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The effect of TRX sling exercises on some biomechanical variables and the achievement of javelin throwing in specialized school athletes

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ABSTRACT

Objectives: To prepare exercises (TRX) with ropes considering bio-kinematic variables and performance improvement at javelin throw for the specialized school grade athletes, and also to assess the effect of (TRX) exercises through bio-kinematic variables and the level of accomplishment at javelin throw for these athletes.

Methods: The study used the experimental method for the sample group with pre- and post-test. The research sample was selected by the age method from the school athletes specialized in javelin throwing, that numbered a total of 5 athletes, who underwent their training within the 2021-2022 season.

Results: The TRX exercises contributed to the improvement of biomechanical variables, namely the angles of inclination of the aiming arm, the angle of the torso inclination, the angular velocity, the starting velocity, and the shoulder angle of the research sample.

Conclusions: The use of modern TRX exercises showed to be highly effective in increasing the technical performance at the javelin throwing for the research sample.

KEYWORDS: Rope Exercises (TRX); Bio-kinetics; Javelin Throw; Biomechanics

1. INTRODUCTION

Exercises are an essential component of sports' training and the origin of all motor skills. They serve special purposes in correcting technique and improving physical and motor capabilities to enable skillful performance, by having an impact on the biodynamic effects of the athlete's sports skills. The training process in the sports field is closely related to and based on other sciences, as it is not possible to plan sports training sessions or creating training programs and curricula without relying on statistics, physiological tests, kinesiology, biomechanics and other sciences.

Through sports training based on general scientific and mechanical foundations to reach the highest athletics levels, including the effectiveness of javelin throwing. Moreover, it is certain that the qualitative idea of training athletes is not training strength alone, but it goes beyond it to training general physical characteristics, down to the stages of special training. Therefore, according to the type of specialized sporting event, training is required along with a routine comprising modern exercises and training devices to achieve the best possible results in javelin throwing event. The use of TRX ropes helps in increasing the strength and flexibility of the body through a set of exercises that targets those skills. These exercises require hanging a part of the body above the ground or it tilting with straps, using TRX ropes to build up the body's resistance to those ropes by tilting the body specific directions (Al-Fadhli & Alwan, (2012).

In order to improve the javelin throwing performance for the specialized athletes of the school, the researcher found that it is important to correct and increase the biokinetic variables through the implementation of special TRX exercises that aim to develop both variables. In order to reach this goal, the research proposes the implementation of other sciences to support and improve results. The proposed program will rely on sources, references and opinions of experts and specialists in addition to the use of kinetic analysis programs to reach the best level of performance through the implementation of TRX exercises and the measurement of their impact on biodynamic variables and accomplishment in javelin throw.

This research aims to: 1) Prepare exercises (TRX) with ropes considering bio-kinematic variables and performance improvement at javelin throw for the specialized school grade athletes. 2) Assess the effect of (TRX) exercises through biokinematic variables and the level of accomplishment at javelin throw for specialized school-grade athletes.

2. METHODS

2.1. Design and participants

This research used the experimental method for the sample group with pre- and post-test. The subject of the study requires defining the research community in this type of study in accordance with the observed phenomenon (Al Fadhli, 1986). The research sample was selected by the age method from the school athletes specialized in javelin throwing, that numbered a total of 5 athletes, who underwent their training within the 2021-2022 season. Homogeneity was checked throughout the variables body weight, height and age, and it is shown in Table 1.

Table 1. Homogeneity of the sample in the variables body weight, height and age

Variables	Unit	Arithmetic mean	Median	Standard deviation
Weight	kg	50.82	50	7.044
Height	cm	162.54	163	4.63
Age	years	13.98	14	1.022

2.2. Instruments and procedures

The materials used in this research were: Software Kinota version 0.8.15, adhesive tape, wall-mounted high-rebound bungee cords, Sonny video camera, computer and plasma TV (LG).

The most important biokinetic indicators of the effectiveness in javelin throwing were selected after the kinetic analysis of the activity, with the following results: Front arm inclination angle; Inclination angle of the trunk; The angle of the knee joint of the pushing leg; Angular velocity; Cruising speed; Shoulder angle.

The exploratory experiment was conducted on 11/13/2022 with 2 javelin throwers. Its purpose was to verify the vocabulary of the training curriculum on TRX exercises, the safety of the devices and tools used, and to identify errors and obstacles to overcome them. They were photographed to identify the location, dimensions, and height of the cameras. Moreover, the clarity was verified of the image and the time required for each imaging adjusted to conduct the imaging.

Pre-tests were conducted on 12/10/2021 at ten in the morning on the sample of the main experiment in the arena and field stadium of the school.

Regarding the main experiment, the kinetic analysis was conducted through imaging. Three cameras were used to photograph the sample, and the locations of the cameras were fixed in their positions according to the data of the reconnaissance experiment. The first camera was from the left side of the shooter (300 images / sec), set at a height of 1.40 m from the center of the camera focus to

the ground. As for the second camera, it was placed on the right side of the shooter, and three attempts were given to each participant in which they would be photographed. The research used the best attempt for each athlete's results for the purpose of analyzing it and extracting the values of the biokinetic variables of the research. Part of the main section of the training units for the research sample.

For the training, the ropes were fixed on the wall to the top and a routine of exercises was performed and then presented to the experts, with the purpose of improving the strength of the muscles working on the shoulder joint and the range of motion of the joint. The exercises were implemented as follows:

Five sessions were given per week. The exercises were described in the curriculum of the training unit presented to the trainer and they were included in the main section. The exercises consisted of multiple repetitions that would increase along with the number of training sessions. The training sessions were implemented over the span of six weeks, at the rate of five sessions per week, and thus the presentation of the sessions was (30 training sessions). The intensity gradient was adjusted for changing of rest times between repetitions and between the groups.

The post-tests were conducted on 1/25/2022 at ten o'clock in the morning on the research group in the arena and field stadium of the school, and under the same conditions that the pre-tests were conducted.

2.3. Statistical analyses

The statistical analyses were conducted with the Statistical Package for the Social Sciences (SPSS) version 23. The statistical techniques used were the calculation of arithmetic mean and standard deviation, and the means comparison through t tests. $P<0.05$ was used as the significance level.

3. RESULTS AND DISCUSSION

Through the results of Table 2 and 3, we see that there is a was a significant difference for the test participants after the study. The p value for all variables was <0.05 which hinted towards the emergence of other significant differences for those variables. The kinetic analysis helped in measuring the kinetic variables as well as the training process for javelin throwers on ideal angles and kinetic variables. The analysis concludes that the (TRX) sling exercises contributed to the creation of significant differences that helped in improving the results of lifting through the motor skills parts and their details in a comprehensive manner and the aim is to serve better motor skills.

Table 2. Comparison of biokinetic variables in pre-test and post-test

Variables	Pre-test		Post-test		t	p
	M	SD	M	SD		
Throwing arm inclination angle (degrees)	77.32	15.03	78.32	14.99	2.93	<0.05
Stem tilt angle (degrees)	26.71	7.32	32.45	7.01	2.84	<0.05
Knee joint angle of the pushing leg (degrees)	155.89	28.91	151.34	28.23	3.09	<0.05
Angular velocity of the arm (degrees)	142.23	97.61	156.73	17.54	4.21	<0.05
Cruising speed (sec)	16.97	2.92	16.98	2.88	3.27	<0.05
Shoulder angle (degrees)	75.41	61.044	75.83	10.00	4.56	<0.05

Table 3. Comparison of javelin throw results in pre-test and post-test

Variables	Pre-test		Post-test		t	p
	M	SD	M	SD		
Javelin throw results	23.79	1.86	24.28	1.77	2.15	<0.05

The researcher believes that all the biokinetic variables point towards the exercises resulting in an increase in performance also believes that the TRX exercises contributed to improving the results of the research sample group, as the repetitions and the performance of the exercises with ropes contributed to increasing the flexibility of the joints and muscle strength.

The high motor compatibility obtained by the sample, especially the relationship between the two legs and arms in the steps of intersection, throwing, switching, the angle of the javelin throw and performance at the high speeds are all developments associated to the exercises set according to the standards of skill determined through the derivation of these exercises, which in turn resulted in a better performance and effectiveness at javelin throwing.

The researcher attributes these differences to the use of exercises ropes (TRX) with certain repetitions, that contributed to an increase on performance relevant to those variables in a way that serves the training's effectiveness.

Research suggests that this is achieved by overcoming the inertia of the body and converting energy into kinetic energy that is transmitted from the muscles of the trunk to the throwing arm, and then working to transfer the weight of the body from the feet to the throwing arm, within the momentum index for each part (Fadel, 2000). Strength (body mass x velocity) determines the performance ends with the arms, then the momentum of the torso is added to the arms, and this feature represents

significant importance in performance. The researcher believes that the training programs presented by her, according to the training sessions using (TRX) exercises, have developed the motor field.

This is especially true for the angles when performing the motor activities required for javelin throwing through the organization and coordination between the nervous and muscular systems, creating a harmonious relationship between the motor capabilities and the angles of each performance. In order to achieve optimal performance in biomechanics it is necessary to have flexibility and strength at the correct time to achieve better performance and avoid excessive effort on the muscles (Al-Fadhli, 1986).

These exercises are considered one of the modern methods, and it is safe to say that they contributed to the sample's performance of the repetitions and totals without boredom, impulsiveness and suspense, and thus led to an improvement in their results.

4. CONCLUSIONS

The TRX exercises contributed to the improvement of biomechanical variables, namely the angles of inclination of the aiming arm, the angle of the torso inclination, the angular velocity, the starting velocity, and the shoulder angle of the research sample. The use of modern TRX exercises showed to be highly effective in increasing the technical performance at the javelin throwing for the research sample.

5. RECOMMENDATIONS

There is a need to test and use training methods that can be used in accordance with the training situation and that work to support the training process in an appropriate manner according to the athletes' ages. The use of biomechanical variables can yield desirable results in athletics and for different sports. Conducting studies similar to this research would establish and measure the relationship of some biomechanical variables and technical performance. Employing TRX exercises in other sports and games within the period of special preparation of the training can help develop specialized strength and technique.

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AUTHOR CONTRIBUTIONS

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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