting with a five-minute warm-up and ending with a five-minute cool-down. The exercises are performed progressively, starting from light intensity to heavy, with an increase in the number of repetitions and sessions. Precautions or contraindications for using the Swiss ball include conditions such as amputation, post-surgery, decreased body balance, and geriatric patients (Carriere, 1998).

The main benefits of Swiss ball exercises include improved balance, coordination, proprioception, kinesthetic awareness, strength, endurance, stability, and range of motion (ROM). These exercises can also activate muscles according to their function, such as abdominal muscles and intervertebral muscles, thus enhancing control and protection of the lumbar spine and pelvis (Hodges, 2003). Therefore, these exercises can help reduce muscle tension, improve posture, and increase flexibility and joint stability (Carriere, 1998).

This study was conducted to examine the effect of Swiss ball exercises on trunk flexibility in students aged 17–21 years who have a sedentary lifestyle due to prolonged sitting during academic activities. Additionally, this study aims to prove whether Swiss ball exercises with a specific duration can significantly improve trunk flexibility.

Literature Review

Definition of Swiss Ball

A Swiss ball is a rubber-like ball ranging in size from 45 cm to 120 cm. It is flexible, elastic, and has various uses in fitness training. The use of the Swiss ball is adapted to the user's posture, providing flexibility in exercises for various needs. This ball is made from special materials such as anti-burst krylon, making it safe for use even under intensive conditions.

Swiss ball exercises can include core muscle strengthening, body stabilization, and flexibility improvement. The ball can be used by children, adults, and seniors. The advantage of the Swiss ball is its ability to provide enjoyable and effective exercises, improving balance, strength, and proprioception. This training also offers good stimulation for the musculoskeletal system, including the back and lumbar muscles (Purnomo, 2006; Aagaard, 2011).

Trunk Flexibility Measurement Instrument

One method to measure trunk flexibility is the Sit and Reach test. This test aims to measure lower back and hamstring flexibility and is used as an indicator of general flexibility. The steps for this test include:

1. The subject sits with straight legs and the soles of the feet resting on the measuring device.
2. The subject performs a trunk flexion movement as far as possible, keeping the arms straight.
3. The distance reached by the hands is recorded in centimeters.

This test is known for being simple and highly accurate in measuring lower back and hamstring flexibility. With adequate warm-up before the test, the results will be more valid (Lemmink, 2003).

Swiss Ball Exercises

Various exercises with the Swiss ball can be designed to improve trunk flexibility, including:

1. Stability Ball Crunch
   Lie on the ball with the back as the support, both feet on the floor, and hands touching the ears. This exercise targets abdominal muscles, such as the rectus abdominis, obliques internus, and transversus abdominis.
2. Prone Back Extension
   The starting position is lying face down on the ball with hands behind the head. The movement involves trunk extension, which helps strengthen the lower back muscles.
3. Supine Hip Extension
   Lie on your back with the ball under the pelvis. This exercise involves a hip bridge movement, which strengthens the gluteal and lower back muscles.

Each exercise is performed progressively, starting from low intensity to high intensity, with a session duration of approximately 45 minutes each, for 4 weeks, and a frequency of 3 times per week (Sekendiz et al., 2010).

Precautions and Contraindications of Swiss Ball Exercises

Swiss ball exercises have several contraindications, including:

1. Non-weight bearing: These exercises are not recommended for individuals with weight-bearing issues in the lower extremities.
2. Amputation: Amputation conditions can reduce balance while using the ball.
3. Post-surgery: Certain post-surgical conditions require special supervision before performing these exercises.
4. Impaired balance: Individuals with significant balance disorders may require additional assistive devices when using the Swiss ball.

A cautious approach is necessary to avoid injury risks. For example, geriatric patients with osteoporosis should avoid these exercises due to the high risk of falling (Carriere, 1998).

Research Methodology

This study employed a one-group pretest-posttest design to analyze the effect of Swiss ball exercises on trunk flexibility among adolescents aged 17–21 years. The research was conducted at the Physiotherapy Laboratory of Airlangga University over five months, from January to May 2024. The study subjects comprised students selected based on specific criteria, with data collected simultaneously before and after the exercise intervention.

The population for this study included all Airlangga University students aged 17–21 years with sedentary habits (sitting >4 hours per day). Sampling was conducted using purposive sampling, involving 30 subjects who met the

inclusion criteria. The inclusion criteria included students with no history of injuries or severe health conditions that could affect trunk flexibility. The exclusion criteria included subjects experiencing acute pain during the exercise or failing to complete the entire research program.

Data collection was conducted in two phases: initial measurement (pretest) and final measurement (posttest). Trunk flexibility was measured using the Sit and Reach Test, which evaluates the flexibility of the lower back and hamstring muscles. The intervention consisted of Swiss ball exercises conducted over four weeks, with a frequency of three sessions per week, each lasting approximately 45 minutes. The exercise procedure included a five-minute warm-up, 35 minutes of core exercises with movements such as stability ball crunches and prone back extensions, and a five-minute cooldown.

Pretest and posttest results were analyzed using SPSS version 25.0. Normality testing was conducted using the Shapiro-Wilk test, while the mean differences between pretest and posttest were analyzed using a paired t-test. A p-value < 0.05 was considered statistically significant.

Data Analysis Results

The subjects consisted of active male and female students from the Faculty of Vocational Studies at Airlangga University, aged 17–21 years. The following data were collected by the researchers:

Table 1
General Data of Subjects

	N	Min	Max	Mean
Age (years)	19	19	21	1,1
Body Weight (kg)	19	44	66	54,42±6,60
Height (cm)	19	154	171	160,05±4,63
BMI (kg/m^2)	19	17,85	24,39	21,19±1,91

A total of 19 subjects (5 males and 14 females), with an average weight of 54.42 kg and average height of 160.05 cm (mean BMI of 21.19 kg/m²), met the inclusion criteria. The average age of the subjects was 20 years, and based on a questionnaire, all subjects reported sitting for more than 4 hours per day and leading a sedentary lifestyle.

Table 2
Spesific Data of Subjects

	N	*Sit and Reach Test (SRT)*	
		Pretest (cm)	***Posttest (cm)***
Min	19	20,5	28
Max	19	46	48
Mean	19	30,82±6,91	37,94±5,08

Measurements in this study used the Sit and Reach Test (SRT), performed before and after the Swiss ball exercise intervention. The average pretest SRT result was 30.82 cm, while the average posttest SRT result was 37.94 cm.

Subsequently, a normality test was conducted to determine whether the data were normally distributed. The Shapiro-Wilk method was used, as the sample size was less than 50. The results of the normality test for the Sit and Reach Test (SRT) measurements are as follows:

Table 3
Normality Test Using Saphiro-Wilk

	Sit and Reach Test (SRT)	
	Mean	**p-Value**
Pretest	30,82±6,91 cm	0,4042
Posttest	37,94±5,08 cm	0,4052

The table above indicates that the pretest and posttest Sit and Reach Test (SRT) results have p-values of 0.4042 and 0.4052, respectively. Since p > 0.05, the data were determined to have a normal distribution. Therefore, a paired t-test was used to determine the significance of the effect when the data followed a normal distribution. If the data did not follow a normal distribution, the Wilcoxon test would be used.

A differential test was also applied in this study. After conducting a paired t-test, the following results were obtained:

Table 4
Differential Test Using the Paired T-Test Method

	Sit and Reach Test (SRT)	
	Mean	p-Value
Pretest	30,82±6,91cm	4,91 e-08 = 0,001
Posttest	37,94±5,08 cm	

The table above indicates a p-value of 0.001, where p<0.05p < 0.05p<0.05, signifying a significant change. This result suggests that the Swiss ball exercise method has an impact on trunk flexibility.

Discussion

1. General Subject Data

This study involved male and female students from the Faculty of Vocational Studies at Airlangga University, aged 17–21 years. The

19 subjects were selected based on sedentary lifestyle criteria, defined as sitting for more than 4 hours per day. Of these, 5 were male, and 14 were female. Overall, the subjects had an average body weight of 54.42 kg (range: 44–66 kg) and an average height of 160.05 cm (range: 154–171 cm), with an average Body Mass Index (BMI) of 21.19, classified as normal.

The results showed that BMI could influence trunk flexibility. Subjects with a normal BMI tended to have better flexibility compared to individuals who were overweight or obese. Excess adipose tissue accumulation in the abdominal area among overweight or obese individuals often impedes trunk flexion movements during flexibility tests like the Sit and Reach Test. Conversely, subjects with a normal or underweight BMI demonstrated more optimal range of motion, supporting previous research highlighting the negative correlation between high BMI and flexibility (Amandito et al., 2014; Gilleard et al., 2007). Other factors, such as anthropometric changes and muscle shortening, can also affect flexibility in individuals with high BMI.

Furthermore, gender also emerged as a variable influencing flexibility. Women generally have better flexibility levels than men. This is attributed to hormonal factors, where higher estrogen levels in women contribute to muscle elongation and joint flexibility. Previous studies have shown that women achieve higher Sit and Reach Test scores compared to men, corroborating the findings of this study (Minarro et al., 2009).

Age also plays a significant role in influencing flexibility. Within the age group of 17–21 years, subjects are in the peak developmental phase of flexibility. Muscle elasticity and joint flexibility are typically optimal at this age before gradually declining due to the aging process. Previous studies have reported that flexibility peaks during adolescence and begins to decrease in adulthood due to reduced tissue elasticity and increased joint stiffness (Harsono, 2012; Alter, 2012).

This study underscores the importance of considering BMI, gender, and age when analyzing trunk flexibility. With subjects aged 17–21 years, having a normal BMI and appropriate activity levels, the findings reflect an optimal group for observing the effects of Swiss ball exercises on flexibility. These findings align with existing literature, providing a solid foundation for further research in the context of flexibility training.

2. Specific Data on Subjects

Trunk flexibility in this study was measured using the Sit and Reach Test (SRT), which evaluates the flexibility of the lower back, hip, and hamstring muscles. Before the Swiss ball exercises, the average pretest SRT score was 30.82 cm (categorized as average), with a range of 20.5–46 cm. After a four-week intervention, the average posttest score increased to 37.94 cm (categorized as above average), with a range of 28–48 cm.

The average improvement of 7.12 cm indicates the effectiveness of the Swiss ball exercises in enhancing trunk flexibility. A normality test using the Shapiro-Wilk method confirmed that the pretest and posttest data followed a normal distribution ($p>0.05p > 0.05p>0.05$). These results affirm that Swiss ball exercises significantly improve trunk flexibility in adolescents aged 17–21 years with sedentary habits.

3. The Effect of Swiss Ball Exercises on Trunk Flexibility in Adolescents Aged 17–21 Years

The study findings demonstrate that Swiss ball exercises have a significant impact on improving trunk flexibility in adolescents aged 17–21 years. The normality test using the Shapiro-Wilk method confirmed that the pretest and posttest data were normally distributed, allowing the paired t-test to measure differences before and after the intervention. The paired t-test results yielded a ppp-value of $4.91×10−84.91 \times 10^{-8}4.91×10−8$ ($p<0.05p < 0.05p<0.05$), indicating a significant increase in trunk flexibility following the Swiss ball exercises.

This study aligns with previous research that utilized the Sit and Reach Test (SRT) to evaluate trunk flexibility. For instance, a study by Sari et al. (2017) compared Swiss ball exercises and Pilates exercises among university students, showing that Swiss ball exercises were more effective in improving flexibility, with an average pretest-posttest difference of 8.1 cm compared to 6.8 cm for Pilates. This finding is supported by another study conducted on female students at the Health Polytechnic of Surakarta, which also reported a significant increase in SRT scores

after nine weeks of Swiss ball exercises (Rahmawati et al., 2015).

Swiss ball exercises involve movements that activate the abdominal and intervertebral muscles, improving joint stability, muscle strength, and proprioception. These exercises are effective in enhancing trunk function by strengthening the lower back muscles, improving dynamic balance, and increasing flexibility. Research by Sekendiz (2010) also confirmed that 12 weeks of Swiss ball exercises improved trunk flexibility and lower back muscle endurance in female office workers, supporting the findings of this study.

Swiss ball exercises offer additional benefits by engaging the entire body, unlike floor-based exercises, which are more limited. The use of a ball increases the range of motion, spinal stability, and flexibility through dynamic exercises. Furthermore, it positively impacts lumbar and pelvic spine control, contributing to better posture maintenance. With these various benefits, Swiss ball exercises can serve as an effective alternative for improving flexibility, particularly in the adolescent age group of 17–21 years.

The results of this study affirm that Swiss ball exercises are an efficient training method for enhancing trunk flexibility. These findings are particularly relevant to adolescents, who are at the peak of flexibility development, and can be used as an effective intervention to reduce the risk of musculoskeletal disorders caused by sedentary activities.

4. Limitations and Risks of the Study

The subjects of this study included both male and female university students, acknowledging that gender differences in flexibility may have influenced the results. The second limitation of this study was the lack of examination for hamstring tightness, which could potentially affect the measurements. The third limitation was that the researcher conducted data assessments directly without involving an instructor to assist with data evaluation. Although the researcher made every effort to maintain neutrality during the assessments, there is a possibility of bias or lack of objectivity in the results.

The risks or side effects potentially encountered during the study included dizziness, particularly during exercises that involved a head-down position, as well as pain caused by stretching of the vertebrae and hamstring muscles. Other risks included muscle cramps and injuries. However, no side effects were observed during the study.

Conclusion

The average Sit and Reach Test (SRT) measurement before the exercise was 30.82 cm, indicating that the subjects had an average SRT score. After the exercise, the average increased to 37.94 cm, placing the subjects in the above-average category. This demonstrates an improvement in trunk flexibility following the Swiss ball exercises. It can thus be concluded that there was a significant difference in the measurements, confirming that Swiss ball exercises had an effect on trunk flexibility in adolescents aged 17–21 years.

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