

7-3-2026

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Recommended Citation

Maara, Haneen Hussein and Malih, Fatimah Abed (2026) "The Effect of Wall-Based Pilates Exercises on Core Muscle Strength in Fitness Classes," *Modern Sport*: Vol. 25: Iss. 3, Article 1.
DOI: <https://doi.org/10.54702/2708-3454.2121>

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SPECIAL ISSUE ARTICLE

The Effect of Wall-Based Pilates Exercises on Core Muscle Strength in Fitness Classes

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Abstract

Physical fitness is an essential component of health and plays an important role in the performance of female students in the College of Physical Education and Sports Sciences for Women. Muscular strength is one of the key components necessary to meet the physical requirements of practical classes. In the absence of sufficient physical fitness, students may not be able to perform or master the basic skills of various sports activities. Physical fitness is closely connected with the proper functioning of the nervous and muscular systems. Hence, this study aimed to examine the effect of wall-based Pilates exercises on core muscle strength among first-year female students at the College of Physical Education and Sports Sciences for Women, University of Baghdad. An experimental design was used in this study. The sample consisted of 40 students who were divided into two equal groups. The experimental group performed wall-based Pilates exercises for a period of 10 weeks, while the control group used traditional Pilates exercises. Post-test comparisons of the mean scores showed that the experimental group outperformed the control group in core muscle strength tests (push-up, squat, and sit-up). The experimental group, which performed wall-based Pilates exercises, achieved mean scores of 25.9, 29, and 29.2, respectively. In contrast, the control group recorded lower mean scores of 19.1, 24, and 24.25. The calculated t-values were 12.52, 3.66, and 6.19, respectively. All differences were statistically significant at $p < .05$ in favor of the experimental group, indicating that wall-based Pilates exercises were more effective than traditional Pilates exercises. The study recommends adopting these exercises due to their effectiveness and safety without requiring expensive equipment while supporting Sustainable Development Goal 3 (Good Health and Well-Being).

Keywords: Wall-based pilates, Exercises, Core muscles strength, Physical fitness

1. Introduction

Physical fitness and health are major concern in developed countries. Regular and continuous physical activity helps improve physical and mental health and supports general well being. It is also linked with a longer life expectancy across populations worldwide (Booth et al., 2012). Accordingly, the World Health Organization (WHO) recommends muscle strengthening activities that target all major muscle groups. These activities should be performed at moderate to high intensity at least twice per week (Kohl et al., 2012). Wall-based Pilates exercises are considered an innovative training method. This approach uses the wall as a supportive tool that enhances the effectiveness of exercise routines. Through wall support

and resistance, these exercises help develop muscular strength, flexibility, and body awareness. In addition, wall-based Pilates provides a practical and accessible form of physical training suitable for various age groups to improve health fitness (Ogle, 2019). In its early stages, Pilates training focused on strengthening the core muscles and improving flexibility through floor exercises and the use of special rollers. With time, other tools such as walls, small balls, and elastic bands were introduced to provide additional support during exercise. This led to the development of wall-based Pilates exercises.

These exercises focus on strengthening the core muscles and improving balance by using the wall as a supportive surface. The wall increases the challenge for stabilizing muscles and enhances coordination

Received 20 January 2026; revised 26 February 2026; accepted 16 March 2026.
Available online 3 July 2026

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<https://doi.org/10.54702/2708-3454.2121>

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between muscle groups, which helps improve body stability. Through reviewing published studies in academic databases that addressed the use of wall exercises and their effects on health-related fitness, it was found that Pilates exercises consist of a series of physical training activities performed using different equipment such as balls and ropes without a wall. These exercises aim to enhance strength, endurance, flexibility, and balance. They also contribute to comprehensive physical conditioning and body rehabilitation (Abdullah & Wahba, 2010, p. 482).

According to Ahmed et al. (2022, p. 140), wall-based Pilates exercises are considered one of the modern exercise methods. They involve a set of movements designed to strengthen the core muscles and improve body balance. These exercises also play an important role in body rehabilitation and injury prevention. Furthermore, they provide therapeutic benefits that help individuals recover and return to their normal daily activities.

Faraj (2013, p. 385) indicated in her study that these exercises help improve muscular strength, muscle tone, flexibility, and body balance. They also contribute to achieving optimal athletic performance. These exercises treat the body as a unified system, and wall-based Pilates focuses on training all parts of the body.

Abdullah and Abdulkarim (2024, p. 42) confirmed that exercises designed according to the Pilates approach contribute to improving certain physical abilities and offensive skills among players at the National Center for Sports Talent Development. Based on this perspective, the importance of this research lies in applying wall-based Pilates exercises to enhance core muscle strength among first-year female students without the need for costly equipment or special training tools in gymnasiums or fitness sessions in colleges of physical education and sports sciences. By understanding the execution principles, advantages, and common errors to avoid, these exercises can be incorporated into an effective program for developing core muscle strength and improving physical fitness and well-being. Physical fitness is one of the most important factors for female students in colleges of physical education and sports sciences. Muscular strength, in particular, is necessary for performing the movement elements needed in these practical lessons. When students lack sufficient physical fitness, it becomes very difficult for them to perform or master basic sports skills. They may also be unable to perform the physical and motor tasks needed in sports activities or everyday life. Physical fitness is strongly linked to the functioning of the nervous and muscular systems, which

reflect the student's physical condition and health status.

This study presents wall-based Pilates exercises and considers the general trends in their use. It also highlights the need to identify relatively understudied areas of research. The results may guide future research and support the development of strategies related to the impact of these exercises on students' muscular strength. Furthermore, these exercises may help address several physical and health fitness challenges among different groups of individuals.

Based on this perspective, the researchers ask the following question:

Are wall-based Pilates exercises effective in strengthening the core muscles of first-year female students?

2. Research methodology

2.1. Research method

An experimental method was adopted in this study. The design involved two equivalent groups with pre-test and post-test measurements in order to examine the research problem.

2.2. Research population and sample

The study population included 68 first-year female students enrolled at the College of Physical Education and Sports Sciences for Women, University of Baghdad, during the academic year 2024–2025. These students were distributed into three classes. The study sample was selected using a random method from two sections, namely Class B (20 students) and Class C (20 students). As a result, the sample included 40 students, representing 58.8% of the total population. The two classes were randomly assigned as an experimental group and a control group. Table 1.1 shows that the skewness coefficient values fall within ± 1 , indicating that the population is normally distributed.

2.3. Instruments, equipment, and data collection tools

- Arabic and international academic references.
- A smooth wall with dimensions of 15 meters in length and 3 meters in height.
- A Casio electronic stopwatch.
- A 20-meter leather measuring tape.
- A personal laptop computer (HP).
- A height and weight measuring device.
- A chair and a floor exercise mat.

Table 1.1. Illustrates the normal distribution of the study sample.

Variables	Unit of Measurement	Mean (Average)	Median	Standard Deviation	Skewness Coefficient
Height	centimeter	169	168	2.52	0.29
Weight	kilograms	60.27	60	3.41	0.37
Age	years	18.6	18.5	0.42	0.59

2.4. Tests used

2.4.1. Push up test

The Push-up test is a widely used, simple and effective fitness assessment to measure upper body muscular strength and endurance. The test assesses the strength of the pectoralis major (chest), anterior deltoids (shoulders), and triceps muscles.

- Starting Position: Begin on your hands and knees, with hands shoulder-width apart and arms fully extended. Drop your hips slightly so there is a straight line from your shoulders to your knees.
- The Movement: Lower your body until your elbows reach a 90-degree angle or your chest approaches the ground.
- Return: Push back up to the starting position with arms fully extended.
- Scoring: Count the maximum number of repetitions performed correctly.

2.4.2. The bodyweight squat test (Wood, 2010)

The test measures how many squats an individual can perform with proper form before fatigue. Taking into account ankle mobility, core stability, and hip position.

How to Perform the Test

- Warm-up: Perform a brief warm-up for 5–10 minutes.
- Starting Position: Stand upright with feet shoulder-width apart, facing away from the chair. Hands can be placed on the hips or extended forward for balance.
- The Movement: Squat down in a controlled manner as if sitting in the chair. The goal is to lightly touch the chair with the backside or reach at least a 90-degree knee angle (thighs parallel to the ground).
- Return to Start: Immediately stand back up to the starting, fully extended position.
- Repetitions: Repeat this sequence until proper form can no longer be maintained or the individual is unable to continue the movement.
- Scoring: The total number of complete and correct repetitions was recorded.

2.4.3. The sit-up test (Ferguson, 2014)

The test is a measure of muscular endurance in the abdominal and hip-flexor muscles.

How to Perform the Test

- The Setup: Lie on your back on the mat. Bend your knees at a 90-degree angle, place your feet flat on the floor, Cross your arms over your chest (fingertips touching opposite shoulders) OR place your hands behind your ears. Do not interlock fingers behind your head, as this encourages pulling on the neck.
- Partner: Have your partner hold your ankles firmly to keep your feet on the ground.
- The Movement: Curl your upper body up until your elbows touch your thighs (or until your back is vertical), Lower your back until your shoulder blades touch the floor, Exhale on the way up, inhale on the way down.
- Scoring: The total number of repetitions completed within 60 seconds is recorded.

2.5. Pilot study

A pilot study was conducted for the research tests on Wednesday, 05-02-2025, at 10:00 a.m. The pilot sample included six female students from Section A. This study was carried out to identify any difficulties that might arise during the implementation of the tests and to evaluate the effectiveness of the equipment and the testing procedures.

A second pilot experiment was carried out for the wall-based Pilates exercises on Thursday, 06-02-2025, at 10:00 a.m. using the pilot sample. The purpose of this trial was to identify any potential difficulties that might occur when applying these exercises.

2.6. Main experiment

2.6.1. Pre-test

The pre-test was conducted for both the experimental and control groups on Thursday, 13-02-2025, at 10:00 a.m. in the fitness hall. The participants first completed a warm-up before the tests were carried out. All temporal and spatial conditions were kept

Table 2.2. Presents the equivalence of the experimental and control groups in the pre-test based on the t-test and their homogeneity according to Levene's test.

Group Statistics	Independent Samples Test						
	Mean	Std. Deviation	Levene's Test	Sig	T- Test	Sig	Significance
Push-Up Test							
Experimental	17.9	1.58	0.926	0.342	1.095	0.280	Non-significant
Control	17.3	1.86					
Bodyweight Squat Test							
Experimental	21.75	3.33	1.962	0.169	0.420	0.677	Non-significant
Control	22.15	2.64					
Sit-Up Test							
Experimental	22.7	1.97	2.235	0.143	0.731	0.469	Non-significant
Control	22.1	3.09					

Statistically significant at the 0.05 level.

consistent to ensure that they would be identical to those used in the post-tests.

After the research sample was randomly distributed, the equivalence between the experimental and control groups was confirmed in the pre-test. As illustrated in Table 2.2, the results indicate that the two groups were equivalent and homogeneous.

2.6.2. Implementation of wall-based pilates exercises

Following the preparation of the wall-based Pilates exercises, they were implemented with the experimental group during the main section of the fitness class. The training sessions were conducted on Sunday for two hours and on Tuesday for two hours, resulting in four hours of training per week over ten weeks. The program was designed according to the principles of progressive training and variation between exercises, training units, and weekly sessions. Different muscle groups were also alternated between exercises.

The training load in this program was structured based on the duration of exercise performance, as follows:

- 20 seconds of performance: 5 repetitions in 5 sets, with a total training volume of 25 repetitions and a work–rest ratio of 1:3.
- 30 seconds of performance: 5 repetitions in 4 sets, with a total training volume of 20 repetitions and a work–rest ratio of 1:3.
- 40 seconds of performance: 5 repetitions in 3 sets, with a total training volume of 15 repetitions and a work–rest ratio of 1:3.
- 60 seconds of performance: 5 repetitions in 2 sets, with a total training volume of 10 repetitions and a work–rest ratio of 1:2.

The total duration of each training session was (120) minutes. It consisted of (20) minutes for the preparatory part, (90) minutes for the main part, and (10) minutes for the concluding part. From the main part,

30–40 minutes were devoted to implementing the experiment (independent variable), while the remaining time was used to perform the other parts of the training session. The control group followed their regular training program, which included Pilates exercises without using the wall, while maintaining the same training duration.

The experiment began on 16-02-2025 and ended on 22-04-2025.

2.6.3. Post-tests

The post-tests were conducted after the completion of the main experiment for both the experimental and control groups. These tests took place on Thursday, 24-04-2025, at 10:00 a.m. The participants performed a warm-up before the tests were carried out. The same temporal and spatial conditions used in the pre-tests were maintained.

2.7. Statistical procedures

All data collected were analyzed through SPSS software. The statistical techniques applied included the mean, standard deviation, skewness coefficient, Levene's test, independent samples t-test, and paired samples t-test.

3. Presentation and discussion of the results

3.1. Presentation of the results

The results in Tables 3.1 to 3.3 and Fig. 3.1 show that the experimental group improved more in the core muscle strength tests than the control group. This improvement may be due to the use of wall-based Pilates exercises. These exercises provide a safe and effective training method, especially for female students in the College of Physical Education and Sports Sciences who have lower levels of physical fitness.

Table 3.1. Presents the statistical indicators between the pre-test and post-test for the control group sample.

Group Statistics	Paired Samples Test						
	Mean	Std. Deviation	Paired Differences		t-test	Sig	Significance
			Mean	Std. D			
Push-Up Test							
pre-test	17.3	1.86	1.8	0.67	12.33	0.000	significant
post-test	19.15	2					
Bodyweight Squat Test							
pre-test	22.15	2.64	2.15	0.81	11.83	0.000	significant
post-test	24.3	2.53					
Sit-Up Test							
pre-test	22.1	3.0	2.15	0.87	10.98	0.000	significant
post-test	24.25	2.98					

Statistically significant at the 0.05 level.

Table 3.2. Presents the statistical indicators between the pre-test and post-test for the experimental group sample.

Group Statistics	Paired Samples Test						
	Mean	Std. Deviation	Paired Differences		t-test	Sig	Significance
			Mean	Std. D			
Push-ups Test							
pre-test	17.9	1.58	8	2.0	17.22	0.000	significant
post-test	25.9	1.33					
Bodyweight Squat Test							
pre-test	21.75	3.33	7.7	3.24	10.68	0.000	significant
post-test	29.5	5.8					
Sit-Up Test							
pre-test	22.7	1.97	6.5	2.09	13.9	0.000	significant
post-test	29.2	1.96					

Statistically significant at the 0.05 level.

Table 3.3. Presents the statistical indicators between the experimental and control groups in the post-test.

Group Statistics	Independent Samples Test				
	Mean	Std. Deviation	T-Test	Sig	Significance
Push-Up Test					
Experimental	25.9	1.33	12.52	0.000	significant
Control	19.1	2			
Bodyweight Squat Test					
Experimental	29.	5.	3.66	0.001	significant
Control	24.	2.53			
Sit-Up Test					
Experimental	29.2	1.96	6.19	0.000	significant
Control	24.25	2.98			

Statistically significant at the 0.05 level.

3.2. Discussion

The researchers believe that the progress of the experimental group is related to the use of wall-based Pilates exercises. The wall provides both support and sensory feedback. Pressing the feet or the back against the wall stimulates the nervous system and increases the activation of motor units in the core muscles, which helps maintain correct posture.

Wall-based Pilates exercises help stabilize the pelvis and the spine. This stabilization occurs through deep activation of the core muscles, including the rectus

abdominis, the oblique muscles, and the transverse abdominis (Kloubec, 2010).

In addition, the use of the wall reduces the student's need to focus on maintaining balance, as occurs in traditional free Pilates exercises. This allows the student to direct more muscular effort toward the trunk region, which helps accelerate the strengthening of the core muscles (Panhan et al., 2019).

Wall-based Pilates exercises involve both static and dynamic contractions to maintain specific joint angles, such as keeping the legs at a 90-degree position against the wall. This position demands constant

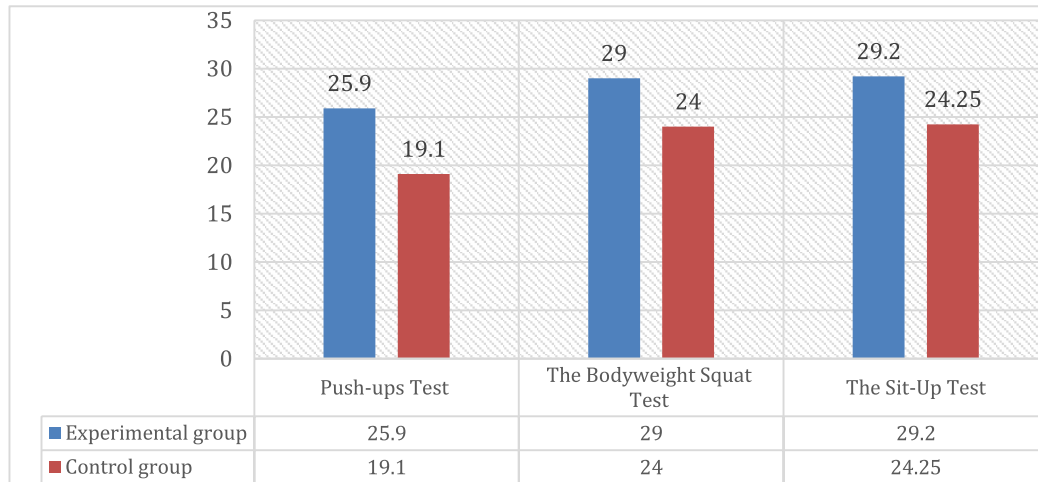


Fig. 3.1. Shows the differences in the mean values between the two research groups.

engagement of the abdominal and back muscles against gravity, contributing the development of muscular strength and endurance. The wall also supports the students' sensorimotor awareness. It assists them in maintaining proper body alignment and enhances the effectiveness of the training load applied to the core muscles.

Sekendiz et al. (2007) found that Pilates exercises lead to significant improvements in trunk strength, muscular endurance, and flexibility among women who are not accustomed to regular physical activity.

Moreover, the wall supports proper spinal alignment. When the spine is in its natural posture, core muscles function more efficiently than in incorrect flexed positions (Tozimen & Yildiz, 2020). Researchers also attribute the experimental group's improvement to the psychological and physical safety of wall-based Pilates exercises. These exercises are classified as low-impact, which reduces fears of injury among students and enables them to give greater effort during training. This has a positive effect on post-test results.

Scientific sources indicate that wall-based Pilates exercises effectively improve muscular strength and endurance of the trunk region (Isacowitz & Clippinger, 2020).

The present study also relies on using the wall as a supportive tool based on the principle of the closed kinetic chain. This principle has been shown to improve joint proprioception and increase body stability (Karahana et al., 2014).

Performing the exercises with wall support helps ensure the proper activation of the transverse abdominis and the oblique muscles. Studies using electromyography (EMG) have confirmed the importance of activating these muscles to achieve lumbopelvic stability (Phrompaet et al., 2011).

This training approach is suitable for first-year female students because they often need exercise programs and postural adjustments that match their physical fitness level.

4. Conclusions and recommendations

4.1. Conclusions

Based on the presentation and discussion of the results, the study reached the following conclusions:

Wall-based Pilates exercises showed a positive effect in improving arm strength endurance, leg muscle strength, and abdominal muscle strength.

The experimental group that performed wall-based Pilates exercises outperformed the control group in the push-up, squat, and sit-up tests. This indicates that wall-based Pilates exercises were more effective than traditional Pilates exercises performed by the control group.

The results also indicate that wall-based Pilates exercises had a comprehensive effect on the main muscle groups of the body. The improvement was balanced and was not limited to one specific muscle group.

4.2. Recommendations

According to the findings of the present study, the researchers propose the following recommendations:

1. It is recommended to incorporate wall-based Pilates exercises into training sessions for the target group due to their effectiveness in improving muscular strength and endurance.
2. Core and abdominal exercises, such as the sit-up exercise, should be emphasized in training

programs because they play an important role in improving general physical fitness.

3. Training programs should also include body-weight exercises (calisthenics), such as push-ups and squats. These exercises are effective for developing muscular strength without requiring special equipment.
4. More research should be conducted on different age groups and on additional physical or skill-related variables that were not addressed in the present study.
5. Regular fitness tests should be performed to monitor physical development and to adjust the training loads of female students in the College of Physical Education and Sports Sciences.

Author's declaration

Conflicts of interest

None.

We confirm that all tables and figures in this article are ours and written by the researchers themselves.

Ethical clearance

This manuscript approved by the Scientific Committee of the College of Physical Education and Sports Sciences for Women, University of Baghdad, Iraq, on (2025/02/10).

Author's contributions

All contributions to this study were carried out by the researchers **Haneen Hussein Maara**, who conducted the study procedures, collected and organized the data, participated in the implementation of the experimental program, and contributed to drafting the manuscript; **Fatimah Abed Malih**, who developed the research idea, designed the study, supervised the research procedures, interpreted the results, and reviewed and finalized the manuscript, with the assistance of a number of experts: **Prof. Dr. Fatimah Abed Malih** in Statistics and **Asst. Lect. Inam Al-Azzawi** in Translation.

Facilitating the task

This study was supported by the College of Physical Education and Sports Sciences for Women/University of Baghdad.

Roles of each researcher in the research

- **Haneen Hussein Maara** was responsible for participating in the implementation of the study procedures, collecting and organizing the data, assisting in conducting the experimental program, contributing to the interpretation of the results, and assisting in drafting the manuscript.
- **Fatimah Abed Malih** was responsible for the conceptualization of the research idea, study design, literature review, supervision of data collection and experimental procedures, interpretation of the results, reviewing the manuscript, and final revision.

Funding statement

This research received no external funding.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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تأثير تمارين بيلاتس الجدار على تقوية العضلات الأساسية في درس اللياقة

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كلية التربية البدنية وعلوم الرياضة للبنات / جامعة بغداد، العراق.

المستخلص

تعد اللياقة البدنية أهم الركائز الأساسية التي تستند إليها طالبات كلية التربية البدنية وعلوم الرياضة للبنات بشكل عام وقوة عضلات الجسم بشكل خاص لتلبية احتياجاتهم الحركية في الدروس العملية، فالطالبة التي لا تمتلك لياقة بدنية لن تستطيع أداء أو إتقان المهارات الأساسية للفعاليات الرياضية كونها مرتبطة ارتباطاً بأداء الأجهزة العصبية والعضلية والوظيفية. لذا هدفت الدراسة إلى التعرف على تأثير تمارين بيلاتس الجدار في تقوية العضلات الأساسية لدى طالبات المرحلة الأولى بكلية التربية البدنية وعلوم الرياضة للبنات (جامعة بغداد). اعتمد البحث المنهج التجريبي على عينة من (40) طالبة قُسمت بالتساوي إلى مجموعة تجريبية (مارست بيلاتس الجدار لمدة 10 أسابيع) وضابطة (مارست بيلاتس تقليدي). أظهرت نتائج المقارنات البعدية في الأوساط الحسابية تفوق المجموعة التجريبية التي خضعت لتطبيق تمارين بيلاتس الجدار على المجموعة الضابطة في اختبارات قوة العضلات الأساسية (الضغط، والقفصاء، والجلوس من الرقود) إذ حققت أوساط حسابية (25.9)، (29)، (29.2) على التوالي، بينما حققت المجموعة الضابطة أوساط حسابية أقل (19.1)، (24)، (24.25) وبلغت قيم (T) المحسوبة (12.52)، (3.66)، (6.19) على التوالي عند مستوى خطأ أقل من مستوى دلالة (0.05) ولمصلحة المجموعة التجريبية. مما يؤكد أن تمارين بيلاتس الجدار كانت أكثر تأثيراً من تمارين البيلاتس وحدها مع المجموعة الضابطة. أوصت الدراسة باعتماد هذه التمارين لفاعليتها العالية، لأمانها، وعدم حاجتها لمعدات مكلفة. وبذلك تحقق هذه الدراسة الهدف الثالث (الصحة الجيدة والرفاه) من أهداف التنمية المستدامة.

الكلمات المفتاحية: تمارين، بيلاتس الجدار، تقوية العضلات الأساسية، لياقة بدنية