



The Effect of Pilates Exercise on the Muscle Strength of Female Students: A Case Study in Gorgan, Iran

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Received 2022 November 22; Revised 2022 December 17; Accepted 2022 December 20.

Abstract

Background: Physical activities in adolescence are one of the critical health concepts in adolescents, especially females, because they are prone to musculoskeletal disorders due to the weakness of the trunk muscles.

Objectives: This study aimed to determine the effect of Pilates exercise on the muscle strength of female students aged 13 - 15 years.

Methods: This research was conducted on 50 girl students of the first secondary school in Gorgan, Iran, in 2022, who were selected by a multi-stage cluster sampling method. The samples were divided into case and control groups. The test group received eight sessions (30 - 45 minutes) of Pilates twice a week for four weeks. The control group performed routine school sports. The results were analyzed using inferential statistics and SPSS software version 21.

Results: The independent *t*-test showed a significant difference between the Pilates and control groups for upper ($P < 0.01$) and lower body muscles ($P < 0.01$). In addition, the ANCOVA test showed a significant difference between the two groups in terms of upper-body ($P < 0.01$) and lower-body muscle strength ($P < 0.01$) by removing the pre-test effect.

Conclusions: Based on the results, Pilates exercises strengthened female students' upper and lower body muscles. This sports method is inexpensive and does not require a large space or facilities. Therefore, educational and health managers in schools can use this sports method to strengthen students' physical and mental health.

Keywords: Pilates, Muscle Strength, Students, Girl

1. Background

Today, physical activities have decreased due to various reasons such as the development of new technologies, changes in lifestyle, and the tendency of people to engage in mental activities (1-3). The most significant decrease in physical activity is in children and adolescents, especially girls (4). Currently, only 20 - 25% of girls and 35 - 40% of boys act based on the World Health Organization (WHO) guidelines to do at least 60 minutes of moderate to vigorous physical activity during the day (5).

Physical activities in adolescence improve health in adulthood (6-9). Therefore, physical activity in adolescence is a critical concept in health (5). Muscular and skeletal disorders are one of the common problems of inactivity in adolescents, especially adolescent girls, which is often caused by the weakness of the trunk and skeletal muscles

(10-12). Muscle defect in the spine decreases balance and impairs movement function, causing back pain in adolescence and adulthood (13).

Meanwhile, exercise is essential in increasing muscle endurance (14). Exercise strengthens anabolic increases growth hormone and protein synthesis, following the growth factors of muscle hypertrophy and physical fitness (15). Therefore, sports training effectively increases muscle strength and creates physical fitness (16, 17).

Pilates is one of the most effective traditional functional exercises recommended to improve individual balance (18). These exercises simultaneously coordinate several muscle groups and positively affect the body's general flexibility and health by strengthening the trunk, body position, and breathing with body movements (19).

Pilates is a set of sports exercises that engages the body and brain to strengthen all body parts, increase endurance,

and target the deepest part of the body muscles (16). Muscles emphasize that the purpose of these exercises is to strengthen the muscles to keep the body balanced (20). Therefore, school sports are an excellent training opportunity and physical activity (3). Performing these exercises does not require special skills and equipment and can be used on a mat for people with a normal physical fitness level (21).

2. Objectives

This research aimed to investigate the effect of Pilates on the muscle strength of female students in Gorgan, Iran.

3. Methods

This experimental study was conducted on two Pilates groups (25 people) and a control group (25 people) using the cluster sampling method on female students of the first secondary school in Gorgan, Iran, in 2022, who were selected by the multi-stage clustering. The inclusion criteria were 13-15-year-old female students, a lack of a history of musculoskeletal abnormalities based on the self-report form at the beginning of the study, and the written consent of the student's parents to participate in this study. The exclusion criteria were unwillingness to continue participating in sports sessions and the absence of more than two sessions in Pilates exercises. First, a list of the first secondary girl schools in Gorgan was prepared. Then, three schools were selected as research environments by simple random and lottery methods. The students' health records were examined with the help of the sports coach and the health care coach after explaining the research objectives to the managers and sports coaches of these schools and getting their participation. Then, a list of people who met the conditions to participate in this study was prepared, and the research units were selected by a simple random method. In the next stage, the research units were re-divided into two test and control groups by lottery. The researcher assured parents and research units about the safety of the study and the confidentiality of the study results before conducting the study. Participants could also withdraw from the study if they were unwilling during the research.

To conduct this research, two researchers recorded the upper and lower body muscle strength of the Pilates and control groups before conducting the study. The test group received eight sessions (30 - 45 minutes) of Pilates exercise twice a week. In addition, the researcher taught the Pilates group how to do these exercises twice a week at home.

Meanwhile, the control group performed routine school sports.

The one-repetition max (1RM) test was used as a standard test to measure upper and lower body muscle strength. The validity and reliability of this tool were confirmed in several previous similar studies. Prior to conducting this study, the validity of the questionnaire was confirmed by ten colleagues with master's degree and Ph.D. in physical education. In this method, the participants were asked to lift their maximum weight to determine the 1RM after a proper warm-up. Further, the participants were asked to use the metal weight ten times to evaluate the upper body muscles by the chest press method and lower body muscles by the leg squat method. Then, the muscle strength was examined based on the equation 1.

$$RM = \frac{Moved\ weight\ (kg)}{[1.0278 - (no.\ of\ repetitions\ until\ exhaustion \times 0.0278)]}$$

The collected data related to demographic characteristics and measurement of upper and lower body muscle strength were imported to SPSS software version 21. Then, the data were analyzed by inferential statistics (paired *t*-test, independent *t*-test, and ANCOVA test) at a significance level of 0.05 after determining the normality of the results.

4. Results

The average age of the Pilates and control groups were 13.84 ± 0.74 and 14.08 ± 0.81 , respectively. The independent *t*-test showed no significant difference between the two groups ($P = 0.28$). The average weight was 36.56 ± 7.01 in the Pilates and 38.36 ± 6.59 in the control group. There was no significant difference between the test and control groups for this variable ($P = 0.35$), according to the independent *t*-test. The average height of the Pilates group was 159.01 ± 5.41 and 160.01 ± 6.52 for the control group, with no significant difference based on the independent *t*-test ($P = 0.45$). The leg length was 89.84 ± 8.3 in the Pilates group and 91.88 ± 8.32 in the control group, and the independent *t*-test did not show a significant difference ($P = 0.1$).

In the control group, the muscle strength of the upper body was 30.86 ± 7.68 before the intervention and 33.15 ± 5.91 after the intervention. The paired *t*-test showed that the average upper body muscle strength had no significant difference ($P = 0.15$). In addition, the muscle strength of the lower body was 37.38 ± 7.21 before and 38.75 ± 5.41 after the intervention. The paired *t*-test did not show a significant difference between muscle strength in the control group ($P = 0.33$) (Table 1).

Table 1. Comparison of Muscle Strength of the Participants in the Pilates Group and the Control Group Before and After the Intervention

Groups	Before Intervention		After Intervention		P-Value	
	Upper Body	Lower Body	Upper Body	Lower Body	Upper Body	Lower Body
Control	30.86 ± 7.68	37.38 ± 7.21	33.15 ± 5.91	38.75 ± 5.41	0.15	0.33
Pilates	33.99 ± 2.57	37.49 ± 3.52	37.47 ± 4.89	41.55 ± 6.37	< 0.01	< 0.01
P-value	0.27	0.66	< 0.01	< 0.01	-	-

In the Pilates group, the muscle strength of the upper body was 33.99 ± 2.57 before the intervention and 37.47 ± 4.89 after the intervention. The paired *t*-test showed that the average upper body muscle strength significantly differed ($P < 0.01$). Further, the muscle strength of the lower body was 37.49 ± 3.52 before and 41.55 ± 6.37 after the intervention. The paired *t*-test showed a significant difference between muscle strength in the control group ($P < 0.01$) (Table 1).

Furthermore, the independent *t*-test showed no significant difference before the intervention in the average muscle strength of the upper ($P = 0.27$) and lower ($P = 0.66$) body between the Pilates and control groups. There was a significant difference between the test and control groups in upper and lower body muscle strength after the intervention ($P < 0.01$) (Table 1).

ANCOVA test showed a significant difference in upper body muscle strength by removing the pre-test effect ($P < 0.01$, $\eta^2 = 0.11$). About 11% of the changes in upper body muscle strength were related to Pilates exercise (Table 2). Based on the ANCOVA test, removing the pre-test effect showed a significant difference in lower body muscle strength ($P < 0.01$, $\eta^2 = 0.1$). Approximately 10% of lower body muscle strength changes are related to Pilates exercise (Table 3).

5. Discussion

This study showed that Pilates exercise increases the strength of female students' upper a. These results were consistent with other similar studies. Rezaei et al. reported that Pilates exercises positively affected the strength of abdominal and trunk muscles (22). Rahmani et al. stated that Pilates strengthens physical strength and muscles (23). Based on Hosswini et al., muscle exercises increase endurance and trunk muscles (24). In addition, Shahrokhi et al. found that eight weeks of Pilates exercises increase abdominal muscle strength and reduce back pain (25).

Gala-Alarcon et al. evaluated the effect of Pilates exercises on the abdominal muscles and showed a direct relationship between Pilates exercises and strengthening the

abdominal muscles (26). Ebrahimi concluded that Pilates exercise improves the flexibility and balance of all the superficial and deep muscles of the body (27). Afroudeh investigated the effect of Pilates exercises on lumbar lordosis and showed that strengthening the quadriceps, hamstring, abdominal, and back muscles reduces the amount of lumbar lordosis (28). Okhli et al. indicated that Pilates exercises significantly affect lower muscles and the correction of lumbar lordosis in high school girls ($P = 0.001$) (10).

Pilates is a set of specialized exercises involving the body and brain to increase the endurance and flexibility of the body (24). In addition, Pilates is a set of technical activities and exercises that reduce body fat percentage, increase muscle strength (27), maintain body balance, and improve spine condition (29). Pilates exercises are influential in stretching the lumbar muscles and hip flexors. Further, Pilates plays a vital role in increasing the strength and endurance of the whole body by focusing on the body center and strengthening the abdominal and pelvic muscles (10). Based on the results of this study and similar research, Pilates focuses on improving muscle control, enhancing balance, maintaining the organs, and performing daily movements correctly. Pilates engages the body and brain to increase the strength and endurance of all body parts and target the deepest part of the muscles (30). In addition to the advantages mentioned above, Pilates exercises increase physical and mental health (31).

One of the research limitations was the COVID-19 outbreak and the lack of acceptance of some parents to participate. The researcher tried to control this limitation to some extent by explaining the research objectives and informing the parents, students, administrators, and teachers.

Based on the results, Pilates increased the upper and lower body muscle strength of high school female students, maintained balance, and prevented musculoskeletal disorders. Since this sport has a high-performance capability and is effective, it can be used as a low-cost, attractive, and effective recreational method to increase physical activity among adolescents, especially girls.

Table 2. The effect of Pilates Exercise on the Strength of Upper Body Muscles of Female Students

Variables	Sum of Squares	df	Mean of Squares	F	Eta	P-Value
Modified model	330.89	2	165	5.9	0.3	0.005
Post-test separator	1123.95	1	1123.95	40.18	0.446	0.01
Group	173.06	1	173.06	3.48	0.11	< 0.01
Error	1314.38	47	27.98	6.18		
Sum	64004.8	50				
Total	1645.9	49				

Table 3. The effect of Pilates Exercise on the Strength of Lower Body Muscles of Female Students

Variables	Sum of Squares	df	Mean of Squares	F	Eta	P-Value
Modified model	225.5	2	112.75	3.41	0.12	0.04
Post-test separator	934.45	1	934.45	28.29	0.37	< 0.01
Group	95.48	1	95.48	3.86	0.1	0.04
Error	1574.21	47	33.03	2.89		
Sum	82386.87	50				
Total	1777.71	49				

Acknowledgments

The authors would like to express their gratitude to all participants and their parents who helped to conduct this research.

Footnotes

Authors' Contribution: N. B.; data curation, formal analysis, software, writing-original draft, writing review, and editing; N.H.; supervision, investigation, methodology, project administration, and data curation; F. J., F. F., T.H.T and F.R.N; formal analysis, methodology, and data curation.

Conflict of Interests: Authors declare no conflict of interest.

Ethical Approval: The study protocol was approved by the Ethics Committee of Aliabad Katoul Branch, Islamic Azad University, Aliabad Katoul, Iran (Ethic code: IR.IAU.CHALUS.REC.1400.057 and IRCT ID: IRCT20211212053363N1). Available at: <https://www.irct.ir/trial/60623>

Funding/Support: This study was supported by Aliabad Katoul Branch, Islamic Azad University, Aliabad Katoul, Iran (Grant number: 162422112). Available at: <https://aliabad.iau.ir/en>

Informed Consent: Verbal consent was obtained from the participants to participate in the present study.

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