Alberta Journal of Educational Research

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Volume 70, Number 1, Spring 2024

70th Anniversary Issue

URI: https://id.erudit.org/iderudit/1110072ar
DOI: https://doi.org/10.55016/ojs/ajer.v70i1.77592

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Publisher(s)

Faculty of Education, University of Alberta

ISSN

0002-4805 (print)
1923-1857 (digital)

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Cite this article

Kaouri, I., Argiriadou, E., Katartzi, E., Praskidou, A.-K., Vrabas, I. & Mavrovouniotis, F. (2024). Assessment of the Effectiveness of a Pilates Program on Physical Fitness Among Adolescent Students in School. *Alberta Journal of Educational Research*, *70*(1), 98–113. https://doi.org/10.55016/ojs/ajer.v70i1.77592

Article abstract

The purpose of the present study was to examine the effectiveness of a Pilates program in the context of the physical education course at school, on aerobic capacity, muscular strength, muscular endurance, and flexibility of high school students. The voluntary participants were 42 high school students, aged 15 to 17 years, randomly divided into a Pilates group (PG; n = 24) that were taught and practiced Pilates exercises and a control group (CG; n = 18) that participated in the regular physical education school program, during physical education course at school, twice a week, for 45 minutes, for 10 weeks. After the 10-week period, PG significantly improved in all physical fitness parameters, while CG only in muscular endurance. The results demonstrated the very positive effects of the Pilates program as an alternative form of physical activity during the physical education course at school, on physical fitness parameters of high school students.

Alberta Journal of Educational Research, Vol. 70.1, Spring 2024, 98-113

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The purpose of the present study was to examine the effectiveness of a Pilates program in the context of the physical education course at school, on aerobic capacity, muscular strength, muscular endurance, and flexibility of high school students. The voluntary participants were 42 high school students, aged 15 to 17 years, randomly divided into a Pilates group (PG; n = 24) that were taught and practiced Pilates exercises and a control group (CG; n = 18) that participated in the regular physical education school program, during physical education course at school, twice a week, for 45 minutes, for 10 weeks. After the 10-week period, PG significantly improved in all physical fitness parameters, while CG only in muscular endurance. The results demonstrated the very positive effects of the Pilates program as an alternative form of physical activity during the physical education course at school, on physical fitness parameters of high school students.

Le but de cette étude était d'examiner l'efficacité de l'entrainement base sur des exercices "Pilâtes" dans le cadre d'un cours d'Éducation Physique à l'école, sur la capacité aérobie, la force musculaire, l'endurance musculaire et la flexibilité des élèves de la classe secondaire. Les participants volontaires étaient 42 élèves du secondaire, âgés de 15 à 17 ans, répartis au hasard en un groupe Pilates (PG ; n = 24) qui a appris et pratiqué des exercices de Pilates, et un groupe témoin (CG ; n = 18) qui a participé au programme scolaire régulier d'éducation physique, pendant le cours d'éducation physique à l'école, deux fois par semaine, pendant 45 minutes, pendant 10 semaines. Après la période de 10 semaines, le PG s'est amélioré de manière significative dans tous les paramètres de condition physique, tandis que le CG n'a amélioré que l'endurance musculaire. Les résultats ont démontré les effets très positifs du programme Pilâtes, comme forme alternative d'activité physique à l'école, sur les paramètres de condition physique des élèves du secondaire.

Nowadays, adolescents, in their everyday lives, experience increased schoolwork load, many responsibilities, and reduced available free time, leading to a sedentary lifestyle. In addition, they spend on average 6.1 hours each day as screen time, watching television, or using a computer or other smart technology (Viner & Cole, 2005). Thus, globally, 81% of adolescents aged 11 to 17 are insufficiently physically active (World Health Organization [WHO], 2022). However, this phenomenon does not concern only the lifestyle of adolescents, but also constitutes a risk factor for developing obesity.

Obesity increases the risk of metabolic, vascular, and musculoskeletal disease, as well as

cardiovascular disease, colon cancer, and liver disease (Blair, 2009; Must & Strauss, 1999). Obesity along with inactivity are factors associated with cardiovascular disease, the process of which begins in childhood, continues in adolescence and adulthood, and imparts a heightened risk of premature mortality (Ruiz et al., 2009).

In addition, physical inactivity, sedentary behavior, and low cardiorespiratory fitness are strong risk factors for the development of chronic diseases, resulting in morbidity and mortality, as well as an economic burden to a wider part of society because of health and social care provision, and reduced occupational productivity (Kumar et al., 2015).

Gunnell et al. (1998) examined the relation between body mass index (BMI) measured during childhood and adult all-cause and cardiovascular mortality in a 57-year follow-up of a cohort study. They found that all-cause and cardiovascular mortality were associated with higher childhood BMIs. The researchers concluded that if everyone had a moderate level of cardiorespiratory fitness, overall mortality would be reduced by about 17%, whereas if no one were obese, risk reduction would be only 2–3% (Gunnell et al., 1998). Consequently, it is imperative to increase both physical activity and cardiorespiratory fitness levels to offset the adverse effects of inactivity and sedentary time.

In order for this to happen in adolescents, we must use alternative forms of physical activity that can inspire their participation in physical education classes at school and physical activity outside of school but also form the basis of a lifelong exercise, with many positive effects on physical well-being parameters for adolescents nowadays and for adult citizens in the future (Kaouri et al., 2023). Adolescence represents a critical period of development during which personal lifestyle choices and behavior patterns are established, including the choice to be physically active (Kumar et al., 2015).

One such physical activity is the Pilates method. Participating in Pilates has very positive effects on teenagers and specifically strengthens all the muscles of the body, helps with correct posture, emphasizes upright posture, and improves flexibility, neuromuscular coordination, and motor control. It also improves balance and endurance and prevents injuries. Body functionality, appearance, and overall feeling are enhanced as well. Adolescents who participate in Pilates exercise gain body awareness and an understanding of how the body works while boosting their self-esteem and confidence. Additionally, participating in a Pilates program can help teens with weight management (Ambition Studios, 2019; Bennetto, 2020; González-Gálvez et al., 2015; Mavrovouniotis et al., 2013).

Although the beneficial health changes following a Pilates method program have been reported, no explicit analysis has been performed of its effects on adolescents' physical fitness in a school context. Thus, the purpose of the present study was to examine the effectiveness of a Pilates program, implemented in school physical education course, on physical fitness parameters of high school students due to their participation in the program. It was hypothesized that a Pilates program, implemented in the physical education course at school, would improve physical fitness parameters, such as aerobic capacity, muscular strength, muscular endurance, and flexibility of high school students.

Method

Design

The present research was a 10-week randomized controlled trial in which adolescent students in

1st to 3rd Grade of High school (ages 15 to 17 years old) were randomly assigned to a Pilates group (PG; n = 24) or a control group (CG; n = 18).

Participants

A total of 60 students were contacted. The participants were students from high schools in Katerini, a city in Greece, who volunteered to participate in the study. The inclusion criteria were (a) being physically active in the subject of physical education, (b) no participation in any physical activity/exercise program out of school, and (c) a renewed Individual Student Health Card after a medical check-up. The exclusion criteria were (a) presenting any health problem at the moment of the measures and (b) missing more than 2 sessions of the total number of lessons of the Pilates program. After the exclusion of 9 students who did not meet inclusion criteria, 51 students were randomly assigned simply by lot to either PG (n = 25; 15 females and 10 males) or CG (n = 26; 15 females and 11 males). However, during the research 9 students lost to follow-up (3 students changed school, 3 students had a musculoskeletal injury, and 3 students did not complete the required lesson participation). Finally, PG had 24 students, 14 females, and 10 males, and CG had 18 students, 10 females, and 8 males. All parents and/or guardians signed an informed consent. The study was conducted in accordance with the Declaration of Helsinki and was approved by the Research Ethics Committee of Aristotle University of Thessaloniki.

Procedure

The physical education teacher personally interviewed the students of both groups regarding age, academic performance in their previous school year, and involvement in physical activity outside of school. Then, they participated in tests to assess physical fitness parameters, which were carried out during physical education lessons at school. Lessons included time for demonstration of the tests and instructions concerning correct and safe execution, as well as warm-up time. Then, the PG received a Pilates exercise program implemented over 10 weeks, with 2 sessions/week (45 min/session). Adolescents assigned to the CG attended their usual physical education school program, with the same frequency and duration (2 sessions/week, 45 minutes/session), both in the school context. The personal interviews, measurements, Pilates program, and regular physical education school program were conducted by Ifigeneia Kaouri, physical education teacher and Pilates instructor, with extensive practical experience in Pilates method and physical education teaching.

The Pilates program began at a basic level, incorporating more difficult principles and exercises gradually. Each Pilates session was divided into warm-up, main part, and cool down. The Pilates method exercises are described in the Appendix. For the first 6 lessons, students were considered beginners, in lessons 7–14 they were considered intermediate, and for lessons 15–20 they were considered advanced. In each lesson, the warm-up lasted 5–8 minutes and emphasized breathing exercises; shoulder, chest, and spine mobility; glute and hamstring flexibility; squats; balance in one or two feet; and proper posture exercises (standing position). The main part lasted 32–35 minutes and contained selected exercises from the Appendix (the Hundred, the Roll Up, the Spine Stretch, Bird-Dog, Crunches, the One Leg Circle, the One Leg Stretch, Rolling Back, Plunk & Leg Pull Front, the Saw, Swimming, the Shoulder Bridge). The first 6 lessons (beginners) were based on proper breathing, proper body posture, breath-movement combination, integration of core muscles, and exercise technique, as presented by Joseph Pilates (Pilates, 1945).

During the subsequent 8 lessons (intermediate), the repetitions of the already taught exercises were increased (8–10 repetitions), and basic exercises were developed to intermediate (Preparatory exercise for Teaser, the Double Leg Stretch, Criss Cross, the Double Kick, the Hip Twist with Stretched Arms, the Teaser for intermediate). In the last 6 lessons (advanced), the exercises' technique was perfected, all exercises were performed in their final form and repetitions were increased to 10–12, for 2 sets. Finally, the cool-down lasted 5 minutes and concentrated on breathing, relaxation, and flexibility exercises (Appendix). The intensity of Pilates lessons was high, as students' heart rate (HR) ranged at 180 beats per minute, i.e., at 85–90% of HRmax. Throughout the execution of Pilates exercises, instructions were given, and corrections were made for correct breathing, as well as proper and conscious muscle activation.

Concerning the CG, every lesson in the physical education course was divided into warm-up, main part, and cool down. The warm-up lasted 5–8 minutes and contained a relaxed jog or low-to-moderate intensity group game and stretching, followed by running exercises. The main part of the physical education course lasted 32–35 minutes and included basketball, handball, football, volleyball, ping-pong, badminton, circular-cross training, drills, jumping, throwing, competitive games, and body strengthening. The class ended with a 5-minute cool-down followed by relaxing exercises and stretches.

After the end of the Pilates program and regular physical education school program, the students in both groups participated again in tests concerning the assessment of physical fitness parameters, during physical education lessons at school.

Measurements

Anthropometric Characteristics

Weight was measured using a SECA 762 scale (SECA, Germany), and height using a GPM anthropometer (Siber-Hegner, Switzerland). BMI was calculated with the Quetelet index formula (BMI = weight [kg]/height [m]^2).

Aerobic Capacity

Cooper's 12-minute walk test (Cooper, 1977) was used to assess aerobic capacity. In this test, children walk as fast as possible for 12 minutes and the distance covered is measured in meters (m). The measurement takes place in a specially designed and measured space, meter by meter. To check the reliability of the test, heartbeats per minute are measured at the end of each test, which for all students ranged from 168 to 192 beats per minute. Score: distance covered during this 12-minute walk in m.

Muscular Strength

In order to evaluate muscular strength, the standing long jump, from Eurofit Fitness Tests, was used. In this test, students stand with feet apart at a regular distance (shoulder width), with toes just behind a starting line. With bent knees and both arms at the front and parallel to the ground, students swing both arms, push dynamically, and jump as far as possible. Score: distance from the starting line to the back of students' shoes in centimeters (cm). Two attempts are allowed and the best one is recorded.

Muscular Endurance

To evaluate muscular endurance, the number of trunk curls in 30 seconds, from Eurofit Fitness Tests, was used. In this test, a student lies on a mattress with their back straight and hands behind the neck. Their knees are bent at a 90° angle, heels and soles of the feet touching the mat, with the help of a classmate. The student, starting from a sitting position, lies back on their back so that their shoulders touch the mat, and returns to a sitting position with elbows out and forward so that they touch their knees. The test begins when the timer starts. Score: total number of correct trunk curls achieved in a 30-second time period.

Flexibility

To assess flexibility, the trunk bending from a sitting position with extended knees, from Eurofit Fitness Tests, was used. In this test, a ruler in cm is attached to the edge of a bench or a box. Students bend their torso forward with their arms fully extended as far as they can, while keeping their knees straight. The test is repeated twice, and the best effort is recorded. Score: ruler's mark in cm at the point where students' fingertips reach after bending.

Statistical Analysis

Statistical analysis was performed using the statistical package SPSS 29.0 for windows. G-power analysis was conducted, and the total needed sample size was 27. After analyzing the normality of variables (Kolmogorov-Smirnov test), a t-test for independent samples was used to test the differences between the 2 groups at baseline for anthropometric characteristics. Paired t-test for parametric and Wilcoxon test for nonparametric variables were carried out for each group between the 2 phases of the study regarding physical fitness parameters. The level of significance was set at $p < 0.05$.

Results

Table 1 presents the anthropometric characteristics of the PG who participated in the Pilates program, and the CG who participated in the regular physical education school program. Independent samples t-tests showed that, at baseline, there was no significant difference between the two groups, concerning age, height, weight, and BMI (Table 1).

Table 1

PG's and CG's Anthropometric Characteristics and Statistical Significance

Characteristics	Pilates Group		Control Group		*p*
	M	*SD*	*M*	*SD*	
Age (years)	15.87	0.74	15.44	0.86	0.089
Height (m)	1.69	0.07	1.68	0.07	0.883
Weight (kg)	61.46	10.44	62.0	12.69	0.880
BMI (kg/m^2)	21.17	3.25	21.41	2.80	0.831

Figure 1

Aerobic Capacity of PG and CG Before and After the 10-Week Period

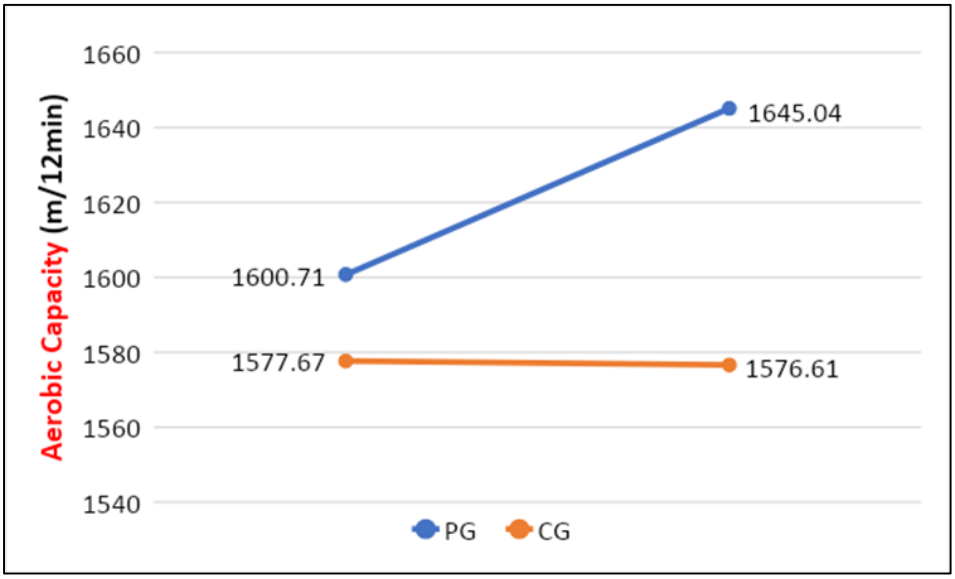


Table 2

Descriptive Data and Differences of Physical Fitness Parameters of PG and CG

Group	Physical Fitness Parameters	Pre 10 weeks		Post 10 weeks		*p*
		M	*SD*	*M*	*SD*	
PG	Aerobic capacity (m covered)	1600.71	110.33	1645.04	112.93	0.001
	Muscular strength (jump length in cm)	153.83	31.99	161.96	34.86	0.001
	Muscular endurance (curls number in 30 sec.)	19.83	4.05	23.63	3.36	0.001
	Flexibility (cm)	20.96	7.56	23.54	6.68	0.001
CG	Aerobic capacity (m covered)	1577.67	107.00	1576.61	112.94	0.846
	Muscular strength (jump length in cm)	161.83	33.19	161.17	33.16	0.097
	Muscular endurance (curls number in 30 sec.)	17.72	4.01	18.67	3.90	0.01
	Flexibility (cm)	17.39	8.78	17.56	8.52	0.507

Figure 1 and Table 2 show the statistics for aerobic capacity, prior to and following the 10-week Pilates program concerning the students in the PG, and prior to and following the 10-week regular physical education school program regarding the students in the CG. As for the PG, there was a significant improvement in aerobic capacity from 1600.71±110.33 m before intervention to 1645.04±112.93 m after intervention ($t = -4.001$, $p<0.001$). On the contrary, aerobic capacity in the CG remained almost unaltered ($p = 0.846$).

Figure 2 and Table 2 present the statistics for muscular strength, prior to and following the 10-week Pilates program for the students in the PG and prior to and following the 10-week regular

physical education school program for the students in the CG. It is obvious that muscular strength improved significantly in PG from 153.83±31.99 cm to 161.96±34.86 cm after the 10-week Pilates program ($t = -4.823$, $p<0.001$), while remained unchanged for the CG after the 10-week regular physical education school program

Figure 3 and Table 2 show the statistics for muscular endurance, prior to and following the 10-week Pilates program for the students in the PG and prior to and following the 10-week regular physical education school program for the students in the CG. Muscular endurance in PG improved significantly from 19.83±4.05 repetitions before the program to 23.63±3.36 repetitions after the program ($t = -6.793$, $p<0.001$). Similarly, the students in the CG show a significant improvement in the second phase of measurements ($t = -2.799$, $p<0.01$) compared to their initial values (17.72±4.01 repetitions before; 18.67±3.90 repetitions after).

Moreover, Figure 4 and Table 2 show statistics about flexibility, prior to and following the 10-week Pilates program for the students in PG and prior to and following the 10-week regular physical education school program for the students in CG. Statistical analysis showed that flexibility improved significantly in PG from 20.96±7.56 cm before to 23.54±6.68 cm after intervention ($t = -3.740$, $p<0.001$), a fact that was expected and remained almost unchanged in CG ($p = 0.507$).

The statistical analysis of the results regarding measurements carried out before and after the 10-week Pilates program shows that the students who participated in Pilates significantly improved all physical fitness parameters. However, the students in CG who participated in the regular physical education school program presented no improvement in all physical fitness parameters, except for the improvement of muscular endurance. These results demonstrate that participation in a Pilates program significantly improved students' physical fitness (Table 2).

Figure 2

Muscular Strength of PG and CG Before and After the 10-Week Period

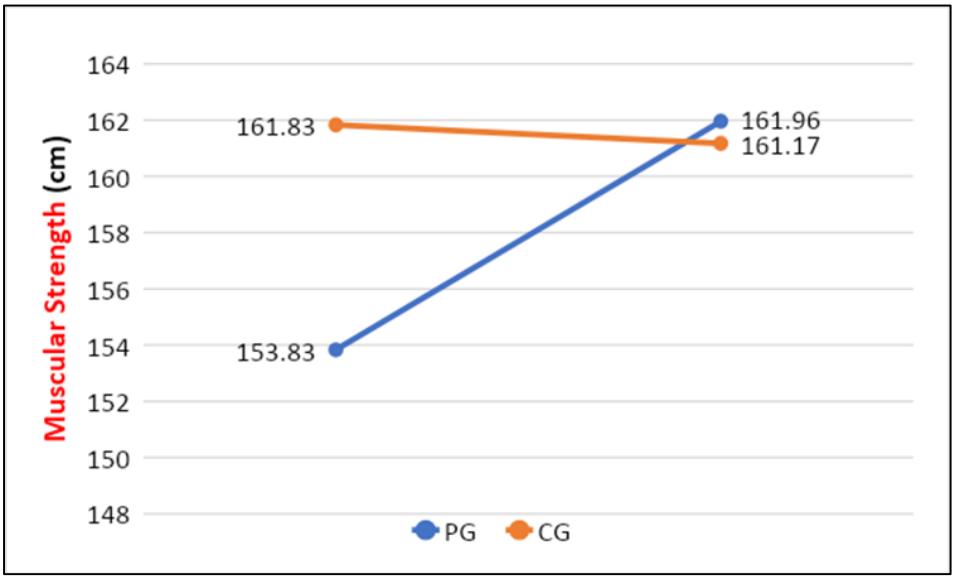


Figure 3

Muscular Endurance of PG and CG Before and After the 10-Week Period

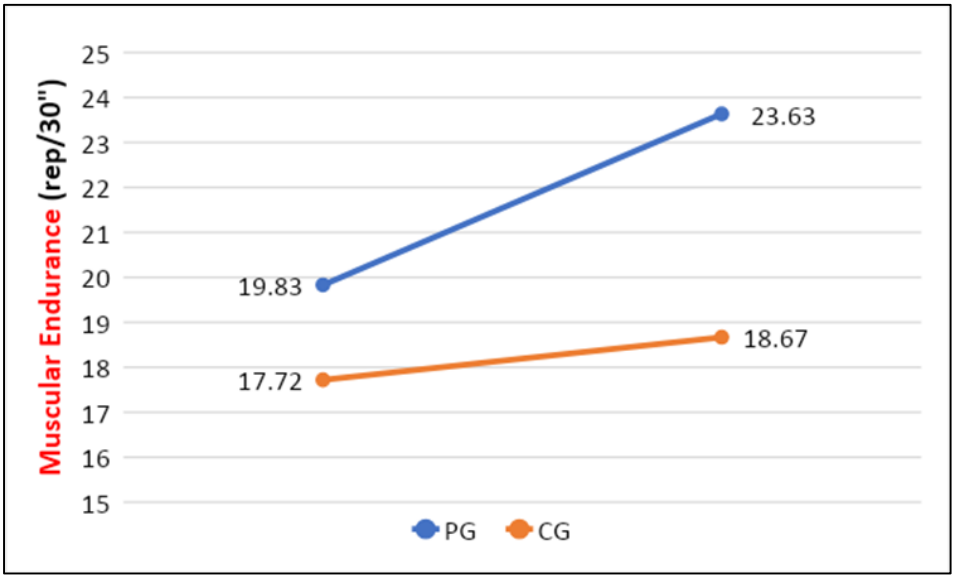
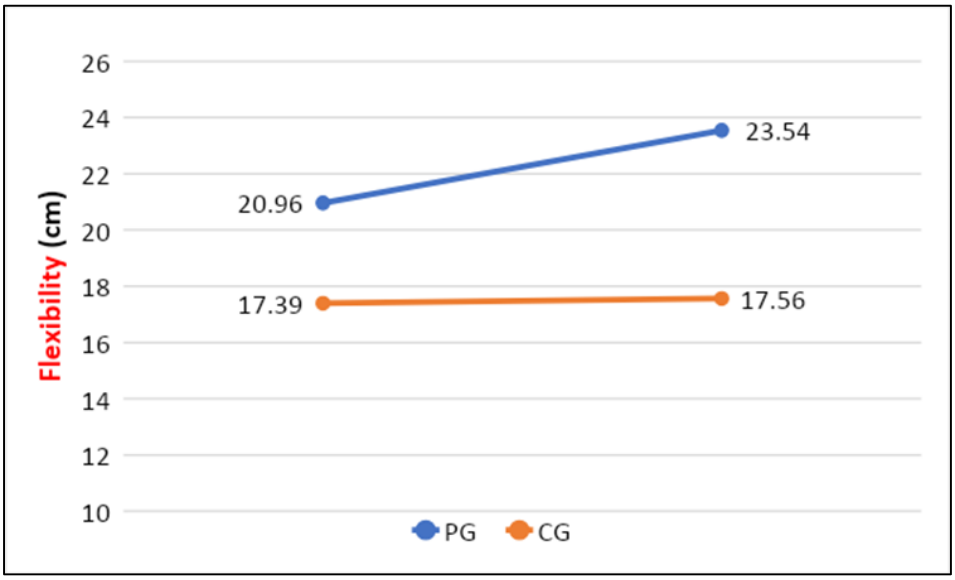


Figure 4

Flexibility of PG and CG Before and After the 10-Week Period



Discussion

The results of the present study demonstrate that the 10-week Pilates program during the physical education course at school had significant effects on high school students' physical fitness. Specifically, there was an improvement in aerobic capacity, muscular strength, muscular endurance, and flexibility in PG due to their participation in the Pilates program. Thus, the results confirm the research hypothesis. Conversely, CG's performance declined in aerobic capacity and muscular strength, improved in muscular endurance, and remained the same in flexibility.

Regarding aerobic capacity, its significant improvement in the PG may be due to the intensity of Pilates sessions, which was high, as students' HR ranged at 85–90% of HRmax. During Pilates, exercises such as squat, front, reverse, and side plank are performed. During these exercises the participation of many and large muscle groups is achieved, leading to respiratory and cardiovascular system activation. In addition, one of the basic principles of Pilates is proper breathing, which increases respiratory muscle strength, lung capacity, functionality, and performance (Gildenhuys et al., 2013; Tozim & Navega, 2018).

Besides, it has been suggested that although Pilates, like some other types of physical exercises, is not traditionally considered as cardiorespiratory exercise, nevertheless, could increase cardiorespiratory fitness (Eliks et al., 2019). The neuromuscular stimulation achieved during Pilates may be of sufficient intensity to improve cardiorespiratory fitness, providing benefits concerning participants' maximal Oxygen consumption (VO2max; Teixeira de Carvalho et al., 2017). In addition, Pilates' positive impact on cardiorespiratory fitness may be explained by lumbopelvic region strengthening, ribcage increased flexibility, and breathing exercises (Fernández-Rodríguez et al., 2019).

The findings of the present study confirm the study of Wolkodoff et al. (2008), who found that an 8-week combined cardio and Pilates program provides sufficient training stimulus for 14 healthy sedentary individuals (12 women and two men), aged 23–64 years, resulting to significant gains in VO2peak. Additionally, in agreement with the results of the present study, Tinoco-Fernández et al. (2016) found that practicing the Pilates method for 10 weeks, three times a week for 1-hour each time, has a positive influence on cardiorespiratory parameters, and, specifically, improved significantly mean heart rate, respiratory exchange ratio, and oxygen equivalent in healthy, sedentary university students aged 18–35 years. Moreover, the findings of the present study confirm the findings of other studies that found significant improvements in aerobic capacity after an 8-to-12-week Pilates program, in young healthy trained runners, aged 18±1 years (Finatto et al., 2018), healthy adult women, aged 48±7 years (Mikalački et al., 2017), overweight and/or obese individuals, aged 55.9±6.6 years (Rayes et al., 2019), individuals with heart failure, aged 46±12 years (Guimarães et al., 2012), and in individuals with chronic stroke, aged 63±8 years (Lim et al., 2016). Thus, it can be said that participation in Pilates brings about a significant improvement concerning VO2max of adults regardless of their health status. In fact, Fernández-Rodríguez et al. (2019), recommended Pilates exercise for the prevention of cardiovascular diseases in healthy and special population groups.

Concerning flexibility, a very significant improvement in students who participated in the Pilates program was expected, since the main goal in every Pilates session is stretching and the greatest possible range of all movements. In agreement, González-Gálvez et al. (2015) implemented a Pilates program twice a week, for 55 minutes each time, for 6 weeks in adolescent students at a Secondary school, aged 14.4±0.6 years, while the CG participated in a typical physical education course. Researchers assessed hamstring flexibility, using trunk bending from a sitting position with extended knees, just like in the present study. After the Pilates program, adolescent participants showed significant improvements in hamstring flexibility compared to those who only participated in the typical physical education course (González-Gálvez et al., 2015). Moreover, the findings of the present study confirm the study of Wolkodoff et al. (2008), who found improvements in low-back/hamstring flexibility, combined hip flexion, and combined torso rotation, in healthy sedentary adults who participated in an 8-week combined cardio and Pilates program.

As for muscular endurance, measured by the number of trunk curls (curl-ups) in 30 seconds,

its significant improvement after the Pilates program may be due to activation and empowerment of all trunk muscles. Pilates exercises emphasize abdominal and low back muscle strengthening while maintaining good posture and body alignment. Moreover, Pilates exercises involve activation of the transversus and obliquus internus abdominal muscles, thought to stabilize the lumbar spine (Bernardo, 2007). Besides, one of the basic principles of Pilates is strengthening the core, i.e., activation, stabilization, and strengthening of trunk muscles, since it is considered the powerhouse of the whole body. Another basic principle of Pilates is alignment aiming correct posture, movement control, and injury avoidance (Pilates, 1945). Therefore, it is completely normal to see a large improvement in muscular endurance. It is worth mentioning that the students who participated in the Pilates program after the intervention stated that their bodies felt stronger and their posture more correct. Regarding CG's improvement in muscular endurance, this may be due to their participation in regular physical education class at school, during which they executed curl-ups. Besides, curl-ups are a favorite exercise for adolescents because they focus mainly on abdominal muscle fitness and the image of their abdomen (Kaouri et al., 2023).

Regarding muscular strength, its significant improvement in the intervention group may be due to Pilates exercises, such as squats, balance exercises, handstands and/or single-leg stands, coordination of all parts of the body, during which the muscles of the legs and buttocks work and neuromuscular jointing increases. The results of the present research confirm the findings of Preeti et al. (2019), in which 20 badminton players aged 17–28 years, who participated in a Pilates program for 5 weeks, significantly improved muscular strength, agility, dynamic balance, and coordination skills, compared to the CG. Furthermore, the present findings are in agreement with research on adult women (Kao et al., 2014) and elderly subjects (Lima et al., 2021), who participated in Pilates programs and showed muscular strength and functional mobility improvements.

The findings of the present study confirm previous studies in adolescents aged 13.9±1.3 years, adolescent baseball players aged 15 years, and adolescents with a history of back pain aged 14.12±0.4 years, all of whom improved significantly in muscular strength and muscular endurance of trunk and abdominal muscles, as well as in flexibility (González-Gálvez et al., 2019, 2020; Park et al., 2020). Furthermore, the present findings are in agreement with studies that examined the effect of a Pilates program on female students (Kibar et al., 2016), on young female dancers (Ahearn et al., 2018), on adult physically inactive women (Tolnai et al., 2016), and on middle-aged women (Kloubec, 2010), and found improvements in muscular strength and muscular endurance of trunk and abdominal muscles, and flexibility.

Summing up, Pilates may affect positively the physical fitness of adolescent students. Given the need to engage young people in physical activity that may have positive effects and also achieve lifelong engagement, the findings of this research are very important. Additionally, although the sample of this research is a representative part of Greek adolescent students and there is an equivalent CG, recommendations for future research include increasing the sample size, in order to generalize these effects to the whole Greek adolescent student population.

Thus, the present research is important not only because it innovates regarding the discussed subject and the lack of relevant literature, but also because the implemented Pilates program, which had positive effects on students' physical fitness, can find practical application in the context of the physical education course at schools. Consequently, Pilates may constitute an attractive, alternative form of physical activity with many benefits, that may enrich physical education courses, especially regarding adolescent students.

Conclusions

Pilates exercise is an attractive and enjoyable form of physical activity due to its different movement content, non-competitive nature, and accompaniment of pleasant and relaxing music, as well as being adjustable to participants' age and fitness level. Moreover, Pilates exercise is an effective form of physical activity, as it focuses on enhancing strength, flexibility, core stability, control of trunk and pelvic segments, posture, and breathing (Kliziene et al., 2017; Wells et al., 2012). However, it is worth mentioning that Pilates exercise achieves a balanced development of muscle strength and flexibility, having a safe load on the joints (Geweniger & Bohlander, 2014). Therefore, it could be said that Pilates is an ideal form of exercise for adolescents. Additionally, the immediate positive effects of participating in Pilates may influence individuals to be more physically active (Tolnai et al., 2016). Thus, the improvement of adolescent students' physical fitness due to their participation in a Pilates program is a very important fact concerning their healthy growth and development. At this point, it is worth remembering Joseph Pilates who recommended the participation of children and young people in general in exercises of his method, and states:

> In childhood, habits are easily formed- good and bad. Why not then concentrate on the formation of only good habits and thus avoid the necessity later on in life of attempting to correct bad habits and substituting them for good habits (Pilates, 1934, p. 136).

Therefore, it can be stated that Pilates exercise is an effective and safe form of physical activity that can lead to an improvement in adolescent students' physical fitness. Lastly, Pilates can be transformed into a good habit for adolescents that can accompany them as a lifelong exercise, providing them with health, well-being, and quality of life.

References

Ahearn, E. L., Greene, A., & Lasner, A. (2018). Some effects of supplemental Pilates training on the posture, strength, and flexibility of dancers 17 to 22 years of age. *Journal of Dance Medicine & Science, 22*(4), 192–202. https://doi.org/10.12678/1089-313x.22.4.192

Ambition Studios (2019, May 4). Pilates for teens. https://www.ambitionstudios.com.au/blog/2019/5/4/pilates-for-teens

Bennetto, L. (2020, January 13). *Pilates helps build self-esteem in the teen years*. Infinity Pilates. https://www.infinitypilates.com/news/pilates-helps-build-self-esteem-in-the-teen-years/

Bernardo, L. M. (2007). The effectiveness of Pilates training in healthy adults: An appraisal of the research literature. *Journal of Bodywork and Movement Therapies, 11*(2), 106–110. https://doi.org/10.1016/j.jbmt.2006.08.006

Blair, S. N. (2009). Physical inactivity: The biggest public health problem of the 21st century. *British Journal of Sports Medicine, 43*(1), 1–2. PMID: 19136507 https://bjsm.bmj.com/

Cooper, K. H. (1977). *Aeroviosi: Theoria kai praxi tis askisis gia olous* [Aerobics: Theory and practice of exercise for all]. Athens: Alkion Pubs [in Greek]

Eliks, M., Zgorzalewicz-Stachowiak, M., & Zeńczak-Praga, K. (2019). Application of Pilates-based exercises in the treatment of chronic non-specific low back pain: State of the art. *Postgraduate Medical Journal, 95*(1119), 41–45. https://doi.org/10.1136/postgradmedj-2018-135920

Fernández-Rodríguez, R., Álvarez-Bueno, C., Ferri-Morales, A., Torres-Costoso, A. I., Cavero-Redondo, I., & Martínez-Vizcaíno, V. (2019). Pilates method improves cardiorespiratory fitness: A systematic

review and meta-analysis. *Journal of Clinical Medicine, 8*(11), 1761. https://doi.org/10.3390/jcm8111761

Finatto, P., Da Silva, E. S., Okamura, A. B., Almada, B. P., Storniolo, J. L. L., Oliveira, H. B., & Peyré-Tartaruga, L. A. (2018). Pilates training improves 5-km run performance by changing metabolic cost and muscle activity in trained runners. *PLoS ONE, 13*(3), e0194057. https://doi.org/10.1371/journal.pone.0194057

Geweniger, V., & Bohlander, A. (2014). *Pilates-A Teacher's Manual*. Springer.

Gildenhuys, G., Fourie, M., Shaw, I., Shaw, B., Toriola, A. L., & Witthuhn J. (2013). Evaluation of Pilates training on agility, functional mobility and cardiorespiratory fitness in elderly women. *African Journal for Physical, Health Education, Recreation and Dance, 19*(2), 505–512. https://www.ajol.info/index.php/ajpherd/article/view/89839

González-Gálvez, N., Carrasco-Poyatos, M., Marcos-Pardo, P. J., Vale, R. G. D. S., & Feito, Y. (2015). Effects of a pilates school program on hamstrings flexibility of adolescents. *Revista Brasileira de Medicina do Esporte, 21*(4), 302–307. https://doi.org/10.1590/1517-869220152104145560

González-Gálvez, N., Marcos-Pardo, P. J., & Carrasco-Poyatos, M. (2019). Functional improvements after a Pilates program in adolescents with a history of back pain: A randomized controlled trial. *Complementary Therapies in Clinical Practice, 35*, 1–7. https://doi.org/10.1016/j.ctcp.2019.01.006

González-Gálvez, N., Vaquero-Cristóbal, R., & Marcos-Pardo, P. J. (2020). Effect of Pilates method on muscular trunk endurance and hamstring extensibility in adolescents during twelve weeks training and detraining. *Journal of Bodywork and Movement Therapies, 24*(2), 11–17. https://doi.org/10.1016/j.jbmt.2020.02.002

Guimarães, G. V., Carvalho, V. O., Bocchi, E. A., & d'Avila, V. M. (2012). Pilates in heart failure patients: A randomized controlled pilot trial. *Cardiovascular. Therapeutics, 30*(6), 351–356. https://doi.org/10.1111/j.1755-5922.2011.00285.x

Gunnell, D. J., Frankel, S. J., Nanchahal, K., Peters, T. J., & Davey Smith, G. (1998). Childhood obesity and adult cardiovascular mortality: a 57-y follow-up study based on the Boyd Orr cohort. *The American Journal of Clinical Nutrition, 67*(6), 1111–1118. https://doi.org/10.1093/ajcn/67.6.1111

Kao, Y.-H., Liou, T.-H., Huang, Y.-C., Tsai, Y.-W., & Wang, K.-M. (2014). Effects of a 12-week Pilates course on lower limb muscle strength and trunk flexibility in women living in the community. *Health Care for Women International, 36*(3), 303–319. https://doi.org/10.1080/07399332.2014.900062

Kaouri, I., Argiriadou, E.., Katartzi, E., Kontou, M., Praskidou, A.-K., Kaouri, A., Vrabas, I., & Mavrovouniotis, F. (2023). The examination of the effects of a Greek traditional dance program on physical fitness parameters of high school students. *Physical Activity Review, 11*(2), 63–74. https://doi.org/10.16926/par.2023.11.22

Kibar, S., Yardimci, F. Ö, Evcik, D., Ay, S., Alhan, A., Manço, M., & Ergin, E. S. (2016). Can a pilates exercise program be effective on balance, flexibility and muscle endurance? A randomized controlled trial. *The Journal of Sports Medicine and Physical Fitness, 56*(10), 1139–1146. PMID: 26473443. https://pubmed.ncbi.nlm.nih.gov/26473443/

Kliziene, I., Sipaviciene, S., Vilkiene, J., Astrauskiene, A., Cibulskas, G., Klizas, S., & Cizauskas, G. (2017). Effects of a 16-week Pilates exercises training program for isometric trunk extension and flexion strength. *Journal of Bodywork and Movement Therapies, 21*(1), 124–132. https://doi.org/10.1016/j.jbmt.2016.06.005

Kloubec, J. A. (2010). Pilates for improvement of muscle endurance, flexibility, balance, and posture. *Journal of Strength and Conditioning Research, 24*(3), 661–667. https://doi.org/10.1519/JSC.0b013e3181c277a6

Kumar, B., Robinson, R., & Till, S. (2015). Physical activity and health in adolescence. *Clinical Medicine, 15*(3), 267–272. https://doi.org/10.7861/clinmedicine.15-3-267

Lim, H. S., Kim, Y. L., & Lee, S. M. (2016). The effects of Pilates exercise training on static and dynamic balance in chronic stroke patients: A randomized controlled trial. *Journal of Physical Therapy*

Science, 28(6), 1819–1824. https://doi.org/10.1589/jpts.28.1819
Lima, M., Silva, B., Rocha-Rodrigues, S., & Bezerra P. (2021). The impact of an 8-week Pilates-based physical training program on functional mobility: Data from septuagenarian group. *Biomedical Human Kinetics, 13*(1), 11–19. https://doi.org/10.2478/bhk-2021-0002
Mavrovouniotis, F. I., Papaioannou, C. S., Argiriadou, E. A.., Mountakis, C. M., Konstadinakos, P. D., Pikoula, I. T., & Mavrovounioti, C. F. (2013). The effect of a combined training program with Greek dances and Pilates on the balance of blind children. *Journal of Physical Education and Sport, 13*(1), 91–100. https://doi.org/10.7752/jpes.2013.01016
Mikalački, M., Čokorilo, N., & Ruiz-Montero P. J. (2017). The effects of a Pilates-aerobic program on maximum exercise capacity of adult women. *Revista Brasileira de Medicina do Esporte, 23*(3), 246–249. https://doi.org/10.1590/1517-869220172303156004
Must, A., & Strauss, R. S. (1999). Risks and consequences of childhood and adolescent obesity. *International Journal of Obesity, 23*(Suppl. 2), S2–S11. https://doi.org/10.1038/sj.ijo.0800852
Park, J. H., Kim, H.-J., Choi, D. H., Park, S., & Hwang, Y. Y. (2020). Effects of 8-week Pilates training program on hamstring/quadriceps ratio and trunk strength in adolescent baseball players: A pilot case study. *Journal of Exercise Rehabilitation, 16*(1), 88–95. https://doi.org/10.12965/jer.1938732.366
Pilates, J. H. (1934). Your health: A corrective system of exercising that revolutionizes the entire field of physical education. In J. Robbins (Ed.), *A pilates' primer: The millennium edition: Includes the complete works of Joseph Pilates, 1998*. Presentation Dynamics Inc.
Pilates, J. H (1945). Return to life through contrology. In J. Robbins (Ed.), *A pilates' primer: The millennium edition: Includes the complete works of Joseph Pilates, 1998*. Presentation Dynamics Inc.
Preeti, S. K., Yadav, J., & Pawaria, S. (2019). Effect of Pilates in lower limb strength, dynamic balance, agility and coordination skills in aspiring state level badminton players. *Journal of Clinical and Diagnostic Research, 13*(7), 01–06. https://doi.org/10.7860/JCDR/2019/41713.12978
Rayes, A. B. R., de Lira, C. A. B., Viana, R. B. Benedito-Silva, A. A, Vancini, R. L., Mascarin, N., &Andrade, M. S. (2019). The effects of Pilates vs. aerobic training on cardiorespiratory fitness, isokinetic muscular strength, body composition, and functional tasks outcomes for individuals who are overweight/obese: A clinical trial. *Peer Journal, 7*, e6022. https://doi.org/10.7717/peerj.6022
Ruiz, J. R., Castro-Piñero, J., Artero, E. G., Ortega, F. B., Sjöström, M., Suni, J., & Castillo, M. J. (2009). Predictive validity of health-related fitness in youth: a systematic review. *British Journal of Sports Medicine, 43*(12), 909–923. https://doi.org/10.1136/bjsm.2008.056499
Teixeira de Carvalho, F., de Andrade Mesquita, L. S., Pereira, R., Neto, O. P., & Amaro Zangaro, R. (2017). Pilates and proprioceptive neuromuscular facilitation methods induce similar strength gains but different neuromuscular adaptations in elderly women. *Experimental Aging Research, 43*(5), 440–452. https://doi.org/10.1080/0361073X.2017.1369624
Tinoco-Fernández, M., Jiménez-Martín, M., Sánchez-Caravac, M. A., Fernández-Pérez, A. M., Ramírez-Rodrigo, J., & Villaverde-Gutiérrez, C. (2016). The Pilates method and cardiorespiratory adaptation to training. *Research in Sports Medicine, 24*(3), 266–271. https://doi.org/10.1080/15438627.2016.1202829
Tolnai, N., Szabó, Z., Köteles, F., & Szabo, A. (2016). Physical and psychological benefits of once-a-week Pilates exercises in young sedentary women: A 10-week longitudinal study. *Physiology and Behavior, 163*, 211–218. https://doi.org/10.1016/j.physbeh.2016.05.025
Tozim, B. M., & Navega, M. T. (2018). Efeito do método pilates na força dos músculos inspiratórios e expiratórios em idosos. [Effect of Pilates method on inspiratory and expiratory muscle strength in the elderly]. *Revista Brasileira de Cineantropometria eDesempenho Humano, 20*(1), 1-9. https://doi.org/10.5007/1980-0037.2018v20n1p1
Viner, R. M., & Cole, T. J. (2005). Television viewing in early childhood predicts adult body mass index. *The Journal of Pediatrics, 147*(4), 429–435. https://doi.org/10.1016/j.jpeds.2005.05.005

Wells, C., Kolt, G. S., & Bialocerkowski, A. (2012). Defining Pilates exercise: A systematic review. *Complementary Therapies in Medicine, 20*(4), 253–262. https://doi.org/10.1016/j.ctim.2012.02.005
World Health Organization. *Physical activity*. https://www.who.int/news-room/fact-sheets/detail/physical-activity (accessed 2022 Oct 5)
Wolkodoff, N., Peterson, S., & Miller, J. (2008). The fitness effects of a combined aerobic and Pilates program an eight-week study using the stamina AeroPilates Pro XP555. *AeroPilates Pro XP 555 Study*.

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Appendix: Pilates Method Exercises

Lesson Part	Exercise	Repetitions	Aims	Instructions
Warm-up 5-8 min	Breathing exercises, whole body mobilization	8-10 repetitions (reps) for each exercise	Whole body warm up, cardiorespiratory, muscular & joints system, spine mobilization	Every movement accompanied by full deep breath to warm up the body, release stress & prepare mind+body for mindful exercise
Main part 32-35 min	The Hundred	50 reps, knees bend for beginners, 100 reps for advanced	Strengthening cardiorespiratory system, abdominal muscles	Lower back on the mat, engage abdominals
	The Roll Up	6-8 reps for beginners, 10-12 reps, *2 sets for advanced	Strengthening abdominal muscles, restoring spine to normal	Chin touches chest during rolling rounded back
	The Spine Stretch	10-12 reps	Spine mobility, strengthening abdominal muscles	On your sitting bones, chin to the chest, abdominals engaged & drawn in
	Preparatory exercise for Teaser	6-8 reps for intermediate, 1 leg at a time, 10-12 reps, *2 sets for advanced, 2 legs	Strengthening abdominal & leg muscles, developing full body coordination, balance	Balance on your pelvis, abdominals engaged, straight back, shoulders away from your ears, extend leg
	The Side Kick Kneeling	3-5 reps for beginners for each leg (lean on hip), 6-8 reps for advanced	Concentrating on waistline & hips, developing balance & coordination	Arm on the floor in line with shoulder, shoulder away from ear, abdominal muscles engaged
	The Side Bend	6-8 reps for advanced (each side)	Strengthening arms, shoulder, & wrist muscles, stretching hip & waistline, developing balance & coordination	Arm in line with shoulder, head-torso-legs in a line.
	Bird-Dog	10-12 reps (each leg)	Strengthening core, developing core stability, balance & coordination	Arms: shoulder wide, shoulders away from ears, abdominals engaged & in, reach as far as you can
	Crunches	10-12 reps for beginners, 1 set forward-1set twist	Strengthening abdominal	Engage deeply the abdominal muscles, press the lower back on the mat & breathe correctly
	The One Leg Circle	5 reps (each leg, each side)	Strengthening abdominal & leg muscles, developing full body coordination	Shoulders & lower back on the mat
	The One Leg Stretch	6-8 reps for beginners, 10-12 reps, *2 sets for advanced	Strengthening abdominal & neck muscles, developing coordination, hip & hamstring flexibility	Chin to chest, lower back on the mat, stable pelvis
	The Double Leg Stretch	6-8 reps for intermediate, 10-12 reps, *2 sets for advanced	Strengthening the anterior chain muscles, developing full body coordination	Head pressed firmly against chest, abdominals engaged & in, lower back on the mat

Lesson Part	Exercise	Repetitions	Aims	Instructions
(Main part 32-35 min, continued)	Rolling Back	10 reps	Self-massage of the spine, developing coordination	Chest in, round back, head down, feet off the mat, abdominal muscles engaged & in
	Criss Cross	6-8 reps for intermediate, 10-12 reps for advanced (each leg)	Strengthening abdominal & leg muscles, developing coordination	Abdominals engaged & in, breathe correctly
	Plunk & Leg Pull Front	8-10 reps for beginners-support on elbows, 10-12 reps, *2 sets for advanced (each leg)	Strengthening the whole body	Arms: shoulder wide, shoulders away from ears, abdominal muscles engaged & in
	The Leg Pull	3-5 reps (each leg), for advanced	Strengthening the whole body	Arms: shoulder wide, shoulders away from ears
	The Saw	5 reps (each side)	Strengthening abdominal and leg muscles, stretching back muscles & hamstring	Abdominals engaged, stretch arms, breathe correctly
	The Double Kick	8 reps for intermediate, 10-12 reps for advanced	Strengthening posterior chain muscles, developing coordination	Head up as high as possible, arms stretched backward as far as possible
	Swimming	10-12 reps (each leg-arm)	Strengthening posterior chain muscles, developing coordination, stretching anterior chain	Hands & legs raised as high as possible
	The Shoulder Bridge	6-8 reps for beginners, 10-12 reps for advanced (each leg)	Strengthening posterior chain muscles, developing coordination & hip mobility	Pelvis raised as high as possible
	Rocker With Open Legs	10-12 for advanced	Developing balance & full body coordination	Grasp ankles firmly, abdominals engaged
	The Hip Twist with Stretched Arms	5-8 reps each side, bent knees for intermediate-stretched knees for advanced	Strengthening abdominal & leg muscles, developing full body coordination	Abdominals engaged, move legs & hips, chest out
	The Teaser	6-8 reps, bent knees for intermediate, straight knees for advanced	Strengthening anterior chain muscles, developing coordination & balance	Abdominals engaged & in, arms & legs in straight parallel lines
Cool-down 5 min	Breathing & stretching exercises		Releasing tension of the working muscles, slowing down breathing & heartbeats	Full & deep breathes, & relaxation