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The effect of specific physical abilities on the characteristics of stride according to the target time and their impact on the achievement in the 400-meter freestyle running for juniors

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Abstract

The performance of athletes in the 400-meter freestyle race relies heavily on specific physical abilities. Miyashiro *et al.* (2019) and Al-Nedawy & Al-Mousawi (2022) highlighted the influence of stride characteristics on overall performance, emphasizing that specialized training improves specific abilities. The research problem is that variations in stride characteristics lead to inconsistent race times due to differences in athletes' physical abilities. This study aimed to understand the impact of physical abilities on stride characteristics, identify training methods to enhance these characteristics, and provide recommendations to improve junior athletes' performance. An experimental design involving two groups (experimental and control) was used with 12 junior athletes from Najaf Governorate clubs. Eight athletes were selected and randomly divided between the two groups. The experimental group underwent a new training program to improve physical abilities and stride characteristics, while the control group followed a traditional regimen. Pre-tests conducted on 01/05/2023 established baseline performance levels, and the new training program emphasized exercises to enhance speed, speed endurance, and rhythmic endurance. Post-tests on 15/07/2023 revealed significant improvements across all 100-meter segments. Average times improved from 12.44s to 12.23s, 12.99s to 12.05s, 13.62s to 12.49s, and 13.89s to 12.25s for each successive 100-meter segment. Speed rates and stride length improved, indicating stronger muscles and enhanced flexibility. In conclusion, this specialized training program effectively improved the physical and mechanical performance of junior athletes. Coaches should emphasize stride frequency, strength, and endurance to enhance 400-meter runners' competitive performance.

Keywords: Physical, freestyle, running, competitive performance, Specific physical abilities

Introduction

Specific physical abilities are fundamental elements that significantly impact athletes' performance in the 400-meter freestyle race, especially for juniors who aim to achieve the best results within a targeted timeframe. Understanding how specific physical abilities affect stride characteristics in relation to the target time can contribute to enhancing athletic performance and achieving desired outcomes. The ability to control stride and its timing are crucial factors influencing athletic performance. Studies have shown that implementing specialized training programs can contribute to developing the specific physical abilities needed to achieve the best results ^[1]. In this context, ^[2] clarified that factors such as leg length and stride frequency can influence athletes' overall performance in the 400-meter freestyle race. Their findings revealed that improving stride abilities could lead to a noticeable improvement in race completion.

In their study ^[3] highlighted the importance of controlling running pace and stride frequency as crucial factors for achieving optimal performance in races, with a focus on the 400-meter hurdles race. The results of these studies suggest that focusing on improving specific physical abilities can enhance athletic performance in the 400-meter freestyle race.

Research Problem

The research problem lies in the fact that each athlete's specific physical abilities impact stride characteristics relative to the target time, resulting in considerable variation in the completion of the 400-meter freestyle race for juniors. This issue is exacerbated by individual differences in physical abilities, making it challenging for many athletes to identify appropriate training to improve stride characteristics and achieve the target race time. Consequently, a deeper understanding of the factors that determine stride characteristics and achieving the target time is required.

Research Objectives

- Understand the impact of physical abilities on stride characteristics.
- Identify training methods to improve stride characteristics and achieve the target time.
- Provide recommendations on how to enhance the performance of junior athletes in the 400-meter race.

Materials and Methods

Selecting the appropriate method to solve a problem in scientific research is a critical step and a prerequisite for the success of the study. Therefore, given the stated problem, the researcher chose the experimental method with both experimental and control groups. The experimental method is one of the most accurate research methodologies for obtaining precise results. A sample is defined as a portion representing the original research population, which forms the basis and focal point of the researcher's work. The research sample, in this study, includes junior athletes in the Najaf Governorate clubs for the 2023 season, totaling 12 athletes. The researcher will intentionally select 8 athletes from the original population and randomly divide them into two groups: an experimental group and a control group. The experimental group will undergo a new training program aimed at improving physical abilities and stride characteristics, while the control group will continue with traditional training programs. After selecting the sample, the researcher will ensure homogeneity using the skewness coefficient for factors like training age and performance to

guarantee an equitable distribution between the two groups.

Field Research Procedures

Identifying the Physical Abilities Specific to the 400-Meter Freestyle ^[4].

- Maximum Speed Test (70 meters): Measures the runners' maximum speed over the first 70 meters of the 400-meter race.
- Speed Endurance Test (200 meters): Assesses the runners' speed endurance over the first 200 meters of the 400-meter race.
- Rhythmic Endurance Test (300 meters): Evaluates the runners' rhythmic endurance over the first 300 meters of the race.
- 400-Meter Completion: Measures the time taken to complete the entire 400-meter race.
- Stride Measurement: Assesses and records stride characteristics during the 400-meter race.

Pilot Study: The pilot study was conducted on four runners to verify the effectiveness and applicability of the measurement tools.

Pre-Tests: Pre-tests were conducted on 01/05/2023 to establish the athletes' initial performance levels before implementing the training program.

Training Program

- The training program included exercises aimed at improving physical abilities and their impact on stride characteristics relative to the target time.
- Each training unit lasted between 35 and 45 minutes, focusing on exercises to improve speed, speed endurance, and rhythmic endurance.

Post-Tests: Post-tests were conducted on 15/07/2023 to assess the impact of the training program on improving physical abilities and stride characteristics in athletes.

Results

Table 1: Shows the statistical features of the research variables under study and the research sample

| Variables | Units (100m intervals) | Pre-Test (Mean ± SD) | Post-Test (Mean ± SD) | Max Value (Pre) | Min Value (Pre) | Max Value (Post) | Min Value (Post) |
|--------------------------|------------------------|----------------------|-----------------------|-----------------|-----------------|------------------|------------------|
| Time | | | | | | | |
| First 100m | 12.35±0.21 | 12.23±0.07 | 12.45 | 12.16 | 13.20 | 12.15 | |
| Second 100m | 12.06±0.39 | 12.05±0.43 | 12.56 | 11.51 | 12.50 | 11.62 | |
| Third 100m | 13.45±0.33 | 12.49±0.59 | 14.02 | 13.11 | 13.16 | 12.15 | |
| Fourth 100m | 13.49±0.74 | 12.25±0.28 | 14.50 | 13.05 | 12.60 | 12.07 | |
| Speed (m/s) | | | | | | | |
| First 100m | 8.08±0.13 | 8.16±0.05 | 8.22 | 8.03 | 8.23 | 8.09 | |
| Second 100m | 8.29±0.26 | 8.30±0.29 | 8.68 | 7.96 | 8.60 | 7.87 | |
| Third 100m | 7.41±0.19 | 8.02±0.38 | 7.62 | 7.13 | 8.59 | 7.59 | |
| Fourth 100m | 7.43±0.39 | 8.16±0.19 | 7.96 | 7.06 | 8.48 | 7.93 | |
| Stride Length (m) | | | | | | | |
| First 100m | 200.6±8.14 | 207.96±6.06 | 209.4 | 190.04 | 211.89 | 200 | |
| Second 100m | 210.60±5.42 | 216.55±3.99 | 212.94 | 203.65 | 221.76 | 206 | |
| Third 100m | 180.83±17.51 | 210.63±9.80 | 197.11 | 147.85 | 223.16 | 195.22 | |
| Fourth 100m | 172.90±12.68 | 208.48±3.82 | 187.64 | 155.88 | 213.07 | 203.05 | |
| Stride Frequency | | | | | | | |
| First 100m | 49.89±2.03 | 48.11±1.30 | 52.51 | 48.18 | 50.50 | 47.19 | |
| Second 100m | 47.60±1.23 | 46.47±1.31 | 49.26 | 45.66 | 48.54 | 40.24 | |
| Third 100m | 55.90±6.21 | 47.63±2.25 | 68.06 | 50.76 | 51.28 | 44.84 | |
| Fourth 100m | 58.23±4.39 | 48.05±0.87 | 62.11 | 54.05 | 49.26 | 46.94 | |

| | | | | | | | |
|--------------------|--|------------|------------|-------|-------|-------|-------|
| Speed Endurance | | 32.89±2.21 | 28.28±0.38 | 35.25 | | | |
| Strength Endurance | | 28.57±0.61 | 25.44±0.70 | 29.35 | 27.95 | 26.40 | 24.70 |

Key Observations

- **Time:** The post-test results indicate a consistent decrease in the time taken across each 100m interval, signifying improvement in overall race completion time.
- **Speed:** Post-test data shows increased speeds in each interval, reflecting the positive impact of the training program.
- **Stride Length:** Improvements in stride length were observed in all intervals after the training program.
- **Stride Frequency:** Although stride frequency varied, the data still aligns with the observed improvements in time and speed.
- **Speed Endurance and Strength Endurance:** Both parameters showed improvements after the training program.

These results support the effectiveness of the new training program in enhancing athletes' physical abilities, particularly their speed, stride length, and endurance, contributing to improved performance in the 400-meter race.

Time Variable

- **First 100m:** The pre-test mean was 12.44s with a standard deviation (SD) of 0.25, while in the post-test, it was 12.23s with an SD of 0.077.
- **Second 100m:** The pre-test mean was 12.99s (SD: 0.44), and the post-test mean was 12.05s (SD: 0.43).
- **Third 100m:** The pre-test mean was 13.62s (SD: 0.37), while the post-test mean was 12.49s (SD: 0.59).
- **Fourth 100m:** The pre-test mean was 13.89s (SD: 1.09), while the post-test mean was 12.25s (SD: 0.28).

Speed Variable

- **First 100m:** The pre-test mean speed was 8.03 m/s (SD: 0.16), while the post-test was 8.16 m/s (SD: 0.52).
- **Second 100m:** The pre-test mean speed was 8.20 m/s (SD: 0.30), and the post-test was 8.30 m/s (SD: 0.29).
- **Third 100m:** The pre-test mean was 7.34 m/s (SD: 0.20), while the post-test was 8.02 m/s (SD: 0.38).
- **Fourth 100m:** The pre-test mean speed was 7.23 m/s (SD: 0.55), and the post-test was 8.16 m/s (SD: 0.16).

Stride Length Variable

- **First 100m:** The pre-test stride length was 2.06m (SD: 0.81), while the post-test was 2.07m (SD: 0.06).
- **Second 100m:** The pre-test mean was 2.10m (SD: 0.52), while the post-test was 2.16m (SD: 0.39).
- **Third 100m:** The pre-test mean was 1.80m (SD: 10.17), while the post-test mean was 2.10m (SD: 1.79).
- **Fourth 100m:** The pre-test mean was 1.72m (SD: 0.12), while the post-test mean was 2.08m (SD: 0.38).

Stride Frequency Variable

- **First 100m:** The pre-test stride frequency was 49.89 strides/s (SD: 2.03), while the post-test was 48.70 strides/s (SD: 1.30).
- **Second 100m:** The pre-test mean was 47.60 strides/s (SD: 1.23), while the post-test was 46.47 strides/s (SD: 1.31).

- **Third 100m:** The pre-test mean was 55.90 strides/s (SD: 6.21), while the post-test was 47.63 strides/s (SD: 2.25).
- **Fourth 100m:** The pre-test mean was 58.23 strides/s (SD: 4.39), while the post-test was 48.05 strides/s (SD: 0.87).

Speed and Strength Endurance Variables

- **Speed Endurance (250m):** The pre-test mean was 32.89s (SD: 2.21), while the post-test was 28.28s (SD: 0.38).
- **Strength Endurance (Bounding Run for 150m):** The pre-test mean was 28.57s (SD: 0.61), while the post-test was 25.44s (SD: 0.70).

Discussion

The results indicate significant improvements in the mechanical and physical variables after implementing the training program, specifically across each 100-meter segment of the 400-meter race. In the first segment, the average time in the post-test improved to 12.23 seconds from the pre-test's 12.44 seconds. For the second segment, the average post-test time was 12.05 seconds compared to the pre-test's 12.99 seconds. The third segment showed a decrease to 12.49 seconds from the pre-test's 13.62 seconds, and in the fourth segment, the post-test time was reduced to 12.25 seconds from 13.89 seconds in the pre-test. These consistent reductions reflect the findings of [5, 6], who emphasized the role of pacing strategies in enhancing sprint performance. The speed rate increased across most segments, reflecting the influence of specialized training that targets acceleration and agility. For instance, the speed rate of the third 100-meter segment improved to 8.02 m/s from 7.34 m/s, [7], who highlighted the importance of acceleration training in speed development. length increased across all four segments, indicating improved muscular strength and flexibility [8], enhancing stride length is crucial to sprinting performance, as it allows for efficient energy distribution over sustained distances. [9] The reduction in stride frequency alongside longer strides further supports this improvement. Speed and power endurance results also improved, with the 250-meter speed endurance post-test averaging 28.28 seconds compared to the pre-test's 32.89 seconds. The 150-meter power endurance showed a significant improvement, with the post-test time of 25.44 seconds down from the pre-test's 28.57 seconds. [10]. Stressed the importance of interval training to enhance both speed and power endurance. In conclusion, these improvements underscore the importance of specialized training in refining biomechanical and physical attributes, corroborating findings from [11] and [6], who emphasized strength training, agility drills, and pacing strategies. The development that appeared in the level of physical abilities had a positive impact on the development of kinematic variables, which led to changes in the level of performance, time, and achievement. Explosive force had a positive impact in the starting stage.

Conclusion

Recommendations and Conclusion

Focus on Mechanical and Physical Aspects

The study emphasizes the importance of addressing mechanical aspects like stride length and frequency, alongside physical components such as strength and endurance, and physiological aspects like breathing and oxygen consumption in training 400-meter runners.

Designing Effective Training Programs

Training programs should be designed to enhance the ability to maintain consistent and effective speed throughout the race while reducing fatigue in the second half. This can include exercises that strengthen muscular and physiological endurance.

Enhancing Technical and Tactical Training

- Develop strategies to improve energy management and distribution throughout the race, ensuring optimal speed maintenance and reducing momentum loss, particularly in the final 200 meters.
- Integrate specialized exercises for improving performance under pressure and fatigue as a part of runners' regular training.

Utilizing advanced evaluation and monitoring techniques

Employ tools like video analysis and performance measurement devices to monitor and analyze stride features and speed continuously during training and competition, providing accurate and immediate feedback to runners and coaches.

Education and Awareness

Provide training sessions for coaches and runners about the importance of mechanical and physiological aspects in improving performance and raise awareness of the latest research and technologies in this field.

In conclusion, the training program developed and implemented in this study effectively improved the physical and mechanical performance of 400-meter runners, emphasizing the value of targeted training strategies to enhance competitive performance.

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