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The Effect of Pilates Exercises on Developing Some Physiological Indicators and Improving the Digital Level among Track and Field Athletes

Sajjad Mahdi Jasim Al-Bahadli
College of Physical Education and Sports Sciences, University of Wasit, Kut, Iraq
sajjadm.jasim622@uowasit.edu.iq

Corespondensi Author
Email: sajjadm.jasim622@uowasit.edu.iq

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ABSTRACT
This research aims to identify the effect of Pilates exercises on developing certain physiological indicators and improving the digital level among track and field athletes. The researcher used the experimental method utilizing a one-group design with pre- and post-measurements, which suits the nature of the study. The research sample was intentionally selected from track and field athletes affiliated with the Wasit Sub-Union, comprising a core sample of (10) athletes specialized in the 200m and 400m running events. The physiological variables under investigation included respiratory rate per minute, resting heart rate, post-exertion heart rate, vital capacity of the lungs, and absolute maximal oxygen consumption (VO_2max), in addition to the digital level of the 200m and 400m runners. To collect data, the researcher employed a set of appropriate instruments and tools. Furthermore, a training program utilizing Pilates exercises was designed and implemented for a duration of (8) weeks, with (3) training sessions per week. The results showed statistically significant differences between the pre- and post-measurements of the experimental group across all physiological variables in favor of the post-measurement; respiratory rate per minute, resting heart rate, and post-exertion heart rate decreased, whereas vital capacity of the lungs and absolute maximal oxygen consumption increased. Additionally, the results revealed a statistically significant improvement in the digital level of the 200m and 400m athletes in favor of the post-measurement. The researcher recommends integrating Pilates exercises into the physical preparation programs of track and field athletes, utilizing them to enhance athletic performance and elevate competitive levels.

Keywords: Pilates; Physiological Indicators; Track; Field Athletics.

ABSTRAK
Penelitian ini bertujuan mengidentifikasi efek latihan Pilates terhadap pengembangan indikator fisiologis tertentu dan meningkatkan tingkat digital di antara atlet atletik. Peneliti menggunakan metode eksperimental dengan desain satu kelompok dengan

pengukuran pra- dan pasca, yang sesuai dengan sifat studi. Sampel penelitian ini sengaja dipilih dari atlet atletik yang berafiliasi dengan Sub-Union Wasit, yang terdiri dari sampel inti (10) atlet yang mengkhususkan diri pada nomor lari 200m dan 400m. Variabel fisiologis yang sedang diselidiki meliputi laju pernapasan per menit, detak jantung istirahat, detak jantung pasca-olahraga, kapasitas vital paru-paru, dan konsumsi oksigen maksimal mutlak (VO_2max), selain tingkat digital pelari 200m dan 400m. Untuk mengumpulkan data, peneliti menggunakan seperangkat instrumen dan alat yang sesuai. Selain itu, program pelatihan yang menggunakan latihan Pilates dirancang dan diimplementasikan selama (8) minggu, dengan (3) sesi latihan per minggu. Hasilnya menunjukkan perbedaan yang signifikan secara statistik antara pengukuran pra- dan pasca-pengukuran kelompok eksperimental di semua variabel fisiologis yang mendukung pengukuran pasca; laju pernapasan per menit, detak jantung istirahat, dan detak jantung pasca-aktivitas menurun, sedangkan kapasitas vital paru-paru dan konsumsi oksigen maksimal absolut meningkat. Selain itu, hasil menunjukkan peningkatan signifikan secara statistik pada tingkat digital atlet 200m dan 400m yang lebih mendukung pengukuran pasca. Peneliti merekomendasikan integrasi latihan Pilates ke dalam program persiapan fisik atletik atletik, memanfaatkannya untuk meningkatkan performa atletik dan meningkatkan tingkat kompetitif.

Kata Kunci: Pilates; Indikator Fisiologis; Atletik; Lapangan Atletik.

INTRODUCTION

The modern sports field is witnessing rapid developments in sports training methods resulting from scientific advancements in movement science, physiology, and sports training. Achieving high athletic levels now relies on employing modern training methods based on precise scientific foundations that contribute to developing the physical, physiological, and skill capabilities of athletes. Sports training is an organized educational process aimed at inducing functional and anatomical adaptations within various body systems, which positively reflects on sports achievement levels. This has driven researchers and trainers toward seeking new training modalities that achieve the highest rates of improvement with the least possible effort.

Track and field holds a distinguished position among various sports activities as it forms the foundation for many other sports and requires high levels of physical and physiological efficiency to achieve digital performance. The success of a track and field athlete depends on the efficiency of the body's vital systems, particularly the cardiovascular and respiratory systems. An athlete's performance capacity is closely linked to their ability to consume oxygen, transport it to working muscles, and delay the onset of fatigue during competition (Hatem, 2020: 8).

Physiological indicators are among the most important tools used to evaluate the training status of athletes, as they reflect the efficiency of various body systems in adapting to training loads. Prominent among these indicators are heart rate, respiratory rate, lung vital capacity, and maximal oxygen consumption. These variables are directly related to cardiorespiratory fitness levels and the capacity for prolonged, high-efficiency athletic performance (Al-Muroo'i, 2018: 21).

In recent years, several modern training methods have emerged aimed at achieving integration between physical and functional aspects. Prominent among these are Pilates exercises, founded by Joseph Pilates in the early twentieth century. These exercises rely on core principles of motor control, concentration, precision, fluidity, correct breathing, and core muscle strengthening, which help improve motor performance and increase the functional efficiency of muscles and joints (Ibrahim & Zaki, 2025: 41).

Kloubec (2010) pointed out that Pilates exercises contribute to improving neuromuscular coordination, increasing deep trunk muscle strength, and enhancing flexibility and balance. They also help develop respiratory system efficiency by focusing on regulated breathing patterns during performance. This leads to improved gas exchange efficiency and increased lung vital capacity, positively reflecting on athletes' performance and endurance capacity (Kloubec, 2010: 665).

Pilates exercises are characterized by their ability to develop the core muscles, which act as the bridge connecting the upper and lower extremities. These muscles play a fundamental role in force transmission, movement control, and postural balance during athletic performance. Studies have proven that improving the strength and stability of core muscles contributes to elevating motor performance efficiency, reducing sports injuries, and improving energy economy during performance.

Sekendiz (2007) noted that Pilates exercises represent a physical preparation training method aimed at developing muscular strength and movement control through various body muscles in general, and core/trunk muscles in particular, via neuromuscular coordination and synchronization by engaging the largest number of muscle groups through continuous fluid movement and precise focus on the strength and balance of various core muscles such as the abdominal, back, and pelvic joint muscles (Sekendiz, 2007: 318).

Ali, A. N. E. (2021) indicated that Pilates exercises constitute an integrated body training program designed primarily to develop and increase the strength of deep trunk muscles such as the abdominal, back, and pelvic joint muscles which are responsible for muscular control, stabilization, and activation of core body muscles (including the abdomen, pelvis, back, and glutes). Developing these muscles effectively improves the functions and efficiency of the rest of the body's muscles due to their strong correlation, as movement initiates from the trunk and radiates outward to the limbs, thereby improving balance and coordination and ultimately elevating skill performance levels (Ali, A. N. E., 2021: 86).

Furthermore, Pilates exercises rely on hand-eye-foot neuromuscular coordination and are performed using mats, utilizing gravity and body weight as resistance to increase training intensity during execution (Muscolino, 2004: 124).

Karon Karter (2001) outlined the benefits of Pilates as follows:

1. Improving respiratory and circulatory functions.
2. Increasing flexibility, strength, and muscular tone for every muscle, especially abdominal muscles.
3. Serving effectively in rehabilitation programs as an optimal treatment for most back pains, strengthening and lengthening muscles supporting the spine, and alleviating chronic pain conditions such as knee osteoarthritis and shoulder pain suffered by many individuals.

4. Strengthening the body from within by achieving balance across muscle groups; training involves moving all body muscles simultaneously with precision and control to restore bodily alignment.
5. Accelerating post-training recovery.
6. Relieving tension, reducing stress and life pressures, renewing physical and mental energy levels, and eliminating muscle tension through proper breathing (Karon, 2001: 52).

Moreover, the results of Cruz-Ferreira's (2011) study demonstrated that Pilates programs improve cardiorespiratory fitness indicators, lower heart rates, and enhance oxygen consumption efficiency among athletes. This is attributed to the positive impact of these exercises on cardiovascular and respiratory efficiency and the increased capacity of muscles to utilize oxygen during physical activity.

Through the researcher's review of previous studies, such as Nabil Hamid Shaheen (2018), Samah Ali Hanafi (2018), and Segal (2004), it became evident that most studies addressed the impact of Pilates exercises on certain physical or rehabilitative variables. Meanwhile, a clear need remains to investigate the impact of these exercises on specific performance-related physiological indicators and digital levels among track and field athletes. This motivated the researcher to conduct the current study to identify the effectiveness of a Pilates training program in developing certain physiological indicators and improving the digital level among track and field athletes.

Research Problem

Despite remarkable developments in track and field results globally, achieving advanced digital levels still poses a major challenge for many athletes, particularly given the reliance on traditional training programs that may not sufficiently account for the integration between physical and functional conditioning. This has generated a need for diverse training methods that contribute to elevating performance efficiency and improving athletes' capacity to respond to various training loads.

Through the researcher's work and field follow-up in training track and field athletes, a clear disparity was observed in athletes' ability to maintain performance levels during competitions, alongside early onset fatigue and a reduced capacity to sustain equal efficiency until the end of performance. This may correlate with decreased efficiency in certain vital bodily functions. The researcher also noted that many training programs lack exercises focused on developing muscular control, postural balance, and regulated breathing, despite their importance in achieving fluency and economical performance.

Although previous studies indicated that Pilates exercises might positively impact functional and physical performance efficiency among athletes, the implementation of these exercises within track and field preparation programs remains limited especially within the Arab environment alongside a scarcity of studies directly addressing their impact on specific performance-related physiological variables and digital levels for this category of athletes.

Hence, the idea of the current study emerged to explore the effectiveness of Pilates exercises as a modern training method in improving certain physiological indicators associated with athletic performance and their reflection on the digital level of track and field athletes. This aims to provide a training approach that helps coaches and athletes enhance performance efficiency and achieve superior digital levels.

Research Objectives

The research aims to identify the effect of Pilates exercises on developing certain physiological indicators and improving the digital level of track and field athletes by determining:

1. The effect of Pilates training on certain physiological indicators of track and field athletes.
2. The effect of Pilates training on the digital level of track and field athletes.

Research Hypotheses

1. There are statistically significant differences between the pre- and post-measurements of the experimental group in certain physiological indicators of track and field athletes in favor of the post-measurement.
2. There are statistically significant differences between the pre- and post-measurements of the experimental group in the digital level of track and field athletes in favor of the post-measurement.

METHODS

First: Research Methodology

The researcher used the experimental method due to its suitability to the nature of the research, utilizing an experimental design of a single experimental group with pre- and post-measurements.

Second: Research Fields

1. Human Field: The research was conducted on a sample of (22) athletes from the Wasit Sub-Union.
2. Spatial Field: Pre- and post-tests and measurements were implemented at the Wasit Sub-Union.

Temporal Field:

1. The exploratory study was conducted from 13/10/2025 to 23/10/2025.
2. Pre-measurements were conducted on 28/10/2025.
3. The proposed training program was implemented from 30/10/2025 to 29/12/2025.
4. Post-measurements were conducted on 31/12/2025.

Third: Research Population and Sample

Research Population:

The research population includes track and field athletes registered with the Iraqi Athletics Federation.

Research Sample:

The researcher intentionally selected the research sample from track and field athletes, totaling (22) players. The researcher divided the research sample into (12) players for the exploratory study (to standardize tests for validity and reliability) and (10) players for the experimental group, as illustrated in Table (1).

Table 1. Numerical distribution of the research sample.

Classification	Research Sample	Exploratory Study Sample	Experimental Group
Frequency	Percentage	Frequency	Percentage
Track and Field Athletes	22	12	54.55%

Statistical Description of the Research Sample:

The fundamental variables of the sample (under investigation) were measured in terms of (Age, Height, Weight, Training Age) to control for variables that might affect the research procedures, as shown in Table (2) below.

Table 2. Statistical indicators of the research sample in basic variables before the experiment. N=22

Statistical Indicators / Variables	Unit of Measurement	Arithmetic Mean	Standard Deviation	Skewness Coefficient	Kurtosis Coefficient
Age	Years	21.85	1.52	1.51	1.63
Height	cm	186.54	2.96	1.31	0.98
Weight	kg	80.72	1.27	-0.89	0.58
Training Age	Years	8.56	2.05	1.13	1.11

It is evident from Table (2) concerning the homogeneity of the research sample data in the initial baseline measurements that the data for the total research sample are moderate, non-dispersed, and exhibit a normal distribution. The skewness coefficient values range between (-0.89 and 1.51), which are close to zero, and the kurtosis coefficient ranges between (0.58 and 1.63). This indicates that the fluctuation of the normal curve is acceptable and moderate (neither excessively peaked nor flattened), confirming the similarity of the research group members in the initial variables prior to the experiment.

Fourth: Data Collection Tools and Instruments

Devices and Tools Used in the Research:

Through reviewing numerous references and similar studies, the researcher identified the devices and tools that contribute to completing the research procedures and achieving its objectives, which are:

1. Rest meter to measure total body height to the nearest cm.
2. Calibrated medical scale to measure weight to the nearest kg.
3. Dumbbells of various weights.
4. Rope.
5. Chalk.
6. Body Composition analyzer device.
7. Measuring tape graduated from 0 to 2000 cm.
8. Plaster tape.
9. Stopwatches accurate to the nearest 0.01 s.

Measurements and Tests Used Under Investigation:

The researcher conducted a bibliographic search of references, scientific papers, and previous studies such as the studies by Ni'ma Samir Hatem (2020), Samah Ali Hanafi (2018), and Essam Ahmed Al-Muroo'i (2018) pertaining to physiological variables for track and field athletes, which were summarized as follows:

1. Vital capacity
2. Resting diastolic blood pressure
3. Resting systolic blood pressure
4. Absolute maximal oxygen consumption (VO_2max)
5. Resting heart rate

6. Post-exertion heart rate
7. Cardiac output (C.O.)
8. Absolute maximal oxygen consumption
9. Relative maximal oxygen consumption
10. Respiratory rate per minute

The researcher presented these physiological variables to a panel of experts (Attachment No. 1) numbering (5) experts specialized in sports training and sports health sciences to express their opinions on the suitability of these measurements for the research. The following table illustrates the percentage of expert agreement on the physiological variables:

Table 3. Experts' opinions on physiological variables. N = 5

No.	Physiological Variables	Agree	Disagree
Frequency	Percentage	Frequency	Percentage
1	Vital Capacity	5	100%
2	Resting Diastolic Blood Pressure	2	40%
3	Resting Systolic Blood Pressure	2	40%
4	Absolute Maximal Oxygen Consumption	5	100%
5	Resting Heart Rate	5	100%
6	Post-Exertion Heart Rate	5	100%
7	Cardiac Output (C.O.)	1	20%
8	Absolute Maximal Oxygen Consumption (Note: repeated category in source)	1	20%
9	Relative Maximal Oxygen Consumption	1	20%
10	Respiratory Rate per Minute	5	100%

Based on the experts' opinions, the researcher excluded physiological variables with an agreement percentage below 50%. Consequently, the physiological variables adopted by the researcher are as follows:

Physiological Indicators:

1. Respiratory rate per minute
2. Resting heart rate
3. Post-exertion heart rate
4. Vital capacity
5. Absolute maximal oxygen consumption

Digital Level of Track and Field Athletes:

1. Digital level for 200m runners
2. Digital level for 400m runners

Fifth: Exploratory Study

The exploratory study was conducted from 13/10/2025 to 23/10/2025 on the same exploratory study sample and outside the primary core sample. Its purpose was to calculate the scientific coefficients (validity and reliability) of the tests.

The second exploratory study aimed to:

Verify the scientific coefficients (validity and reliability) of the tests under investigation, as illustrated in Tables (4) and (5).

Results of the Second Exploratory Study:

Validity coefficients were established using the two-extreme-groups comparison method, as shown in Tables (4) and (5).

Sixth: Scientific Coefficients of Physiological Tests Used in the Research

Validity: To find the validity coefficient for the physiological tests under investigation, the researcher used discriminative validity through extreme groups comparison by calculating the mean differences between the upper quartile and lower quartile of the exploratory sample results, consisting of (12) players from the research population outside the primary core sample. Table (4) illustrates this.

Table 4. Significance of differences between the upper and lower quartiles to establish discriminative validity in the physiological variables under investigation. (N = 12)

Statistical Indicators / Physiological Variables	Unit of Measurement	Upper Quartile		Lower Quartile		"t" Value	Sig. Level
		M	SD±	M	SD±		
Respiratory Rate per Minute	breaths/min	16.33	0.58	19.67	0.52	9.19	0.00
Resting Heart Rate	beats/min	74.65	1.53	70.50	2.08	8.00	0.00
Post-Exertion Heart Rate	beats/min	184.33	3.06	175.67	3.21	6.88	0.00
Vital Capacity	ml/L (ml)	432100.	4.63	4091.00	5.37	6.42	0.00
Absolute Maximal Oxygen Consumption	ml/min	37819.10	4.15	3493.33	3.95	7.83	0.00

Tabulated "t" value at significance level (0.05) = 3.182 Significant.

It is clear from Table (4) that there are statistically significant differences between the upper and lower quartiles in the physiological variables, where the calculated "t" values ranged between (6.42 : 9.19), which are greater than the tabulated "t" value at a significance level of 0.05, indicating the validity of the physiological variables.

Reliability:

To establish the reliability coefficient for the physiological tests, the researcher used the test-retest method on the same exploratory study sample (12 players). The tests were re-administered after (10) days from the first application to calculate the correlation coefficient between the first and second applications for the exploratory sample under investigation, as shown in Table (5).

Table 5. Reliability coefficient by finding the correlation between the first application and re-test in the physiological variables under investigation. (N = 12)

Statistical Indicators / Physiological Variables	Unit of Measurement	First Application		Re- Application		R-Value
		M	SD±	M	SD±	
Respiratory Rate per Minute	breaths/min	17.38	1.26	17.31	1.22	0.93
Resting Heart Rate	beats/min	71.25	3.48	71.06	3.42	0.95
Post-Exertion Heart Rate	beats/min	180.44	4.02	179.94	4.17	0.94
Vital Capacity	ml	4228.13	5.45	4240.63	5.72	0.96
Absolute Maximal Oxygen Consumption	ml/min	3548.75	4.18	3561.88	4.64	0.97

Tabulated "r" value at significance level (0.05) = 0.553 Significant.

It is evident from Table (5) that there is a statistically significant correlation between the first application and re-test in the physiological variables, where the calculated "r" values ranged between (0.93 : 0.97), which are greater than the tabulated "r" value at a significance level of 0.05, indicating the reliability of the physiological variables under investigation.

Seventh: Pilates Training Program

Program Objectives:

The program aims to develop certain physiological indicators (respiratory rate, resting heart rate, post-exertion heart rate, vital capacity, and maximal oxygen consumption) and improve the digital level of track and field athletes through the use of Pilates exercises.

Foundations of Designing the Proposed Training Program:

When designing the Pilates exercise program, the researcher took into account the following:

1. Suitability of exercises for the age group and level of the research sample members.
2. Progression in training load intensity and volume from easy to difficult.
3. Accounting for individual differences among athletes.
4. Achieving the principle of continuity and regularity in training.
5. Focusing on core muscles (abdomen – back – pelvis).
6. Linking breathing with movement during exercise performance.
7. Ensuring safety and security factors during execution.
8. Alignment between program objectives and the physiological variables under investigation.

Determining the General Framework and Temporal Distribution of the Proposed Pilates Training Program:

After reviewing references, benchmarking studies dealing with Pilates training design, and consulting experts, the researcher formulated the proposed Pilates training program along with its objectives.

Table 6. Temporal distribution of the proposed Pilates training program.

No.	Content	Temporal Distribution
1	Duration of the program in weeks	8 weeks
2	Program phases	2 phases
3	Number of weeks per phase	4 weeks
4	Number of training sessions per week	3 training sessions
5	Total number of units in the proposed training program	24 training sessions
6	Appropriate load in the proposed training program	Phase One: (40% : 60%) Phase Three (Phase Two): (60% : 90%)

Eighth: Basic Study

The basic study was conducted from 28/10/2025 to 31/12/2025, and the researcher clarifies this as follows:

Pre-measurement: Pre-measurements were conducted on 28/10/2025 for the variables under study on the research sample members numbering (10) players, and the tests were administered at the sports clubs.

Program Implementation: The proposed training program was applied to the experimental group numbering (10) players. The proposed training program was implemented over a period of 8 weeks from 30/10/2025 to 29/10/2025 on the core sample (the experimental group). (Note: Dates reflect source text).

Post-measurement: Post-measurements were conducted for the variables under study on the research sample members on 31/12/2025, administered at the sports clubs after (8) weeks of program implementation.

Ninth: Statistical Treatments Used in the Research

The researcher used the following statistical method to process data through the Statistical Package for the Social Sciences (SPSS) to find:

1. Arithmetic mean.
2. Standard deviation.
3. Median.
4. Skewness coefficient.
5. Kurtosis coefficient.
6. t-test (Student's t-test).
7. Pearson correlation coefficient.
8. Frequency and percentage.

RESEARCH RESULTS

Hypothesis: "There are statistically significant differences between the pre- and post-measurements of the experimental group in certain physiological indicators of track and field athletes in favor of the post-measurement."

Table 7. Significance of statistical differences for the (t) test between pre- and post-measurements in physiological variables for the experimental group. (N=10)

Statistical Indicators / Physiological Variables	Unit of Measurement	Pre-measurement		Post-measurement		"t" Value	Sig. Level
		M	SD±	M	SD±		
Respiratory Rate per Minute	breaths/min	18.40	1.35	15.70	1.06	8.92	0.00
Resting Heart Rate	beats/min	72.60	3.20	67.30	2.71	10.44	0.00
Post-Exertion Heart Rate	beats/min	181.40	5.82	171.20	5.14	11.37	0.00
Vital Capacity	Ml	4210.00	6.54	4685.00	7.36	12.61	0.00
Absolute Maximal Oxygen Consumption	ml/min	3580.00	4.61	3945.00	5.02	13.48	0.00

The results in Table (7) reveal statistically significant differences at the (0.05) level between the mean scores of the pre- and post-measurements for the experimental group in favor of the post-measurement mean across all physiological variables (respiratory rate per minute, resting heart rate, post-exertion heart rate, vital capacity, and absolute maximal oxygen consumption), with calculated "t" values ranging between (8.92 : 13.48).

Hypothesis: "There are statistically significant differences between the pre- and post-measurements of the experimental group in the digital level of track and field athletes in favor of the post-measurement."

Table 8. Significance of statistical differences for the (t) test between pre- and post-measurements in the digital level for the experimental group. (N=10)

Statistical Indicators / Digital Level	Unit of Measurement	Pre-measurement		Post-measurement		"t" Value	Sig. Level
		M	SD±	M	SD±		
Digital Level for 400m Athletes	s	55.41	1.12	53.18	0.98	* 15.67	0.00
Digital Level for 200m Athletes	s	23.84	0.74	22.32	0.61	* 12.51	0.00

Tabulated "t" value at significance level (0.05) = 2.262

The results in Table (8) demonstrate statistically significant differences at the (0.05) level between the mean scores of the pre- and post-measurements for the experimental group in favor of the post-measurement mean in the digital performance level of track and field athletes (200m and 400m), with calculated "t" values ranging between (12.51 : 15.67).

DISCUSSION

These results align with the findings of Kloubec (2010), which indicated that implementing a training program using Pilates exercises improved the efficiency of the cardiovascular and respiratory systems, enhanced the functional muscle performance, and improved breathing control, positively reflecting on the participants' physiological indicators. These improvements are attributed to Pilates exercises' reliance on regulated movement-accompanied breathing, which enhances respiratory muscle efficiency and gas exchange within the lungs.

Furthermore, these findings concur with Cruz-Ferreira et al. (2011), who indicated that regular Pilates programs contribute to enhancing cardiorespiratory fitness and lowering resting heart rates due to increased cardiac muscle efficiency and improved blood pumping to working tissues, allowing vital functions to be performed more efficiently with less exertion. This explains the noticeable decrease in resting and post-exertion heart rates among the experimental group members in the current study.

The results also agree with Emery, De Serres, McMillan & Côté (2010), who noted that practicing Pilates exercises improves respiratory functions and increases the efficiency of the ribcage and diaphragm muscles, thereby increasing lung vital capacity and enhancing oxygen utilization capacity during physical performance. The increase achieved in vital capacity among the experimental group reflects the positive impact of the implemented training program.

Additionally, these results are consistent with Khaled Abdul-Ghaffar Al-Falah et al. (2022), who pointed out that incorporating Pilates exercises into athletic training programs improved several functional variables related to cardiovascular and respiratory efficiency, reduced fatigue rates, and improved bodily responses to various physical loads. The study confirmed that Pilates exercises contribute to raising

functional performance efficiency through the integration of muscular work and regulated breathing during execution.

They also align with Abu Al-Ela Ahmed Abdel-Fattah (2012), who explained that training programs based on regulated breathing and integrated muscular work induce physiological adaptations characterized by a decreased heart rate, enhanced cardiovascular efficiency, and elevated respiratory efficiency, ultimately leading to improved athletic performance efficiency and capacity to withstand high training loads.

The researcher attributes the observed improvement in the physiological variables under investigation to the distinctive nature of Pilates exercises, which rely on the synchronization of movement and breathing, along with a primary focus on core muscles and integrated muscular activation. This elevated the efficiency of the cardiovascular and respiratory systems and enhanced oxygen consumption and transport to working muscles, thereby reducing respiratory rate, resting heart rate, and post-exertion heart rate, while increasing vital capacity and absolute maximal oxygen consumption (VO_2max).

These results correspond with Sekendiz, Altun, Korkusuz & Akın (2007), who highlighted that applying a Pilates exercise program improved physical fitness components related to athletic performance specifically muscular strength, muscular endurance, and balance positively influencing motor performance and athletic achievement levels. The study confirmed that improvements in physical capabilities resulting from Pilates directly contribute to enhancing competitive performance outcomes.

The findings also agree with Kloubec (2010), who indicated that Pilates exercises develop muscular balance, neuromuscular coordination, and movement efficiency, leading to higher athletic performance levels and minimized energy loss during execution. The study further illustrated that improved motor control reflects positively on achievement levels in sports activities dependent on speed and endurance.

Furthermore, the results align with Abdel-Aziz Al-Nemr & Nareeman Al-Khateeb (2017), who stated that utilizing modern training programs based on scientific principles contributes to improving digital achievement by developing physical and physiological aspects related to athletic performance, noting that improvements in functional capabilities represent one of the most decisive factors affecting track and field competition results.

The researcher attributes the improvement achieved in the digital performance levels of 200m and 400m runners to the positive impact of the Pilates training program on both motor and functional performance efficiency. The program contributed to enhancing core muscle strength and stability, increasing neuromuscular coordination, and elevating respiratory and circulatory efficiency, which led to improved energy economy and delayed onset of fatigue during performance.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The Pilates training program improved certain physiological variables among the track and field athletes in the experimental group in favor of the post-measurement.
2. The Pilates exercise program contributed to a statistically significant decrease in respiratory rate per minute among the experimental group members.

3. Implementing the program led to a statistically significant decrease in resting heart rate, indicating improved cardiovascular efficiency.
4. Pilates exercises contributed to lowering post-exertion heart rates, reflecting an improved recovery capacity among athletes after physical exertion.
5. The training program led to a statistically significant increase in lung vital capacity, indicating enhanced respiratory system efficiency.
6. Pilates exercises contributed to raising absolute maximal oxygen consumption (VO_2max), reflecting improved oxygen transport and utilization efficiency within the body.
7. The experimental group members achieved a clear improvement in the digital performance level of the 200m event after implementing the training program.
8. The program led to a statistically significant improvement in the digital performance level of the 400m event compared to the pre-measurement.
9. Results revealed statistically significant differences between pre- and post-measurements across all physiological variables under investigation in favor of the post-measurement.
10. Results revealed statistically significant differences between pre- and post-measurements in the digital level of 200m and 400m athletes in favor of the post-measurement.

Recommendations

1. Integrating Pilates exercises into physical conditioning programs for track and field athletes due to their positive effect on improving physiological variables and enhancing athletic performance efficiency.
2. Developing comprehensive training programs that combine Pilates with traditional training for muscular power, speed, and endurance to achieve a balance across all physical fitness components.
3. Paying attention to teaching athletes proper breathing techniques during exercise to ensure improved respiratory system efficiency and optimal utilization of lung vital capacity.
4. Training coaches on modern Pilates methods and enabling them to apply these methods scientifically within athlete preparation programs to achieve optimal results.
5. Utilizing modern measurement technologies such as heart rate monitors and performance tracking systems to accurately analyze the effectiveness of Pilates training programs.

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