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The Effect of a Proposed Training Program for Developing Core, Arm, and Leg Muscle Strength on the Time Performance of Middle-Distance Swimmers

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Abstract

Objectives. This study examines whether a targeted strength program for the core, arms, and legs can improve middle-distance swimming performance time. Specifically, it evaluates changes in (1) core strength, (2) arm strength, (3) leg strength, and (4) overall time performance in youth middle-distance swimmers.

Materials and Methods. An experimental method with a pre-test–post-test control group design was used. Participants were 45 youth-category swimmers, randomly selected from several sports groups in Kirkuk Governorate. They were divided into an experimental group and a control group. The experimental group followed a specialized, integrated strength program focusing on the core, arms, and legs, while the control group continued with regular training.

Results. Swimmers who completed the specialized strength exercises showed better time performance than those who only followed the usual training. Post-test comparisons also indicated a statistically significant advantage for the experimental group across all measured variables.

Conclusions. It summarizes and wraps up the ideas, presenting the key findings and insights derived from your study. It should include a concise summary of the main points discussed in the paper, including the research objectives, methodology, and results.

Keywords: Strength training program, Core muscle strength, Upper- and lower-limb strength, Middle-distance swimming, Time performance.

Introduction

Swimming has witnessed remarkable development in recent decades as a result of scientific progress in the fields of sports training, measurement and evaluation, movement sciences, and physiology, which has contributed to improving swimmers' performance times across different age and competitive levels. Modern training programs have become based on precise scientific foundations aimed at developing the physical and technical abilities associated with the specialized performance of each race. Advancement in swimming is no longer based solely on increasing training volume, but rather on the quality of exercises and the extent of their relevance to the swimmer's motor and physiological performance requirements (Abdel Fattah, 2012: 63).

Middle-distance swimming races are considered among the most physically and technically complex events, as they require the availability of an integrated combination of muscular strength, endurance, anaerobic capacity, and technical efficiency in performance. Success in these distances depends on the swimmer's ability to maintain a relatively high swimming speed with economical effort, which requires high efficiency in the work of the arms and legs along with trunk stability throughout the race duration (Counsilman, 201: 136).

Mohamed Abdullah Ali (2021) stated that muscular strength is one of the most important variables affecting the improvement of swimmers' time performance, especially arm strength, which is responsible for generating the primary propulsive force, and leg strength, which contributes to improving starts and turns and maintaining a horizontal body position, in addition to core muscle strength, which serves as the link between the upper and lower limbs and plays a pivotal role in efficiently transferring force and reducing energy loss during swimming (Ali, 2021: 47).

Core training has become one of the modern trends in sports training due to its positive effect on improving balance, stability, and motor control, which is directly reflected in the quality of technical performance in swimming. Weak core muscles lead to increased water resistance and reduced effectiveness of arm and leg strokes, whereas developing them contributes to improving body streamlining and reducing the effort exerted during the race (Gamble, 2013: 59).

Osama Kamel Rateb and Ali Mohamed Zaki (2005) indicated that despite the increasing interest in strength training for swimmers, many training programs applied to the youth category focus on technical aspects and the volume of swimming in water, while neglecting or minimizing attention to strength training outside the water, especially training directed toward developing the functional strength of the core, arm, and leg muscles in accordance with the performance requirements of middle-distance races. This may limit the expected performance improvement for this category (Rateb, Zaki, 2005: 63).

Based on the importance of linking theoretical and practical aspects, the need has emerged to design proposed training programs based on clear scientific foundations to develop the muscular strength of the core, arm, and leg muscles, and to study their effect on the time performance level of middle-distance swimmers, thereby contributing to the provision of a training model that can be utilized in developing the training process within clubs.

Research Problem

Despite the significant development witnessed in swimming at the global level, the performance times of middle-distance swimmers in the youth category in many clubs remain below the desired levels, indicating shortcomings in some components of the training process, particularly those related to specialized physical preparation associated with the requirements of these races.

Through the researcher's practical experience in training and teaching swimming, and his follow-up of swimmers' results in the 200-meter freestyle event, it was observed that many swimmers suffer from a decline in performance efficiency in the final parts of the race despite their proficiency in basic skills, reflecting weakness in some physical abilities that affect continuity and motor stability.

The researcher also observed that the applied training programs place great emphasis on in-water swimming and increasing training distances, with limited use of targeted strength training, especially core muscle training, and a lack of clear integration between arm and leg training in a way that serves the specialized performance of middle-distance races. The results of some physical measurements indicate a clear disparity between the levels of arm and leg strength among juniors, along with a relative weakness in core muscle strength. This negatively affects the efficiency of force transfer between different parts of the body during swimming, leading to increased water resistance and a decrease in the swimmer's average speed.

Despite the abundance of studies that have addressed the effect of strength training on athletic performance in general, studies that have examined the effect of integrated training programs to develop the muscular strength of

the core, arms, and legs on the time performance level of middle-distance swimmers in the youth category remain limited, especially in the Arab environment. This lack of applied studies has led to the absence of clear scientific training models that coaches can rely on to develop muscular strength in an integrated manner that suits the physical and physiological characteristics of youth and achieves tangible improvement in the performance times of middle-distance races.

Research Objectives

The present study seeks to examine the impact of a proposed training program designed to enhance the strength of the core, upper limbs, and lower limbs on the time-based performance of middle-distance swimmers. This objective is achieved by addressing the following aspects:

• Examining the effect of the proposed training program on the development of core muscle strength in middle-distance swimmers.

• Investigating the effect of the proposed training program on improving arm muscle strength in middle-distance swimmers.

• Analyzing the effect of the proposed training program on enhancing leg muscle strength in middle-distance swimmers.

• Determining the effect of the proposed training program on improving the time performance outcomes of middle-distance swimmers.

Research Hypotheses

• It is assumed that significant statistical differences will be present between the pre and post-measurements of the experimental group in terms of core muscle strength, arm muscle strength, leg muscle strength, and swimming time performance for middle-distance swimmers, with superior results in the post-measurement.

• It is also expected that statistically significant differences will appear between the pre- and post-measurements of the control group regarding core muscle strength, arm muscle strength, leg muscle strength, and swimming time performance for middle-distance swimmers, favoring the post-measurement results.

• Moreover it is anticipated that statistically significant differences will emerge between the experimental and control groups in the post-measurements of core muscle strength, arm muscle strength, leg muscle strength, and swimming time performance for middle-distance swimmers, in favor of the experimental group.

Research Procedures

First: Research Method

The experimental approach was adopted in the present study as it is appropriate for the nature and objectives of the research. An experimental design based on pre- and post-testing was applied to two groups: an experimental group and a control group.

Second: Research Population and Sample

- **Research Population**

  The research population consists of youth-category swimming players from various clubs in Kirkuk Governorate for the 2025–2026 season.

- **Research Sample**

  The researcher selected a random sample of (45) youth-category swimmers from various clubs in Kirkuk Governorate and divided them as follows:

- Pilot sample: consisting of (15) swimmers for standardizing the tests under study in terms of validity and reliability.
- Experimental group: consisting of (15) swimmers on whom the proposed training program was applied.
- Control group: consisting of (15) swimmers who received the traditional program applied at the club, as shown in Table (1).

Table 1. Characteristics of the Research Sample

Classification	Number of players	Percentage
Pilot sample	15	33.33%
Experimental group	15	33.33%
Control group	15	33.33%
Total	45	100%

• Statistical Description of the Research Sample

The fundamental characteristics of the study sample, including age, body weight, and height, were measured to ensure control over variables that could potentially influence the research procedures. Table (2) presents the statistical indicators related to these basic variables prior to the implementation of the experimental program.

Table 2. Statistical Indicators of the Research Sample for the Basic Variables Prior to the Experiment. n = 45

Variables	Measurement Unit	Mean	Standard deviation	Skewness coefficient	Kurtosis coefficient
Age	Year	17.24	0.36	1.06	1.62
Weight	Kg.	73.69	1.58	0.99	0.55
Height	cm.	177.25	2.01	0.36-	-0.85

The results presented in Table (2), which address the homogeneity of the research sample in the basic pre-experimental measurements, indicate that the data of the total sample are normally distributed and show no excessive dispersion. The skewness values ranged from −0.36 to 1.06, reflecting distributions close to symmetry. In addition, the kurtosis values ranged between −0.85 and 1.62, indicating acceptable and moderate curve shapes that are neither overly peaked nor excessively flattened. These findings confirm the homogeneity and comparability of the research sample members in the basic variables prior to the implementation of the experiment.

Third: Means and Tools of Data Collection

Devices and Tools Used in Research: Based on a review of relevant references and previous related studies, the researcher determined the appropriate devices and instruments required to carry out the research procedures and achieve the study objectives, as follows: Height measuring device (Rest meter) for total body height. Medical scale

for measuring weight. Stopwatch for measuring time (in seconds). Medicine balls of different weights (3–5 kg). Regulation swimming pool (50 m). Light free weights. Elastic bands. Jump box. Data recording form.

Measurements and Tests Used in the Research:

The researcher referred to previous studies and scientific references that addressed the study variables, consulted the opinions of experts regarding them, and then identified the following tests:

Table 3. Tests Used in the Research

Abilities	Tests	Measurement Unit
Core muscle strength	Front plank test	Sec.
Arm muscle strength	Inclined prone push-up test	Rep.
	Medicine ball throw (5 kg) with both hands for maximum distance	Meter
Leg muscle strength	Standing long jump test	cm.
Swimming time performance	Numerical level of 200 m freestyle swimming	Sec.

Fourth: Pilot Study: The pilot study was conducted during the period from 6/9/2025 to 15/9/2025 on the pilot study sample consisting of (15) swimmers, outside the main sample, in order to measure validity and reliability.

Scientific Coefficients of the Tests Used in the Research:

Validity: To assess the validity coefficients of the tests under investigation, the researcher applied the extreme group method by comparing the mean scores of the upper and lower quartiles of the pilot sample, which consisted of fifteen (15) swimmers. This approach was used to determine the discriminant validity of the tests. The results are presented in Table (4).

Table 4. Significance of Differences Between the Upper and Lower Quartiles for Determining the Discriminant Validity of the Tests Under Study. n = 15

Tests	Measurement Unit	Upper Quartiles		Lower Quartiles		t-value	Significance Level
		Mean	St.d	Mean	St.d		
Front plank test	Sec.	79.31	1.32	72.36	1.03	5.01	0.00
Inclined prone push-up test	Rep.	14.95	1.24	11.02	1.46	4.36	0.00
Medicine ball throw (5 kg) with both hands for maximum distance	Meter	5.86	0.96	4.97	0.89	3.52	0.00
Standing long jump test	cm.	172.94	0.39	159.02	0.52	6.89	0.00
Numerical level of 200 m freestyle swimming	Sec.	145.20	1.25	139.42	1.95	5.02	0.00

Tabulated t-value at significance level (0.05) = 3.182 * Significant

It is clear from the above table that there are statistically significant differences between the upper and lower quartiles in the tests under study, as the calculated t-values ranged between (3.52 to 6.89), which are higher than the tabulated t-value. This indicates the validity of the tests under study.

- **Reliability:** The reliability coefficient of the tests was determined using the test–retest method on the same pilot study sample (15 swimmers). The tests were re-administered after (7) days from the first application to calculate the correlation coefficient between the first and second applications, as shown in Table (5).

Table 5. Reliability Coefficient by Calculating the Correlation Between the First Application and the Re-Test in the Tests. (n = 15)

Tests	Measurement Unit	Experimental Group		Control Group		r-value
		Mean	St.d	Mean	St.d	
Front plank test	Sec.	75.36	1.63	75.44	1.52	0.942*
Inclined prone push-up test	Rep.	12.41	1.24	12.56	1.03	0.953*
Medicine ball throw (5 kg) with both hands for maximum distance	Meter	5.33	0.58	5.39	0.63	0.971*
Standing long jump test	cm.	165.92	1.28	165.85	1.69	0.950*
Numerical level of 200 m freestyle swimming	Sec.	142.31	1.47	142.53	1.52	0.941*

Tabulated r-value at significance level (0.05) = 0.514 * Significant

The results presented in Table (5) reveal statistically significant correlations between the initial administration and the re-test of the measures under study. The calculated correlation coefficients (r) ranged from 0.941 to 0.971, exceeding the tabulated value at the 0.05 level of significance. These findings confirm the reliability of the tests used in the study.

Fifth: The Proposed Training Program to Develop Core, Arm, and Leg Muscle Strength and Its Effect on the Time Performance Level of Middle-Distance Swimmers

1. **Program Objective:** The proposed training program aims to develop the strength of the core, arm, and leg muscles among middle-distance swimmers in the junior category, contributing to improving the time performance level of the 200 m freestyle event. This is achieved through the use of functional and specialized strength training that aligns with the motor and physiological performance requirements of swimming, enhances the efficiency of force transfer between body segments, improves body streamlining in water, and increases the effectiveness of arm and leg strokes during swimming.
2. **Foundations for Designing the Proposed Training Program:** The proposed training program was designed in light of the specialized performance requirements of middle-distance races, taking into account age characteristics and individual differences among junior swimmers, achieving integration between strength training for the core, arms, and legs, and applying progressive training loads in terms of intensity and volume. The program relies on functional exercises related to swimming movements, maintains balance between strength training and in-water skill training, and considers safety, security, and training continuity.
3. **Time Distribution of the Proposed Training Program:**

Table 6. Time Distribution of Training Units in the Proposed Training Program

No.	Item	Time Distribution
1	Number of weeks	(8) weeks

2	Number of units in the program	(24) units
3	Number of units per week	(3) units
4	Duration of one unit	(75) minutes
5	Weekly application time	(225) minutes
6	Total program application time	(1800) minutes

Table (6) indicates that the training program applied in the present study extended over a period of eight (8) weeks and comprised twenty-four (24) training sessions, with three sessions conducted per week. The duration of each training session was seventy-five (75) minutes, resulting in a total program time of one thousand eight hundred and eighty (1,880) minutes.

4. **Components of the Training Unit:**

The training unit of the proposed program to develop core, arm, and leg muscle strength among middle-distance swimmers consists of the following parts: Preparatory part (warm-up): Aims to prepare the various body systems for the training load and includes general and specific warm-up exercises and dynamic stretching exercises, contributing to increasing body temperature and preventing injuries. Main part: Represents the core of the training unit and includes strength training for the core, arms, and legs using functional and specialized exercises, in addition to in-water skill training related to middle-distance races, according to prescribed intensity and volume. Final part (cool-down): Aims to gradually return the body to its normal state after physical exertion and includes cool-down exercises and static stretching that aid recovery and reduce muscular fatigue.

Sixth: Main Study

The main phase of the study was carried out from 19/9/2025 to 22/11/2025 and was organized as follows:

Pre-Test: pre-test measurements for the study variables were conducted on 19/9/2025 on a research sample consisting of thirty (30) swimmers. The participants were equally divided into two groups: fifteen (15) swimmers in the experimental group and fifteen (15) swimmers in the control group. All measurements were administered at the swimming pool of Kirkuk.

Equivalence Between the Two Groups (Control and Experimental):

Table 7. Equivalence Between the Control and Experimental Groups in the Tests (Core Muscle Strength – Arm Strength – Leg Strength – Swimmers' Numerical Performance Level) Before the Experiment. n = 15

Tests	Measurement Unit	Experimental Group		Control Group		t-value	Sig. Level
		Mean	St.d	Mean	St.d		
Front plank test	Sec.	76.23	1.02	75.93	1.32	1.02	0.00
Inclined prone push-up test	Rep.	13.36	0.85	13.86	1.52	0.89	0.00
Medicine ball throw (5 kg) with both hands for maximum distance	Meter	5.18	1.06	5.12	0.77	0.56	0.00
Standing long jump test	cm.	163.92	1.67	164.82	2.01	1.05	0.00

Numerical level of 200 m freestyle swimming	Sec.	143.85	2.03	144.02	1.96	0.86	0.00

Tabulated t-value at significance level (0.05) = 2.048

The data presented in Table (7), which include the statistical indicators of the study variables for both the experimental and control groups prior to the application of the training program reveal the absence of statistically significant between the two groups at the 0.05 significance level. The calculated *t* values ranged between 0.56 and 1.02, all of which were below the tabulated *t* value of 2.048 at the same level of significance, while the corresponding significance values were greater than 0.05. This confirms the homogeneity and equivalence of the experimental and control groups across all measured variables before the initiation of the experimental procedures.

Program Implementation: The proposed training program was applied to the experimental group, which consisted of fifteen (15) swimmers. In contrast, the control group, also comprising fifteen (15) swimmers continued follow the conventional training programs prepared by their coaches. The implementation of the proposed program extended over a period of eight (8) weeks, from 21/9/2025 to 20/11/2025 with three training sessions conducted weekly for the experimental group.

Post-Test: Post-test assessments of the research variables were performed on the study sample on 22/11/2025. All post-measurements were conducted at the Kirkuk swimming pool under the same standardized conditions and procedures used during the pre-test phase.

Seventh: Statistical Treatments Used:

Arithmetic mean. Standard deviation. Median. Skewness coefficient. Kurtosis coefficient. t-test. Pearson correlation coefficient. Frequency and percentage.

Presentation and Discussion of Results:

First: Presentation of the Results of the First Hypothesis and Its Discussion:

There are statistically significant differences between the two measurements (pre- and post-) for the experimental research sample in (core muscle strength – arm strength – leg strength – swimmers' numerical performance level) for middle-distance swimmers.

Table 8. Significance of Differences Between Pre-Measurement and Post-Measurement for Experimental Group in Tests Core Muscle Strength, Arm Strength, Leg Strength, Swimmers' Numerical Performance Level. n = 15

Tests	Measurement Unit	Pre-Measurement		Post-Measurement		t-value	Sig. Level
		Mean	± SD	Mean	± SD		
Front plank test	Sec.	76.23	1.02	92.42	1.36	8.94	0.00
Inclined prone push-up test	Rep.	13.36	0.85	21.21	1.65	13.82	0.00
Medicine ball throw (5 kg) with both hands for maximum distance	Meter	5.18	1.06	6.96	1.56	4.92	0.00

Standing long jump test	cm.	163.92	1.67	187.36	1.69	9.15	0.00
Numerical level of 200 m freestyle swimming	Sec.	143.85	2.03	132.78	1.98	7.36	0.00

Tabulated t-value at significance level (0.05) = 2.145

It is evident from the results of Table (8) results indicate statistically significant differences between the mean scores of the pre-test and post-test measurements of the experimental group in favor of the post-test means across the assessed variables, including core muscle strength, arm strength, leg strength, and swimmers' time performance for middle-distance events. The calculated t-values ranged from 4.92 to 13.82, confirming the effectiveness of the applied training program.

These results are consistent with the findings of Maglischo (2013), which indicated that developing muscular strength is one of the fundamental factors affecting the improvement of swimmers' numerical performance level, especially in middle-distance races. Integrated development of muscular strength contributes to increasing the ability to produce propulsive force and reducing energy loss during performance. The study also clarified that training programs based on scientific foundations contribute to improving time performance efficiency, which is consistent with the results of the current research that showed statistically significant differences in favor of the post-measurement in all muscular strength variables and the numerical performance level. These results are also consistent with the findings of Mohamed Abdullah Ali (2021), which indicated that core-strengthening exercises contribute to improving trunk stability and the efficiency of force transfer between the upper and lower limbs, which positively reflects on motor performance in various sports activities, including swimming. It also confirmed that developing arm strength leads to increased stroke effectiveness and reduced effort exerted during performance. This is consistent with the results of the current research, which showed a large improvement in the plank and push-up tests in favor of the post-measurement.

The findings of Costill et al. (2016) also indicated that leg muscle strength is one of the basic requirements for improving time performance in swimming, especially in starts, turns, and maintaining a streamlined body position in water. The study clarified that developing explosive leg strength contributes directly to reducing the total race time, which is consistent with the results of the current research that showed statistically significant differences in the standing long jump test in favor of the post-measurement. The researcher believes that the noticeable improvement in muscular strength variables and the numerical performance level among the experimental group members is due to the effectiveness of the proposed training program, which relied on developing the muscular strength of the core, arms, and legs in an integrated manner, while taking into account progressive training load and its linkage to the specialized performance requirements of middle-distance races. Regular application of the program and the variety of exercises also contributed to creating positive physical and physiological adaptations that were reflected in improving the numerical performance level of 200 m freestyle swimmers, which confirms the validity of the first hypothesis of the research.

Presentation of the Results of the Second Hypothesis and Its Discussion:

There are statistically significant differences between the two measurements (pre- and post-) for the control research sample in (core muscle strength – arm strength – leg strength – swimmers' numerical performance level) for middle-distance swimmers.

Table 9. Statistical Significance of Differences Between Pre-Test and Post-Test Measurements for Control Group in Core Muscle Strength, Arm Strength, Leg Strength, and Swimmers' Time Performance Level n = 15

Tests	Measurement Unit	Pre-Measurement		Post-Measurement		t-value	Sig. Level
		Mean	St.d	Mean	St.d		

Front plank test	Sec.	75.93	1.32	83.69	1.56	4.72	0.00
Inclined prone push-up test	Rep.	13.86	1.52	16.02	1.32	6.39	0.00
Medicine ball throw (5 kg) with both hands for maximum distance	Meter	5.12	0.77	5.96	0.82	2.03	0.09
Standing long jump test	cm.	164.82	2.01	171.28	1.93	6.88	0.00
Numerical level of 200 m freestyle swimming	Sec.	144.02	1.96	139.69	1.25	4.92	0.00

Tabulated t-value at significance level (0.05) = 2.145

The findings presented in Table (9) indicate statistically significant differences between the pre-test and post-test mean scores of the control group in favor of the post-test measurements across the assessed variables, including core muscle strength, arm strength, leg strength, and swimmers' time performance level in middle-distance events. The calculated t-values ranged from 4.72 to 9.88, reflecting measurable improvements in the control group. The absence of statistically significant differences between the mean scores of the pre- and post-measurements for the control group in the test (medicine ball throw 5 kg with both hands for maximum distance) for middle-distance swimmers, where the calculated "t" value reached (2.03). These results of Costill et al. (2016), which indicated that regularity in traditional swimming training, even in the absence of specialized strength training programs, leads to statistically significant improvement in some physical variables and swimmers' numerical performance level, due to the physiological adaptations resulting from continuity in in-water training. This is consistent with the results of the current research, and numerical performance level in favor of the post-measurement.

These results are also consistent with the findings of Rushall (2018), which indicated that traditional training programs that focus on in-water swimming contribute to improving swimmers' physical and numerical levels to varying degrees, but this improvement is often limited in some components of muscular strength, especially explosive strength and maximal strength of the upper limbs. This explains the absence of statistically significant differences in the medicine ball throw test for the control group in the current research, as their program did not include specific strength training directed at developing arm muscular strength. The researcher believes that the statistically significant improvement in most physical variables and the numerical performance level in the control group is due to the regularity of its members in traditional swimming training during the research application period, which led to positive physical and physiological adaptations.

Presentation of the Results of the Third Hypothesis and Its Discussion:

There are statistically significant differences between the two groups (experimental and control) in the post-measurement in (core muscle strength – arm strength – leg strength – swimmers' numerical performance level) for middle-distance swimmers.

Table 10. Significance of Differences the Two Groups (Experimental and Control) in Post-Measurement in Tests (Core Muscle Strength – Arm Strength – Leg Strength – Swimmers' Numerical Performance Level) n = 15

Tests	Measurement Unit	Experimental Group		Control Group		t-value	Sig. Level
		Mean	St.d	Mean	St.d		
Front plank test	Sec.	92.42	1.36	83.69	1.56	5.69	0.00

Inclined prone push-up test	Rep.	21.21	1.65	16.02	1.32	7.36	0.00
Medicine ball throw (5 kg) with both hands for maximum distance	Meter	6.96	1.56	5.96	0.82	3.01	0.00
Standing long jump test	cm.	187.36	1.69	171.28	1.93	6.92	0.00
Numerical level of 200 m freestyle swimming	Sec.	132.78	1.98	139.69	1.25	4.86	0.00

Tabulated t-value at significance level (0.05) = 2.048

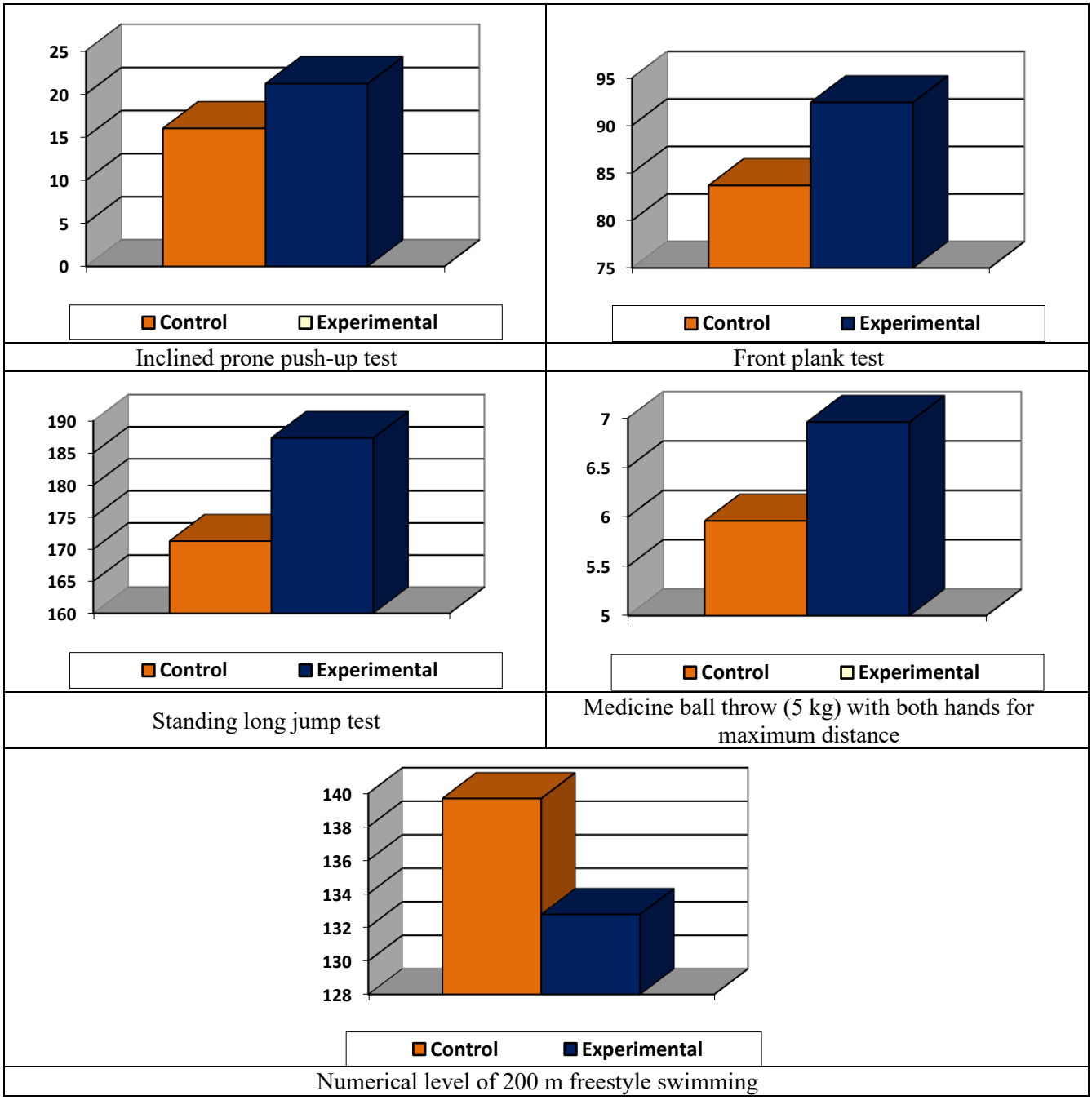

Figure (1): The arithmetic mean of the control and experimental groups for the tests under study.

It is evident from the results of Table (10) and Figure (1) presence of statistically significant differences between the mean scores of the groups (experimental and control) in favor of the experimental group in the tests (core muscle strength – arm strength – leg strength – swimmers' numerical performance level) for middle-distance swimmers, where the calculated "t" values ranged between (3.01 to 7.36). These results are consistent with the findings of Ali Hussein Mohamed (2021), which indicated that training programs based on regulated and specialized strength training achieve greater improvement in physical variables compared to traditional training programs, especially when comparing experimental and control groups in post-measurements. The study clarified that training directed at developing muscular strength contributes to producing effective muscular and neural adaptations,

These results are also of Hibbs et al. (2018) and Mazari Fateh (2019), which indicated that developing core muscle strength is a decisive factor in improving the efficiency of force transfer between the upper and lower limbs, leading to improved motor performance and numerical performance level in sports activities that require high muscular coordination such as swimming. It is noted from the results of the current research that, which indicates the effectiveness of the proposed training program in improving core muscle strength compared to traditional training. The researcher believes that the superiority of the experimental group over the control group in the post-measurement is due to the effectiveness of the proposed training program, which relied on specialized and integrated strength training for the core, arm, and leg muscles, while taking into account the progression of training load and the direct linkage to the specialized performance requirements of middle-distance races.

Conclusions

The research results showed a statistically significant improvement in core muscle strength among members of the experimental group after applying the proposed training program, compared to the pre-measurement. The post-measurement results resulted in a statistically significant improvement in arm muscle strength among members of the experimental group, exceeding the improvement achieved by members of the control group. The research results demonstrated that the proposed training program contributed to developing leg muscle strength in a noticeable manner, which was reflected in the superiority of the experimental group in the post-measurement compared to the control group. The results of the comparison between the two groups in the post-measurement revealed a clear superiority of the experimental group in all research variables under study. The use of training programs based on specialized and integrated strength training for the core, arm, and leg muscles is more effective in improving the time performance of middle-distance swimmers than relying on traditional training alone.

Recommendations

The necessity of applying the proposed training program to develop core, arm, and leg muscle strength within the preparation programs of middle-distance swimmers, due to its positive effect on improving the numerical performance level. Paying attention to integrating specialized and functional strength training for the core muscles and limbs within swimmers' training plans, and not relying solely on traditional in-water training. The necessity of achieving integration between strength training and in-water skill training to ensure improvement in physical and technical performance in middle-distance races. Paying attention to measuring and evaluating physical variables and numerical performance levels periodically using standardized scientific tests to monitor swimmers' level development. Raising coaches' awareness of the importance of core muscle training and its role in improving trunk stability and the efficiency of force transfer during swimming. Benefiting from the research results in developing training plans within clubs and junior preparation centers in line with modern trends in sports training.

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