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The effect of resistance training on some starting and achievement variables for discus throwers

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Abstract

The study aimed to design resistance training for discus throwers, identify their starting and performance variables, and examine the effect of resistance training on developing these variables. The researchers employed an experimental approach with two equivalent groups using pre- and post-tests, suitable for the research problem. The research population included female athletes participating in the Iraqi Athletics Clubs and Institutions Championship in November 2022, with 13 participants. Eight athletes were selected based on achievement levels and research requirements. They were randomly divided into two groups: an experimental group (4 athletes) training with resistance according to a graduated bumper network, and a control group (4 athletes) following standard trainer-led exercises. This represented 61.54% of the research population. The results showed that resistance training significantly improved starting angles, launch height, and discus velocity, with the bumper network playing a crucial role in angle adjustment and providing immediate feedback for technical corrections. The combination of resistance exercises and network-guided practice enhanced coordination, muscle activation, and overall performance. The study concluded that incorporating resistance training with a structured bumper network is highly effective in improving discus throwers' technical and performance outcomes. Researchers recommended adopting such training methods to maximize achievement, develop biomechanical efficiency, and optimize launch angles for better results in competitive performance.

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Introduction

Specialists and researchers in the field of sports have placed great emphasis on solving the problems facing this field and on striving to advance it further. This has been pursued through identifying the most appropriate means of achieving high performance by scientifically controlling the components of training load (intensity, volume, and recovery), applying scientific theories, and utilizing the concepts of training science in addition to various other disciplines. The training process, therefore, must be productive and capable of enhancing outcomes through the use of modern scientific knowledge and advanced technologies, while keeping pace with progress. This requires seeking new solutions and innovative methods that contribute to driving development forward by providing more effective alternatives to the traditional means used in training.

The formation of the physical qualities conducted by the educational system will be created in the process of systemic physical achieving necessary unity with processes from other scientific fields. Because of that, the physical abilities, especially pushing and throwing in track and field events are important. More specifically, events in throwing for track and field training require detailed attention of science, that is supported by special training equipment and tools adapted to achieve the goals in training or correct certain errors that are highly specific but difficult to eliminate without elaborate instruments. These resources save coaches and athletes time, while also improving the efficiency of meeting training goals.

Performance is therefore a consequence of biomechanical variables and their interaction with physical ones. Writes Zāhid (2009) “in throwing events at athletics we have one group of such discipline where physical capacities are on higher level requeriment combined with preparation from the athletse”.

There have been a small number of studies that investigated resistance training for the discus throw discipline. One of the studies was conducted by Saad Jassim (2013), who sought to determine the impact of weighted resistance training on certain physical and technical abilities associated with the throwing position, throw performance, and results in a research sample. The sample was composed of the best eight discus throwers from the National Clubs Championship, information gathered by marks achieved, which accounted for 47.058% of universe of the research. The researcher used an educational experiment, and the most important findings of a physical and technical training with added burdens effect also had clear on some physical abilities,Achieves unique results to reach certain technical (Jallab, 2013).

Another research by Al-Khalidi and Sahib (2023) conducted to reveal the effect of resistance training with means on some take-off variables and performance assay in discus throwing for women with a special need in F55. The sample was made up of four female (F55) discus throw athletes. Results were analyzed by using experimental design. The major results have reported that ancillary tools used by experimental groups in their training even highly contributed more than one of the selected take-off variables studied (Al-Khalidi & Sahib, 2023).

Also, Naheda Qusay and William Lewis (2021) carried out research in order to devises types of elastic bands specifically designed training programs with water resistance for EP and STR End: enhance performance significantly better in the discus throw). The study also examined the impact of such training on different forms of strength and performance. The sample of the study was composed of eight junior athletes at Al-Zubair Club in Basra Governorate. The experimental technique was used and it showed that the exercises contributed in a high ratio to develop of certain strength types, as well as to enhance discus throw distance throwing for both groups (Mashkoor, Ali, & William, 2021).

In a further study by Khamees & Majeed (2017), the authors aimed to design and investigate the effects of body torque-based weight resistance training program on improving instantaneous pushing efficiency, fluidity, as well as acceleration in youth for discus throwing performance. The sample of the study included five players from Diyala Youth Team who were training in the sporting season (2014- 2015). Outcomes were evaluated using the experimental approach. The findings revealed that resistance torque training led to the higher effectiveness of push power at the instant of ball release and a lower angular momentum in preparing phases (Jaber & Salal, 2017).

The problem of the present research emerges from the authors' practical experience in this field, as they both coach female discus throwers. Through reviewing relevant literature and previous studies, they identified several fundamental weaknesses hindering the progress of women's discus throwing at the Arab and Asian levels. One of the most prominent issues is the noticeable reduction in the release angle during the throw, which has been observed among Iraqi discus throwers. This reduction was diagnosed through biomechanical field analyses of discus throwers during national championships. Accordingly, the researchers sought to propose appropriate solutions to this problem through targeted training using weighted implements and by designing a graded-height net in front of the throwing circle. This net allows coaches to directly assess and adjust the release angle in the training field.

Therefore, the current study aimed to design resistance-based training programs for female discus throwers, to identify the values of take-off and performance variables, and to

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investigate the effects of resistance training on the development of these variables in female discus athletes.

Research methodology

The researcher employed the experimental method using a two-group design (experimental and control) with pre- and post-tests, as it was deemed suitable for the nature of the research problem. As Allawi and Rateb (1999) state, "the experimental method represents the most valid approach for solving many scientific problems both practically and theoretically." The research population consisted of female athletes who participated in the Iraqi Clubs and Institutions Athletics Championship for women and juniors, held in November 2022. The total number of participants was 13, representing the research population. From this population, 8 athletes were selected based on their performance level and the requirements of conducting the field experiment. These were divided into two groups: 4 athletes assigned to the experimental group, which trained with resistance exercises using the inclined net system, and 4 athletes assigned to the control group, which followed the coach's conventional training program. The distribution was carried out randomly by lot, and the selected sample represented 61.54% of the total research population.

The investigators used a customized blocking net held by poles that were inserted into the ground, and had a sliding mechanism for adjusting the height. The poles were capable of extending to 10 meters and receding to 5 meters, while being separated from one another by 10 meters. Four colored bands (each representing a different release angle) were attached to the poles with a net.

The release angle for each athlete was determined through video recording and subsequent measurement of the release angle during repeated attempts. Once the individual release angle of each athlete was identified, colored bands were placed on the net, each corresponding to a particular angle, in order to work on gradually increasing the release angle until the optimal value was achieved. In addition, angles were also determined by using a sliding pole of 2 meters in height, fixed with a metal wire. The athlete would stand beside the pole, raise her arm to establish the release angle, and the wire would then be fixed at the designated angle to guide training. Figure (1) illustrates the design of the net.

Figure 1. show the net

The researchers used two video cameras with their stands, operating at a speed of 120 frames per second, manufactured by Sony (Japan), in order to extract the kinematic variables of the discus release. The variables determined by the researchers were as follows:

Release velocity of the discus

This is the average velocity calculated by dividing the measured release distance—from the moment the discus leaves the thrower's hand until after release—by the release time. The values were obtained through video recordings and analyzed using the *Kinovea* software (Jams G. Hang, 1976). Figure (1) illustrates this.

Release angle of the discus

This is defined as the angle formed between the trajectory of the discus center of gravity after release and the horizontal line parallel to the ground. The values were extracted using video recordings and analyzed with the Kenova software (Salameh, 2013). Figure (1) illustrates this.

Release height of the discus

This refers to the vertical distance between the center of gravity of the discus at the moment of release and the ground. It was also determined through video recordings and analyzed using the *Kinovea* software (Al-Quwa, 2004). Figure (2) illustrates this.

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Figure 2. show the kinematic variables of the release

Procedures

Discus Throw Performance Test (Al-Shamma, Dahash, & Abdullah, 2019)

Purpose of the test: To measure the best distance achieved among all attempts. **Unit of measurement:** Meter.

Instruments: Discus throwing circle, 1-kg discus, measuring tape, and recording forms.

Performance description: Each participant performs the throw from within the discus circle, following all regulations of the International Association of Athletics Federations (IAAF) for discus throw. The test includes a set number of attempts.

Recording procedure: The test begins after the athletes perform warm-up exercises and trial attempts. Each participant is then given six official attempts, all of which are recorded on video. The best attempt (i.e., the highest achievement) is analyzed.

A pilot experiment was conducted on two participants from the sample, during which the following procedures were applied:

Discus throw performance test was carried out at the throwing field of the College of Physical Education and Sports Sciences, University of Baghdad, at 3:00 p.m.

The purpose of the pilot study was to identify the following:

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The optimal placement of cameras. One video camera (Casio) with a speed of 240 frames per second, mounted on a tripod, was positioned beside the throwing circle on the side of the throwing arm, at a height of 1.20 meters and a distance of 7 meters from the circle. The camera was oriented perpendicular to the thrower's motion and at a height aligned with the throwing arm. This setup was intended to capture both the release phase and the initial flight of the discus. A calibration scale (1 meter in length) was also placed at the midpoint of the motion path to provide reference for measurement.

The functionality of memory cards (RAM) for each camera and to ensure the frame rate was fixed at 120 frames per second.

Following the pilot study, the researchers conducted the pre-tests on the research sample on Monday (4–5/3/2024) at the University of Baghdad / College of Physical Education and Sports Sciences. Camera positions were fixed and marked, and reference points were identified to facilitate proper installation of the equipment. The pre-tests included both performance measurement and video recording, conducted in the afternoon. After the pre-tests, equivalence of the extracted variables was established, as shown in Table (1).

Table 1. *Equivalence of the sample in physical, kinematic, and performance variables*

Variables	Sub-variables	Unit	Control Group		Experimental Group		T-Value	P-Value
			Mean	SD	Mean	SD		
Release Variables	Release Angle	Degree	34.155	0.347	34.075	0.605	0.229	0.826
	Release Height	cm	156.345	0.700	156.267	0.735	0.153	0.884
	Release Velocity	m/s	18.702	0.433	18.937	0.138	1.034	0.341
Performance	Distance	m	37.067	0.810	37.077	0.952	0.016	0.988

Significant at the 0.05 level, with degrees of freedom (n – 2) = 6

After reviewing numerous books and training curricula, consulting with coaches and specialists, and drawing on their own practical experience, the researchers developed a training program aimed at improving the release variables of female discus throwers. The program relied on the use of weighted implements for the arms and trunk, as well as the graduated-height discus blocking net. The training lasted for 10 weeks, with three training sessions per week, totaling 30 training units.

The researchers adhered, as much as possible, to the principles and rules of training science in implementing these units, as follows:

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- Exercises were introduced in the main section of each training session.
- The program was conducted during the final part of the general preparation phase and the beginning of the specific preparation phase.
- The principle of progressive overload and periodization was applied in executing the training load.
- Both high-intensity repetitive and interval training methods were used for exercises.
- Strength and skill-specific exercises for discus throw required relatively high intensity, ranging from 85% to 100% of the prescribed load.
- Training intensity was measured based on the variation in difficulty resulting from the type of weights used. Additionally, the athletes' perceived exertion in skill execution, particularly when approaching the optimal release angle, was considered.
- A work-to-rest ratio of 1:30 was applied in throwing exercises, and 1:10 in strength-specific exercises.
- Rest intervals ranged between 1.5 to 2.5 minutes between repetitions and 5 to 6 minutes between training sets.
- The number of repetitions for skill execution in discus throwing ranged from 20 to 25, while strength-specific exercises ranged from 6 to 12 repetitions.

Post-tests for performance and release variables were conducted under the same conditions and sequence as the pre-tests.

Result

Table 2. *Mean values, standard deviations, calculated T-values, and significance levels for the release and performance variables of the experimental group*

Phase Variable	Variable	Unit	Pre-Test Mean	SD	Post-Test Mean	SD	Mean Difference	T-Value	P-Value
Release Phase Variables	Release Angle	Degree	34.075	0.605	36.135	0.050	2.060	6.933	0.006
	Release Height	cm	156.267	0.735	157.982	0.331	1.715	6.772	0.007
	Release Velocity	m/s	18.937	0.138	20.107	0.165	1.170	17.036	0.000
	Performance Distance	m	37.077	0.952	38.710	0.568	1.632	4.466	0.021

Significant at $p < 0.05$, with degrees of freedom $(n - 1) = 3$.

Discussing

These data indicate that all release parameters significantly recovered. The improvements in release angle, release height and release velocity illustrate the efficacy of the training program which the researchers conducted on experimental group. Especially, the graduated-height blocking net made a significant contribution to improving the release angle. The improvements between pre and post-tests can be attributed to the common training as well as instantaneous feedback of net, which allows athletes to control -angle in each trial. Using colored bands on the net at predetermined angles as well as video analysis for all athletes, monitoring and assessment were implemented.

Furthermore, training with weighted implements made the performance of such skills very challenging. These heightened demands along with repeated practice in such conditions likely contributed to neuromuscular adaptation and enhancement of intersegmental coordination. Participants were trained to ensure proper biomechanical positioning using proper joint angles, which the researchers stressed during training sessions. These exercises helped to achieve the ideal release angle, which is strongly connected with technical and mechanical phases, physical abilities of an athlete and fluent attitudes – in other words they led to correct throwing position on the incline during practice. This result agrees with earlier studies in which the correct body positions during the throw, and use of physical capabilities and anatomical characteristics are necessary to obtain a release angle that provides maximal discus distance (Z.K., 1995).

Training on slope with the blocking net produced skill gains and improved sensory-motor integration shows real-time information concerning movement performance in spatial and temporal terms (Ahmed, 1998). The use of different types of resistance, such as extra weights and jumps, was mainly intended to generate the best biomechanical conditions for performance (specifically for release angle since it is a determinant factor to tic-tac outcomes). Bartlett (1999) identified three main areas of strength for thrower that contribute to overall strength and biomechanical connection: 1) a generalized year round weight training programmed, 2) targeted muscular strength sessions specific to the needs of technical and mechanical requirements using weighted apparatuses and plyometric exercises, and, 3) absolute strength components associated with individual muscle groups (Clements, 1996).

Training using the blocking-net enhanced final release velocity and reduced errors in angular momentum, suggesting better movement fluidity was achieved between preparatory and final throwing phases. This increase could be attributed to the use of progressive and appropriate resistance training for both lower extremities (i.e., jumping for distance and height) and upper extremity (i.e., multiple types of weighted throws). The authors stressed

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the necessity of maintaining proper technical execution in these tasks to develop the muscle strength. Repetitive practice sets, sport specific activities and strength building are essential to maintain biomechanical demands required for peak performance (McCoy, 2005).

Resistance training used by the investigators included a variety of technical and skill components as weighted implements, weight vests, plyometric jumps, or medicine balls to improve biomechanical characteristics. Discus throwing requires strength and speed, so the training program should focus on speed-oriented drill (ie- jumping and light- implement throwing). Close observation of these weight room workouts is necessary to maintain strength levels while preventing overfatigue in order to be at one's best for throwing.

The authors claim that the increase in release velocity is largely due to improved movement speed of the thrower throughout the kinetic phases in addition to a reduction occurring during flight and transition time (-phase and -phase). The combination of these phases, combined with resistance training, has translated into a performance augmentation. Also, the increase in release velocity was found positively correlated with that of release angle during the process, reflecting an intrinsic relationship among individual variables and effect on following learning phrases according to data (Ahmed, 1998, p.65).

Releases seem to be going over his head even more. The authors ascribe this improvement to the resistance training done against a block net, which encouraged a proper practice by bringing correct joint angle, and so gaining an optimal center of mass height at release. The drills focused on landing joint extension, which accounted for greater release height and thus increased horizontal distance (Paish, 2022). These improvements were also associated with positive technical and biomechanical performance outcomes.

Furthermore, specialized resistance training against different inclines greatly increased muscle fiber recruitment and strengthened neuromuscular co-ordination both in interfacing and between muscles groups. This last response was clearly demonstrated in the post-test results of the experimental group, which showed marked increases in rapid forces for those body segments that were involved in performance. These improvements were directly associated with throwing performance.

Appendix

Specialized Training and Scientific Principles Used in Designing the Program

Note: The actual weights for the legs and arms were determined using the following equation:
Total body weight×Relative weight of the leg=Actual weight of the leg\text{Total body

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weight} \times \text{Relative weight of the leg} = \text{Actual weight of the leg}Total body weight×Relative weight of the leg=Actual weight of the leg

From the actual weight of the leg, the required training load for added weights was calculated as follows:

Actual leg weight×Required intensity=Training load\text{Actual leg weight} \times \text{Required intensity} = \text{Training load}Actual leg weight×Required intensity=Training load

Example:
Body weight = 70 kg
Relative weight of leg = 0.18 → Actual leg weight = 70 × 0.18 = 12.95 kg
Required added weight for training = 12.95 × 0.05 ≈ 0.647 kg per leg

This weight may increase or decrease depending on the intended training intensity.

- Training intensity was also determined according to the number of repetitions performed within a specific time frame.
- Maximum throw distance was used to define the peak intensity for throwing repetitions.
- For jumping exercises, maximum intensity was determined based on the number of jumps and time, to calculate the required training load.
- Training sessions were conducted on Saturdays, Mondays, and Wednesdays each week.
- The program consisted of 30 training units, with three sessions per week.

Week of Training

Week	Unit	Details	Added Weight Intensity	Intensity (%)	Repetitions	Rest Between Reps	Sets	Rest Between Sets
1	1	Disc throw (1 kg) with added weight on legs 3% (flat ground) using blocking net	3%	80%	5	1 min	4	2 min
1	2	Disc throw (1 kg) with added weight on arms 3% (flat ground) using blocking net	3%	80%	8	1 min	4	2 min
1	3	Disc throw (1 kg) with added weight on trunk 5% (flat ground) using blocking net	5%	80% of total throw time	9	1 min	4	2 min

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