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The effect of high-intensity competition speed training using the DYNA FOOT device on developing speed endurance and some biomechanical variables and the performance of 400-meter hurdles

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Abstract

The aim of the research is that these differences result from variations in performance, leading to variations in the application of the mechanical conditions that the barrier player must implement, considering them as one of the digital activities. This reduction is not arbitrary but rather through kinematic analysis, which provides the possibility to detect technical errors related to motion mechanics. The researchers utilized the experimental method with the pre-test and post-test measures for the experimental and control groups, in line with the suitability of the research nature. The research population was defined as players from Baghdad Province for the 2022 season, totaling (8 players). The research sample was selected using a comprehensive enumeration method, and it was divided into two groups: the experimental group and the control group, each consisting of (4 players). The researchers used the statistical package (SPSS) and concluded that the effect of high-intensity speed competition training using the DYNA FOOT device had a positive impact on developing speed endurance and some biomechanical variables, as well as the performance of the 400-meter hurdles for under 18 years old. and this achieves one of the sustainable development goals of the United Nations in Iraq which is (Good Health).

Keywords

Competition speed training, DYNA FOOT device, 400-meter hurdles performance.

Introduction

Scientific and technological advancements have become hallmarks of modern life. This progress has encompassed all aspects of life and is the result of extensive studies, research, and experiments built on scientific foundations to achieve precise scientific outcomes and provide appropriate solutions to problems. Athletics is one of the activities that researchers have extensively studied to improve athletes' performance and elevate their results. The study by (Jumana and Zainab) indicated that (the 400-meter hurdles event requires a necessary rapid exchange and harmony between the steps of fast running and hurdling while maintaining the highest possible speed throughout the race for every phase, including the curve running and the straight run. Furthermore, the athlete must

overcome ten hurdles distributed across the track at a consistent distance of (35) meters between each hurdle) (10). The rhythm and harmony of steps are affected by fatigue, which influences the pace of steps between hurdles and the step over each hurdle. It necessitates trainers to focus on the mechanical characteristics that a 400-meter hurdle athlete should possess. From here emerges the importance of this study in preparing training exercises with competition speed intensity according to the results of the force applied in each step, its duration, and its speed, using the DYNA FOOT device, which provides accurate and standardized values in line with the biomechanical research variables. The research problem lies in the significant advancement in physical aspects and the new

training methods used, as well as the benefit from the intersection of sports sciences with each other through the use of the (DYNA FOOT) device. At the forefront of this is the use of kinematic analysis benefiting from its results to develop speed endurance and some biomechanical indicators and discovering details that rely on numerical data for their realization. Through the researchers' interest, it was found that there are clear differences in the effectiveness of the 400-meter hurdles when compared to the international level. The researchers believe that these differences result from variations in performance, which lead to differences in the application of the mechanical conditions that must be implemented by the hurdler, especially when crossing a hurdle. Reducing 1/100 of a second with each successful hurdle clearance is considered a positive indicator for the athlete in reducing the final time. This reduction is not random but rather achieved through careful study and investigation into the intricacies of this particular performance. A notable study by (Adil Hamid) (utilizing kinematic analysis, provides the capability to uncover technical errors associated with motion mechanics. These errors are attributed to physical fitness limitations. Consequently, it proposes relevant training solutions) (13). One of the research objectives is to prepare training exercises using the DYNA FOOT device to enhance speed endurance and various biomechanical variables and to achieve a 400-meter hurdles performance. The study also seeks to identify high-intensity speed training

routines utilizing the DYNA FOOT device for the improvement of speed endurance and specific biomechanical variables and to achieve a 400-meter hurdles performance.

Research Hypotheses: The Effect of Intense Competitive Speed Training Using the DYNA FOOT device has a positive impact on developing speed endurance and some biomechanical variables and the performance of 400-meter hurdles.

The research areas: Human domain: 400-meter hurdles male runners under (18) years old for the sports season 2022. Temporal domain: The period from Saturday, 8/1/2022, to Saturday, 19/3/2022. Spatial domain: The field and track stadium of the College of Physical Education and Sports Sciences, University of Baghdad, in Baghdad Governorate.

Method and Tools:

The two researchers used the experimental approach with a pretest-posttest experimental and control group design, suitable for the nature of the study.

The research population and its sample: The research population was determined to be the players of Baghdad Governorate for the 2022 season, totaling (8) players. The research sample was selected using a comprehensive enumeration method, and the sample was divided into two groups: the experimental group and the control group, with a total of (4) players in each group.

Homogeneity and Equivalence of the Sample:

Table (1)
illustrates the homogeneity of the research sample individuals.

Variables	Measurement unit	Arithmetic mean	Median	Standard deviation	Skewness coefficient
Height	Meter	176.198	174.000	1.548	0.256
Weight	Kilogram	76.211	76.000	1.499	0.321
Age	Year	24.212	22.000	1.671	0.712

The value of the skewness coefficient falls between ± 3 , which indicates that the distribution of the population is moderately distributed.

Table(2)

It shows the results of the speed endurance post-tests, some biomechanical variables, and performance in the 400-meter hurdles for both the control and experimental groups.

Variables	Measurement unit	Experimental group		Control group		Calculated (t) value	Significance level	Significance of differences
		Arithmetic mean	Standard deviations	Arithmetic mean	Standard deviations			
Approach speed	m/s	2,89	0,05	3,22	0,48	0,54	0,64	Non-significant
Flight speed	m/s	2,62	0,47	2,93	0,62	0,57	0,58	Non-significant
Flight time	second	0,33	0,04	0,33	0,02	0,32	0,75	Non-significant
Speed endurance	second	39.654	0,34	40.753	0,24	1,01	0,34	Non-significant
400 meters hurdles performance	second	54.671	0.654	55.744	0,321	1.564	0321	Non-significant

Significant at a level of ≤ 0.05 and under 8 degrees of freedom.

As for the information collection methods: (observation, tests and measurements, sources and references in Arabic and foreign languages)

As for the research instruments and tools used: athletics field, DYNA FOOT device (1 unit), (40) hurdles, (60) cones, Japanese-made

electronic timing clocks (6 units), measuring tape, Sony video camera with a frequency of (500 frames) (1 unit), Dell laptop computer (1 unit), and electronic medical scale (1 unit).



The figures illustrate the device (DYNA FOOT) and its accessories (No.1).

The Dynamic Force Measurement System (DYNA FOOT) is a system designed to measure the applied force variables on the ground during each step of running. It consists of four components: the data transmission base (which comprises a foot pedal placed on the shoe along with a connecting cable to the force computer

attached to the subject's leg), the signal receiver device that connects to a laptop and receives signals from a distance of up to 100 meters, an electronic watch unit, and the step sensor affixed to the player's foot. The system operates following the attachment of the device to the subject's leg and securing it in place, along with the fixation of the step sensor on the player's foot. Before usage, the system requires input of the subject's age, height, weight, and gender. The

system measures variables of speed rate and distance covered. The collected data can be used as feedback for subsequent training units, and

the information can be stored within the system. See Figure (1), Figure (2), and Figure (3).

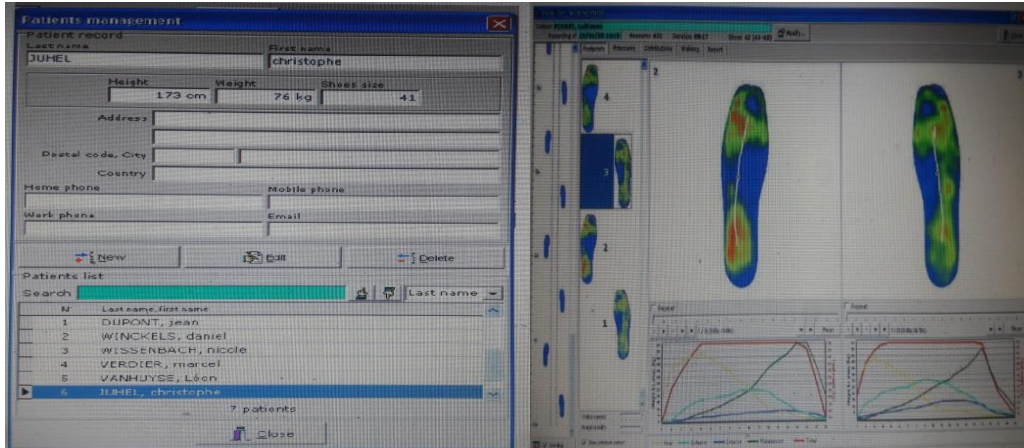


Figure (2)

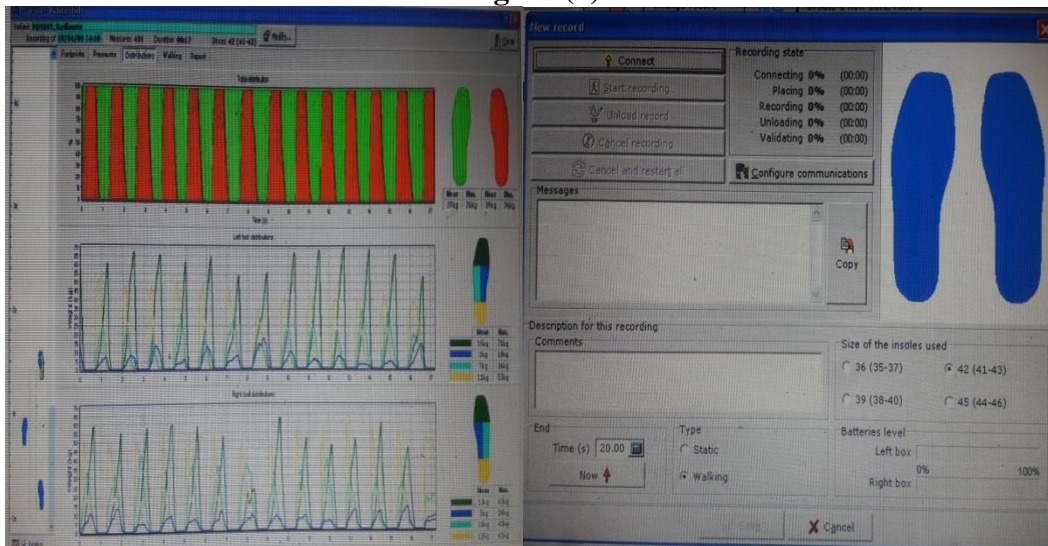


Figure (3)

Measurements of the research variables used: Firstly, approach speed: It is the result of dividing the distance covered by the player during the approach steps by the time taken to cover this distance, and its unit of measurement is (m/s).

Secondly, flight speed: It is the ratio between the take-off distance, represented by the path of the body's take-off from the moment it leaves the ground to the moment the ball is hit, to the time of this take-off (measured in meters per second).

Tests used in the research:

- 300-meter Speed Endurance Test.
- 400 meters' hurdles performance: (2)

Pre-tests:

The researchers conducted the pre-tests on Saturday, 8/1/2022, at the track and field stadium of the College of Physical Education and Sports Sciences, University of Baghdad, in Baghdad province.

Main Experiment:

- The sample began implementing training sessions on Saturday, 15/1/2022, until Wednesday, 16/3/2022.
- Duration of the training program: (8) weeks.
- Total number of training units: (24) training units.
- Weekly number of training units: (3) units.
- Weekly training days: (Sunday, Tuesday, and Thursday).
- Training Methodology used: High-Intensity Interval Training (HIIT) and Repetitive.
- Training intensity used: (80 - 100%).

Post-tests:

The post-tests were conducted on Saturday, 19/3/2022, at the track and field stadium,

College of Physical Education and Sports Sciences, University of Baghdad, in Baghdad Governorate.

Statistical methods used in the research:

The researchers utilized the Statistical Package for the Social Sciences (SPSS) to obtain appropriate statistical analyses.

Results:

Presentation and analysis of the differences between the research groups (experimental-control) for the variables under study.

Presentation and analysis of pretest and post-test results for the variables of speed endurance, biomechanics, and performance in the 400-meter hurdles for the experimental group.

Table (3)

It shows the results of the pre-test and post-test for the experimental group in the variables of speed endurance and some biomechanical variables and the performance of 400-meter hurdles under study.

Variables	Measurement unit	Pre-test		Post-test		Calculated (t) value	Significance level	Significance of differences
		Arithmetic mean	Standard deviations	Arithmetic mean	Standard deviations			
Approach speed	m/s	3,22	0,48	4,25	0,51	3,78	0,000	Significant
Flight speed	m/s	2,81	0,62	3,96	0,43	4,06	0,001	Significant
Flight time	second	0,33	0,04	0,43	0,01	12,83	0,002	Significant
Speed endurance	second	39.654	0,22	39.011	0,33	9,24	0,000	Significant
Performance	second	54.671	0.765	54.121	0121	7.765	0.000	Significant

Significant at a level of ≤ 0.05 and under 3 degrees of freedom.

Presenting the pre-test and post-test results of the variables of speed endurance and some biomechanical variables and the performance of 400-meter hurdles in the control group, along with their analysis and discussion.

Table (4)

It shows the results of the pre-test and post-test for the control group in the variables of speed endurance and some biomechanical variables and the performance of 400-meter hurdles under study

Variables	Measurement unit	Pre-test		Post-test		Pre-test	Post-test	Significance of differences
		Arithmetic mean	Standard deviations	Arithmetic mean	Standard deviations			
Approach speed	m/s	3,22	0,48	4,25	0,51	3,78	0,000	Significant
Flight speed	m/s	2,81	0,62	3,96	0,43	4,06	0,001	Significant
Flight time	Second	0,33	0,04	0,43	0,01	12,83	0,002	Significant

Speed endurance	Second	40.753	0,22	40.121	0,33	9,24	0,000	Significant
Performance	Second	55.744	0.651	55.112	0.321	6.432	0.000	Significant

Significant at a level of ≤ 0.05 and under 3 degrees of freedom.

Presentation, analysis, and discussion of the results of the post-tests in speed endurance tests and some biomechanical variables and the performance of 400-meter hurdles are under study for the control and experimental groups.

Table(5)

It shows the post-test results in speed endurance tests and biomechanical variables and the achievement of a 400-meter hurdle race understudy for both the control and experimental groups.

Variables	Measurement unit	Pre-test		Post-test		Calculate d (t) value	Significance level	Significance of differences
		Arithmetic mean	Standard deviations	Arithmetic mean	Standard deviations			
Approach speed	m/sec.	3,22	0,48	4,25	0,51	3,78	0,000	Significant
Flight speed	m/sec.	2,81	0,62	3,96	0,43	4,06	0,001	Significant
Flight time	second	0,33	0,04	0,43	0,01	12,83	0,002	Significant
Speed endurance	second	38.552	0,22	39.643	0,33	9,24	0,000	Significant
Performance	second	53.572	0.543	54.641	0521	8.775	0.000	Significant

degrees of freedom6Significant at a level of ≤ 0.05 and under

Results Discussion:

The pre-test and post-test tables showed the results of the investigated variables for the research sample. The results indicated significant differences in the post-test in favor of both groups. The researchers attribute these differences to the intense speed competition training using the (DYNA FOOT) device to develop speed endurance and some biomechanical variables and achieve a 400-meter hurdle performance. The researcher mentioned that using kinematic analysis indicators as a guide for designing a specialized training program has resulted in positive results for developing essential speed endurance, surpassing the level of the research sample. These results are beneficial for subsequent tests. It is noticeable that there is a clear reduction in time across all tests due to the implementation of the training program and its impact on the research sample. It has led to significant results and

improvements in the task's outcomes in less than a few seconds, which is noteworthy. From this, we can say that the research objectives have been achieved, as well as the overall achievement. The results were also consistent with the assumptions made by the researchers for this problem, as there were significant differences between the research results and the overall performance of the 400-meter hurdles event. These differences favored the post-tests. The researchers attribute the reasons for this to what was indicated by the study conducted by (Suha and Abeer) that (the implementation of the training program using exercises among female 100-meter hurdles competitors with the same intensity, repetitions, and rest periods plays a role in improving performance) (3). Additionally, the study by (Diana and Aseel) emphasized that (one of the fundamental factors influencing the time a runner takes to clear hurdles is the method by which the body's center

of gravity is minimized during crossing a hurdle) (12). As confirmed by the study conducted by (Diana and Suhad), (the takeoff phase is characterized by rapid and robust movement of the free leg (front), which starts as it crosses the first hurdle and is almost extended) (8). Additionally, the study by (Hadeel and Suhad) (emphasized that assessing the technical performance in hurdling is done by comparing the time difference between covering the distance with hurdles and without them. One of the critical aspects to underscore is that the runner should increase their speed during the acceleration phase. From that moment, they should endeavor to adjust their trunk early, much like in regular short-distance running, to prepare for successfully clearing the hurdle) (9). As (Risan Kharibet) pointed out (which requires the player to have good flexibility and high elasticity in the thigh muscles and good coordination of movements) (4). (Lamiaa and Widad) also indicated that (the mechanical aspects obtained by the runner due to that position are related to bringing the runner's center of gravity directly above the barrier and quickly returning to the ground after the jump) (11). A study by (Sulaiman Ali) emphasized that "technical performance is one of the most comprehensive factors. As speed increases, the runner is required to increase these distances. The mechanical attribute that should be focused on, which complements the takeoff phase, is the full extension of the takeoff leg" (5). (Talha Hussam) indicated that (training is a pedagogically planned process, built on scientific foundations and educational principles, aiming to elevate an individual to the highest possible level in their practiced athletic activity. It is achieved by developing the individual's physical capacities, motor skills, strategic potentials, and cognitive abilities, as well as enhancing psychological motivations and fostering their personal and volitional traits) (6). A study conducted by (Abdullah and Ihab) affirmed that "the utilization of the proposed device ineffective 200m training

sessions enhanced the performance of the sample, thus leading to performance improvement" (1). Another study by (Hawraa and Iman) indicated that (the outcomes of running activities are influenced by the standard level of physical tests) (7). Furthermore, a study by (Ruaa and Bushra) pointed out "the significance of focusing on the development of physical capabilities among players in accordance with their abilities and age groups" (14).

Conclusions:

1. The researchers concluded that there was a noticeable improvement between the pre-test and post-test measurements in the speed endurance training using the DYNA FOOT device for the experimental group. This improvement had a positive effect on the post-test measurements.
2. The results also demonstrated a significant advancement between the pre-test and post-test measurements in the biomechanical variables and accomplishment of the 400-meter hurdles for the experimental group due to the high-intensity competition speed training using the DYNA FOOT device. This improvement favored the post-test measurements.

Recommendations:

1. The researchers recommend focusing on high-intensity competition speed training using the DYNA FOOT device to enhance speed endurance and various biomechanical variables while also accomplishing the 400-meter hurdles.
2. Conduct similar studies and research on different age groups and genders.

Author's declaration:

Conflicts of interest: None

We confirm that all tables and figures in this article are ours and written by the researchers themselves.

Ethical-Clearance: this manuscript approved by local ethical committee of physical education

and sport sciences college for women on (January /2023)

Author's contributions:

All contributions of this study were done by the researchers (I.K. and A.H.) who get the main idea and work on writing and concluding also with number of experts, Alaa fleih Jawad in Statistics, Huda Shihab in revision, Inaam Ghalib in translating, Mazin Hadi in proofreading

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Appendix Used Training Model First week

Training unit	Exercise Items	Intensity (%)	Repetition	Sets	Rest time between	
					Repetition	Sets
Sunday	Sprint 100 meters from a standing start	85	4	3	1 min.	2 min.
	Jumping exercises with alternating leaps		5	2	1 min.	2 min.
Tuesday	Sprint 200 meters from a standing start	85	4	2	2 min.	3 min.
	Hurdle jumping exercises		5	2	1 min.	2 min.
Thursday	Sprint 300 meters from a standing start	85	4	1	2 min.	3 min.
	Box jumping exercises		5	2	1 min.	2 min.

اثر تدريبات بشدة سرعة المنافسة باستخدام جهاز (DYNA FOOT) لتطوير تحمل السرعة وبعض المتغيرات البيوكينماتيكية وانجاز 400 متر حواجز اسراء كامل حسن¹، اسماء حميد كمش² 2&1 جامعة بغداد/ كلية التربية البدنية و علوم الرياضة للبنات

هدف البحث اعداد تدريبات بشدة سرعة المنافسة باستخدام جهاز (DYNA FOOT) لتطوير تحمل السرعة وبعض المتغيرات البيوكينماتيكية وانجاز 400 متر حواجز شباب، حيث تتحدد مشكلة البحث حيث ترى الباحثان أن هذه الفروق هي نتيجة التباين في الانجاز والتي تؤدي الى الاختلاف في تطبيق الشروط الميكانيكية الواجب تنفيذها للاعب الحواجز باعتبارها أحد الفعاليات الرقمية، وإن هذا الاختزال لا يأتي اعتباطاً وإنما من خلال التحليل الحركي والذي يعطي الإمكانية في الكشف عن الأخطاء الفنية المرتبطة بميكانيكية الحركة، واستخدمت الباحثتان المنهج التجريبي بالاختبار القبلي والبعدي للمجموعتين التجريبية والضابطة لملائمته لطبيعة البحث، وتم تحديد مجتمع البحث لاعبي محافظة بغداد للموسم 2022، والبالغ عددهم (8 لاعب) إذ تم اختيار عينة البحث بأسلوب الحصر الشامل وقسمت العينة الى مجموعتين التجريبية والمجموعة الضابطة وبواقع (4 لاعب) واستخدمت الباحثتان الحقيبة الاحصائية (spss) وتوصلت الباحثتان إلى أهم الاستنتاجات ان اثر تدريبات بشدة سرعة المنافسة باستخدام جهاز (DYNA FOOT) اثرا ايجابيا لتطوير تحمل السرعة وبعض المتغيرات البيوكينماتيكية وانجاز 400 متر حواجز تحت ال18 سنة. وهذا ما يحقق احد اهداف التنمية المستدامة للأمم المتحدة في العراق (الصحة الجيدة).

تدريبات سرعة المنافسة، جهاز (DYNA FOOT)، انجاز 400 متر حواجز

الكلمات المفتاحية