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Saif Muhammad Kadhim
General Directorate of Wasit
Education Governorate, Kut,
Iraq

Ali Naeem Ajeel
Faculty of Physical Education
and Sports Sciences, Wasit
University, Kut, Iraq

Special training according to targeted distances and times to develop speed endurance, some biomechanical variables, and achievement of running 400 M. hurdles for juniors

Saif Muhammad Kadhim and Ali Naeem Ajeel

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Abstract

The study aimed to prepare special exercises according to targeted distances and times to develop speed endurance and some biomechanical variables and the achievement of running 400 m. hurdles for juniors as well as to identify the impact of those exercises, the authors assumed that there are statistically significant differences between measurements and pre-post tests in speed endurance and some biomechanical variables and achievement of running 400 m. hurdles for juniors, the authors followed the experimental approach in the manner of one group with pre- and post-test, either the research sample was determined by (5) runners From the runners of the National Center of Sports Talent in Iraq in the province of Baghdad in 400 m. hurdles for juniors, the authors conducted special tests on the sample, which is to test (250 m and 350 m) in measuring speed endurance, and the achievement of a distance of 400 m. hurdles, as well as measuring some biomechanical variables, the authors followed the application of their exercises for 8 weeks distributed over 3 sessions per week, after the completion of the application of exercises and conducting post-tests, The results were extracted by appropriate statistical means, and the results showed that there is a development in the variables of speed endurance, achievement, and some biomechanical variables for the sample, the authors concluded that training at targeted distances and targeted standard times contribute to the development such as speed endurance and some biomechanical variables and achievement.

Keywords: Training, speed endurance, biomechanics, achievement, running 400 m. hurdles

1. Introduction

The remarkable scientific progress witnessed by the world in the last few years, which was evident through the high achievements in sports events and this progress came as a result of competition between countries in order to achieve gold or three places in the Olympics, which prompted them to harness all means and methods of scientific training in building the athlete in all respects and there is no doubt that the most important sciences intertwined with sports training biomechanics, which in turn finds the best kinetic paths to perform the effectiveness and thus reduce the effort and performance of movement in the best way. This development in sports achievements included athletics activities, and this is what was done in the last Olympic Games of high numbers that were also achieved as well as broken records. As the effectiveness of 400 m / hurdles is one of the short events in which the overall physical abilities must be integrated to raise the level of achievement and the overlap of science in the training process in order to achieve a distinct level, as it is necessary to overlap biomechanics in finding the best running technique in terms of step length and frequency and along the race distance associated with a modified step, which is the hurdles step and how to reduce time over the hurdles. In order to keep pace with this development and rapid progress in global achievements, studies and research must be conducted to identify the strengths of the parts of the event at the local level, as well as the fragmentation and analysis of this event into parts in the training process. Where the focus is on the special physical abilities in each part of the race and the development of its own time in order to find an advanced total time to complete the effectiveness of 400 m / hurdles hence the importance of the research by focusing on partial times as well as partial distances that have been targeted according to partial distances and advanced partial times in order to achieve the best advanced level of runners 400 m / hurdles locally.

Corresponding Author:
Saif Muhammad Kadhim
General Directorate of Wasit
Education Governorate, Kut,
Iraq

1.1 Research Problem

The preparation of training curricula must be scientifically and thoughtfully in order to develop the level of training of the athlete and thus the level of achievement and the rates of development vary between the curricula depending on the goal set as well as the accuracy of targeting weakness in the level so the authors resort to targeting complementary curricula to what was concluded by the previous curricula to be a successive series in the development of physical abilities as well as biomechanical variables according to the type of effectiveness. Through the experience of authors in the field of arena and field, the difference in the time of effectiveness of 400 m / hurdles s at the local level and at the global level was observed and studied, and from here the authors decided to stand on this problem, which is the problem of time difference, so the research tended to note the partial times of the effectiveness and compare it with the time of the partial target globally and work on developing exercises to bring the difference between the times closer and thus reduce the difference in the total time.

1.2 Research Objectives

1. Identify the values of time and target distances in some biomechanical variables and complete the 400 m / hurdles for youth.
2. Preparing special exercises according to targeted distances and times to develop speed endurance and some biomechanical variables and the completion of 400 m / hurdles for young people
3. Identify the effect of special exercises according to targeted distances and times to develop speed endurance and some biomechanical variables and the completion of 400 m / hurdles for young people.

1.3 Research Hypotheses

There are statistically significant differences between pre- and post-measurements and tests in speed endurance and some biomechanical variables and the completion of 400 m / hurdles for young people.

1.4 Research Areas

- **Human field:** Runners 400m event / youth hurdles within the National Center of Sports Talent in Baghdad.
- **Time Range:** 14/1/2022 to 25/5/2022.
- **Spatial field:** The athletics track of the National Center for the Care of Sports Talent in Baghdad.

2. Research Methodology and Field Procedures

2.1 Research Methodology

The authors used the experimental method with one group with pre- and post-tests to suit the nature of the research.

2.2 Research Community and Sampled

The research community was determined by the authors and represented by the runners of the effectiveness of 400 m / hurdles s in the National Center for the Care of Sports Talent / Baghdad Governorate, and the number of (7) runners from the category of youth under the age of 20 years, and then the authors deliberately selected the research sample and the number (5) runners for their commitment to training and possession of the appropriate training age and the convergence of their level in terms of time dragged for the effectiveness, as the sample represented (71.42) % of the research community.

2.3 Means of collecting information, devices and tools used

2.3.1 Means of collecting information

A stopwatch that has the ability to measure more than one time during the race (5) type (Casio), Fast camera for kinetic analysis at a frequency of (120) images/second. Number (2), Three-dimensional camera holder, Electronic calculator type (Dell), 10 hurdles, Flags, measuring Tape, White powder, Whistle, cones.

2.3.2 Devices and tools used

Scientific references, World Wide Web (Internet), Observation and experimentation, Kinetic Analysis Program (KINOVEA).

2.4 Identification of research variables and their tests

2.4.1 Physical variables and their tests

In order to identify the most important variables and appropriate tests that are related to the subject of study and research, the authors worked to identify the physical variables of the study as below.

1. Speed endurance.
2. Achievement.

2.4.1.1 Physical Tests

1. Speed endurance test for a distance of 250 meters of standing: ^[1]

- **The objective of the test:** To measure speed tolerance.
- **Tools used:** Running range of at least 400 meters, 6 legal hurdles s, stopwatches
- **Test method:** The tester stands at the beginning of 400 meters and gives the assistant the signal of the start of the timing.
- **Recording:** Time to travel the distance to the nearest tenth of a second is measured once.

2. Speed endurance test for a distance of 350 meters of standing: ^[2]

- **Objective of the test:** Speed endurance measurement of the competition.
- **Tools used:** Running range of at least 400 meters, 9 hurdles, stopwatches.
- **Test method:** The tester stands in the running field and gives the assistant the signal of the beginning of the timing.
- **Recording:** The time traveled is measured to the nearest tenth of a second.

3. Achievement test for the 400m hurdles test: ^[3]

- **Objective of the test:** To measure the real achievement of the competition.
- **Test method:** 10 hurdles s are placed according to the competition law and each individual is given an attempt to cover a distance of 400 meters with ten legal obstacles.
- **Recording:** The time traveled is measured to the nearest tenth of a second.

2.4.2 Biomechanical variables

The authors chose some biomechanical variables on the hurdles, as the choice was made on two hurdles s, the sixth and eighth, which are located within the distance targeted by the authors in the training (250-350) as an indication of the

average values of the rest of the hurdles s that fall within this distance and the variables are.

1. **The total distance to cross the hurdles:** It is measured directly by video analysis, which is represented by calculating the distance before and after the hurdles.
2. **Hurdles passing time:** It can be measured by calculating the upward time with the passing time (flight) and the landing time from the first leave to the first touch.
3. **Momentum force:** The momentum is measured at the moment of pushing before crossing the hurdles through video analysis and from Newton's second law ($P = m \times s/t$)
4. The height of the center of gravity of the body above the hurdles. It is represented by the distance from the hip joint at its highest height above the septum to the ground (vertically).

The above biomechanical variables were measured through the data extracted through rapid video imaging and are handled through the kinetic analysis program (KINOVEA).

2.5 Two Exploratory Experiments: The authors conducted an exploratory experiment on Thursday morning (15/1/2022) in the athletics stadium at the Ministry of Youth and Sports at 9 am, and its purpose is in order to identify the difficulties that they may face when applying the research experiment, as well as to know the adequacy of the assistant work team and the duties assigned to it when conducting tests, as well as knowing the places of distribution of video cameras and their distance from the hurdles and the height of the camera focus, and in the evening of the same day, the authors conducted their exploratory experiment The second purpose is to know the appropriateness of the exercises used for the sample, its times and how to distribute it within the approach followed by the coach of the research sample, by conducting all the exercises on his sample consisting of players from outside the research sample.

2.6 Pre-tests: The authors began to conduct their pre-tests over two days, which fall on Friday and Sunday (16-18/2/2022), as the first day included a distance test (250 m) at 9 am, and in the evening a distance test was conducted (350 m) in order to give sufficient rest to the players, and in order to get a full recovery, a rest day was given between the first and second tests and the achievement test conducted on Sunday for a distance of 400 m hurdles with the measurement of the biomechanical variables of the sixth and eighth hurdles of During videography, video cameras were placed to the left of the inner edge of the track, 28 m from the hurdles and within the second field of the track with a focal height of 140 cm from the ground.

2.7 Training Curriculum

The authors prepared special exercises according to the distance that was targeted from (250-350) m from the race distance according to target times for distances (250 m, 280 m, 330 m, and 350 m), which were trained taking into account the placement of hurdles s in the legal place specified for them within the target distance in the training. As the intensity of the training was adopted from (80% - 100%) for the times targeted by this standard, and that the application of these trainings entered within the main section of the training unit in a way that suits the prepared training curriculum, and the training units numbered (24) units divided into (3) units per week for the days (Saturday, Monday and Thursday), and over a period of (8) weeks, starting from Monday (19/2/2022 until Saturday 14/2/2022), as the authorss relied in applying his training during the units on the principle of ripple in a ratio of (1:3), while The duration of the total training unit took a time ranging between (45-70 minutes), divided into (10-15 minutes) For warm-up, these are for the trainer, and (15-35 minutes) for the application of the exercises of the authors, and followed by (10-15 minutes) for calming and relaxation or exercises complementary to the technical performance by the trainer at times, These trainings were developed on the basis of the components of the training load for the selected age group (youth group) in line with their physical abilities and in a way that positively affects the creation of additional burdens on the functional organs of the body and muscles participating in the performance for the purpose of obtaining and acquiring the required adaptation and development. As well as placing them on mechanical foundations to serve the movement of passing the hurdles, to improve the mechanical and muscular work of performance, and does not affect the working muscles by loading them with additional effort, and the authors relied on developing his exercises in the manner of repetitive training and high-intensity interval training, which is the most appropriate in the development of research variables researched.

2.8 Post-tests

After completing the application of the exercises by the two authors, they conducted the post-tests for the sample members, and the authors was keen to meet the same conditions in which the pre-tests were conducted in terms of place, time, tools, and the method of implementing the tests, accompanied by the same assistant team in the pre-tests, which were carried out during Sunday and Tuesday (15-17/4/2022).

3. Results Presentation and Discussion

3.1 Results Presentation and discussion of speed endurance and achievement tests

Table 1: Shows the arithmetic means, standard deviations and the value of (t) calculated for the speed endurance and achievement test

Variables	Pre-test		Post-test		f	Calculated (t)	Sig. level	Sig. differences
	M.	St.d	M.	St.d				
250m Speed Endurance Test	33.79	0.967	32.15	0.788	1.636	2.871	0.045	Sig.
350m Speed Endurance Test	48.78	0.892	47.55	0.606	1.236	3.888	0.018	Sig.
achievement test	54.32	0.769	53.88	0.847	1.742	2.685	0.003	Sig.

Significant at a degree of freedom (5-1) = 4 and a significance level < 0.05

Through Table (1) it is clear from this to the existence of significant differences and in favor of the post-test in the test (speed endurance for a distance of 250 m -350 m) and

the authors attribute this development to the specificity of training, which targeted a special distance to endure speed and fragmented into partial distances targeted according to

global times for these distances to become more private and this is what positively affected in improving their training efficiency, which earned them the ability to run this distance at the level of speed retention within the limits of the distance, as well as the sample prints To run with a step length and a constant frequency according to the sense of runner target time as a result of the harmony of the exercises that were applied in terms of intensity, training volume and comfort according to the proposed stresses, which corresponded to the requirements of bearing speed for this effectiveness with maximum and sub maximum repetitions, which led to the imprint of the working muscles on high performance and this is what was indicated by (Abu Ela and Allawi) "The training load is the main means of causing internal physiological influences in the body in order to achieve an improvement in the level of functional responses and from then adaptation in body systems and rise in level, Therefore, it is one of the most important factors for success in the training program and thus in improving performance." "The sprinter's ability develops when training in the rhythm of the steps during the distance training of the race at the runners of the 400 meters hurdles, as the runner tries to

maintain the best speed rate during the later stages of the race and thus contributes to reducing time." As for the achievement test, the authors attribute this improvement to the effectiveness of the exercises that were applied to the research sample, the exercises that were with targeted distances that are less than the race distance with high training and very high stress according to the length of the target distance, which stimulates the functional organs and the muscular and nervous systems to work to the maximum potential and make adaptations to the runner and thus will contribute to improving the runner's ability to improve achievement as these distances are of privacy in the requirements of effectiveness and this is confirmed by (Abbas Ali gesture) that Training at partial distances and less than the race distance and with high intensity lies in the importance of improving and upgrading the effectiveness of running 400 meters and in the stage of special preparation. [4].

3.2 Presentation and discussion of the results of the measurement of some biomechanical variables of the sixth and eighth hurdles step

Table 2: Shows the means, standard deviations and t-calculated value for measuring some biomechanical variables for the sixth and eighth hurdles step.

Variables	Pre-test		Post-test		f	Calculated (t)	Sig. level	Sig. differences
	M.	St.d	M.	St.d				
Total hurdles crossing distance (m)	3.410	0.09	3.555	0.081	0.145	6.03	0.002	Sig.
Hurdles Passing Time (sec)	0.528	0.027	0.460	0.019	0.068	5.356	0.003	Sig.
Momentum (N)	2834.6	121.1	3010.5	108.3	175.9	5.246	0.003	Sig.
Height of body gravity center (m)	1.235	0.03	1.268	0.030	0.033	5	0.004	Sig.

Significant at a degree of freedom (5-1) = 4 and a significance level < 0.05

Through Table (2) it is clear from this that there is a significance in the results and in favor of the post-test in the biomechanical measurements of the sixth and eighth hurdles step and the authors attribute these differences, which indicate the emergence of development in all biomechanical variables represented by the total distance to cross the hurdles and the time of crossing the hurdles as well as the momentary thrust force over the target hurdles s to the effectiveness of the exercises prepared with maximum and sub maximum stresses according to the times of a targeted minute that works to make the player run along a step and a high frequency, which leads To adjust the rhythm of the steps when running between hurdles s as a result of speed endurance exercises that stimulate the neuromuscular system to work muscles with high potential despite fatigue and as a result of the remarkable progress in the performance of the sample gradually in the last two weeks of training units, which was attributed to that these exercises enabled the runner to have a speed of frequency and the least time touching the ground in the second arc as a result of the development of the momentary power in these distances, The development of the instantaneous force of the runners also enabled the development of the speed of passing the hurdles and as a result the development of the player's ability to pass the hurdles at the best height of the center of gravity of the body because it depends mainly on the thrust applied before the hurdles as well as the speed of passing the hurdles and thus achieving the best flight time and this is what was extracted in the hurdles s within the target distance, These exercises with such high stresses develop the runner's oxygenated ability to withstand the

performance of the special performance, which leads to maintaining the rhythm of running at different distances of the race, that "the most difficult type of oxygenic ability is to repeat the performance a few times and complete the race distance in a shorter time and faster speed" [5].

The adaptation of the performance that occurred in recent weeks despite the high stresses in the training units during the targeted distances made the biomechanical variables more positive, as well as making the runners have the ability to control the performance above the hurdles from a total passing distance, as well as the flight time over the hurdles, as well as the variables between the hurdles s and the running steps and their frequency.

4. Conclusion

The research aimed to investigate the impact of specially designed training exercises on speed endurance, biomechanical variables, and overall achievement in the 400 meters hurdles for junior athletes. The study focused on pre- and post-tests to measure improvements in these areas after an 8-week training program. The data analysis revealed significant improvements in both speed endurance and biomechanical variables, which contributed to better performance outcomes for the participants.

4.1 Key Findings

1. Speed Endurance: The results showed significant improvements in the 250m and 350m speed endurance tests. Participants demonstrated faster times in the post-tests compared to the pre-tests, indicating enhanced endurance capabilities over these distances.

2. **Achievement Test:** There was a notable improvement in the achievement test for the 400 meters hurdles. The post-test results were significantly better, suggesting that the training program effectively enhanced the overall performance of the athletes.
3. **Biomechanical Variables:** Significant advancements were observed in key biomechanical variables, including the total hurdles crossing distance, hurdles passing time, momentum, and the height of the body's center of gravity. These improvements highlight the effectiveness of the targeted training exercises in refining the athletes' technique and efficiency during the hurdles race.

4.2 Implications

The findings suggest that training programs incorporating specific distances and targeted times can significantly improve both the physiological and biomechanical aspects of junior athletes' performance in the 400 meters hurdles. By focusing on high-intensity, targeted exercises, athletes can enhance their speed endurance and biomechanical efficiency, leading to better race outcomes.

4.3 Recommendations

For coaches and trainers working with junior athletes, it is recommended to integrate targeted training exercises that focus on partial distances with specific intensity levels. This approach not only improves speed endurance but also refines the biomechanical aspects critical for success in the 400 meters hurdles.

The study provides compelling evidence that well-structured training programs focusing on targeted distances and intensities can lead to substantial improvements in athletic performance. The positive changes in both speed endurance and biomechanical variables underscore the importance of a holistic approach to training in track and field events.

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Appendices

The international standard for the effectiveness of 400 m hurdles s in training Target distances adopted by the authors.

Table 1: Time to be achieved at each hurdle in order to run in the desired final time (between 52 and 70 sec)

Time at each hurdle (sec)										
Final time	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10
52.0	6.1	10.0	14.1	18.2	22.5	26.9	31.5	36.1	41.0	46.0
53.0	6.2	10.2	14.3	18.6	23.0	27.4	32.1	36.9	41.8	47.0
54.0	6.3	10.4	14.6	19.0	23.4	28.0	32.8	37.6	42.7	47.9
55.0	6.4	10.6	14.9	19.3	23.9	28.6	33.4	38.4	43.5	48.8
56.0	6.5	10.8	15.2	19.7	24.3	29.1	34.1	39.1	44.4	49.8
57.0	6.6	11.0	15.5	20.1	24.8	29.7	34.7	39.9	45.2	50.7
58.0	6.7	11.2	15.7	20.4	25.3	30.2	35.4	40.6	46.1	51.6
59.0	6.9	11.4	16.0	20.6	25.7	30.8	36.0	41.4	46.9	52.6
60.0	7.0	11.6	16.3	21.2	26.2	31.3	36.7	42.1	47.8	53.5
61.0	7.1	11.7	16.6	21.5	26.6	31.9	37.3	42.9	48.6	54.4
62.0	7.2	11.9	16.9	21.9	27.1	32.5	38.0	43.8	49.5	55.4
63.0	7.3	12.1	17.1	22.3	27.6	33.0	38.6	44.4	50.3	56.3
64.0	7.4	12.3	17.4	22.7	28.0	33.6	39.3	45.1	51.2	57.3
65.0	7.5	12.5	17.7	23.0	28.5	34.1	39.9	45.9	52.0	58.2
66.0	7.7	12.7	18.0	23.4	28.9	34.7	40.6	46.6	52.9	59.1
67.0	7.8	12.9	18.3	23.8	29.4	35.2	41.2	47.4	53.7	60.1
68.0	7.9	13.1	18.5	24.1	29.8	35.8	41.9	48.1	54.6	61.0
69.0	8.0	13.3	18.8	24.5	30.3	36.3	42.5	48.9	55.4	61.9
70.0	8.1	13.5	19.1	24.9	30.8	36.9	43.1	49.6	56.3	62.9