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Effect of Functional strength training on mechanical braking of lower limb in javelin throw

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Abstract: Background: The aim of this study was to improve the digital level using functional strength training for the biomechanical braking of the lower limb of the national javelin throw team players. sample was selected from the Egyptian national team players (javelin throw) of the Egyptian Athletics Federation. Their number was (10) players, and they were the best in the digital level of the javelin throw competition. The results indicated that.

- Significant Difference between pre – tests and post - tests in all physical variables. Highest Change rate was 18.92% and lowest Change rate was 8.5%.
- Significant Difference between pre – tests and post - tests in all mechanical braking variables. Highest Change rate was 370.83% and lowest Change rate was 3.50%.
- Significant Difference between pre – tests and post - tests in digital level of javelin throw for experimental group. Change rate was 5.83%.

In Conclusion, the present study indicates significant improvement in the mechanical braking of lower limb, physical variables and digital level of javelin throw Egyptian players after 8 weeks of functional strength training.

Keywords: Functional strength training, mechanical braking, javelin throw

Introduction

Javelin has a rich history as a weapon, but from the time of the ancient Greeks to the present day, it has been primarily used in sports. It holds the status of an official Olympic sport. (AWF) The main objective in javelin throwing is to launch it as far as possible, and there are various techniques employed to achieve this. During competitions, participants are required to execute their throw within a limited time of 1 minute, with each athlete having 3 attempts. One crucial rule is that for the throw to be valid, the javelin's tip must be the first point of contact with the ground. Additionally, only the classic throw technique is permitted, meaning that variations such as turning one's back to the throwing point are not allowed. (AWF) When it comes to javelin

throw records, certain key movements play a significant role. These include the landing on the supporting foot before the release and the release movement. To maximize the exercise effect, the throwing movement should involve acceleration from the proximal segment to the distal segment (Lee, 2002; Komi & Mero, 1985). Notably, transmitting power from the lower limbs to the upper limbs and then to the javelin at the release point is crucial. Studies have shown that the throw angle, throw speed, and throw height of the javelin at the release point have the most significant impact on records (Bartlett & Best, 1988; Park & Yoon, 2010). Among these factors, mechanical braking has been highlighted as particularly influential (Morriss, et al. 1997).

Mechanical braking in the context of the javelin throw refers to the phase of the throw where deceleration occurs just before the javelin is released. This involves the athlete's technique and biomechanical movements to control the javelin's speed and trajectory. Proper mechanical braking is essential for effective release, maximizing distance while minimizing the risk of injury.

The human body naturally favors the utilization of the most developed musculature while neglecting less conditioned muscle groups. This phenomenon often results in a combination of overperforming and underperforming muscle groups, potentially leading to significant muscular imbalances and injuries. Functional strength training aids in minimizing these imbalances through exercises that engage multiple muscle groups simultaneously, thereby promoting similar recruitment patterns in daily activities. Functional strength training focuses on exercises that prepare the body for real-life movements and activities by engaging multiple muscle groups, particularly the core. This type of training aims to improve overall strength and agility, making everyday tasks easier, such as lifting heavy objects or playing sports.

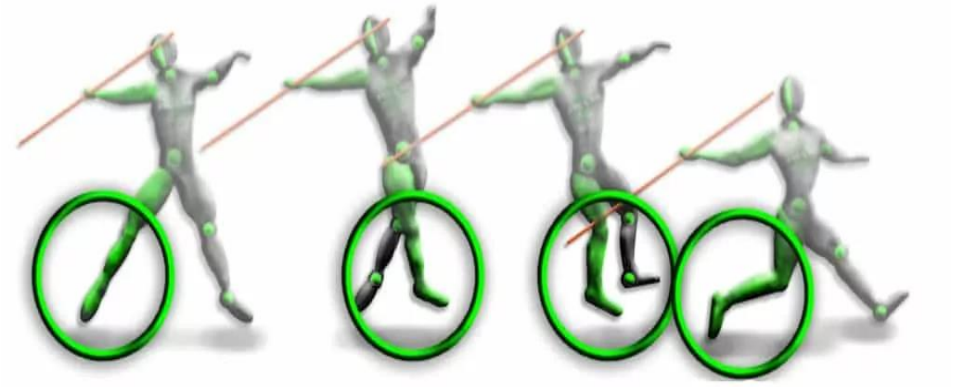


Fig 1. Show mechanical braking of lower limb in javelin throw

Thus, the aim of this study was to improve the digital level using functional strength training for the biomechanical braking of the lower limb of the national javelin throw team players.

Material and Methods.

Sample.

The study sample was selected from the Egyptian national team players (javelin throw) of the Egyptian Athletics Federation. Their number was (10) players, and they were the best in the digital level of the javelin throw competition. The anthropometric characters are described in Table 1.

Reasons for choosing the sample.

- Ease of contact with the research community as the researcher is a player in the Egyptian national team.
- The researcher ensures the seriousness of the research community members in continuing training.
- The chronological age of the research community members is close and the presence of the factor of harmony and cohesion between the players.

Training Protocol

The 8-weeks in-season training program consisted of resistance band training (RBT) and kettlebell training (KT).

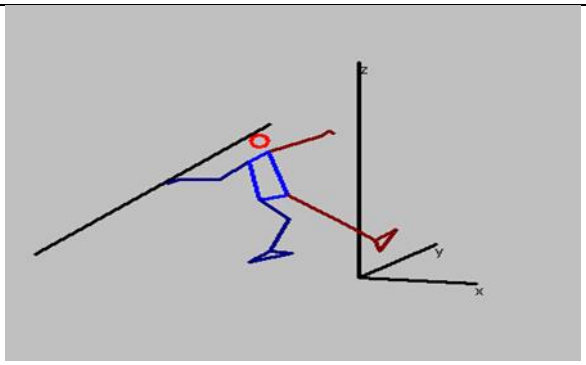
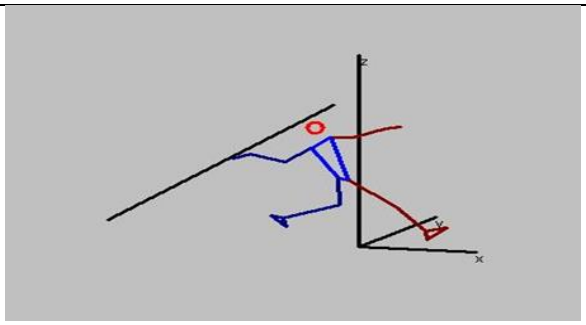
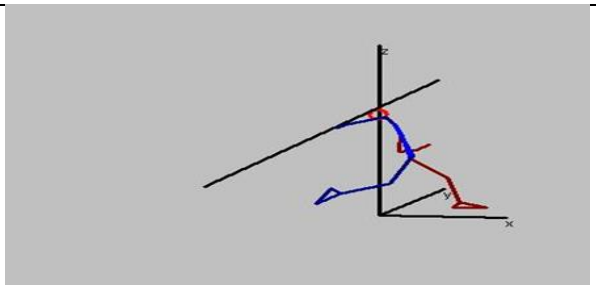
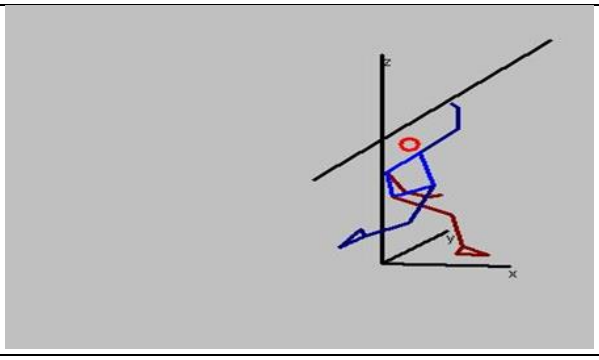
Motion Analysis Tools.

Advanced computer unit - Motion Analysis Program "Simi Motion" - Calibration box 1 m x 1 m x 1 m "Calibration" - Number (4) 125 frames/second video cameras, camera type "Fastec Imaging" - Number (3) tripods equipped with a water balance - Electrical connections - Control (guiding) marks.

Determining the performance stages that were studied:

Considering the research objective, the researcher chose the stage of the last step in the javelin throw competition because of its great importance in reaching the appropriate strength position for the performance.

***Determining the time moments of the skill.**

1- Touching the right hind leg. This is the moment when the player starts to touch the ground with the right back foot in the final step of the approach	
2- Touch of the supporting leg (left). This is the moment when the player starts to touch the heel of the front supporting leg (left) to the ground in the throwing position.	
3- Brake of the supporting leg (left). This is the moment when the front supporting leg (left) is fully straight, and the foot is fully supported on the ground	
4- Moment of release. This is the moment when the javelin connection with the thrower's arm grip is broken.	

Positioning the cameras for 3D skill photography

At this stage, it was ensured that the cameras were positioned in the appropriate manner, as the cameras for the motion analysis unit were equipped, and it was ensured that the three cameras were synchronized with each other. The calibration box 1m x 1m x 1m was placed in the middle of the end of the approach path for throwing the javelin, where the (first) camera was 8.5 meters away from the calibration box, and the (second) camera was 9 meters away from the calibration box, and the (third) camera was 10 meters away from the calibration box, and they were fixed on three tripods, at a height suitable for photographing the skill under investigation at all its stages, and it was also ensured that the shooting angles used facilitate the possibility of seeing the player in all his details during the performance.

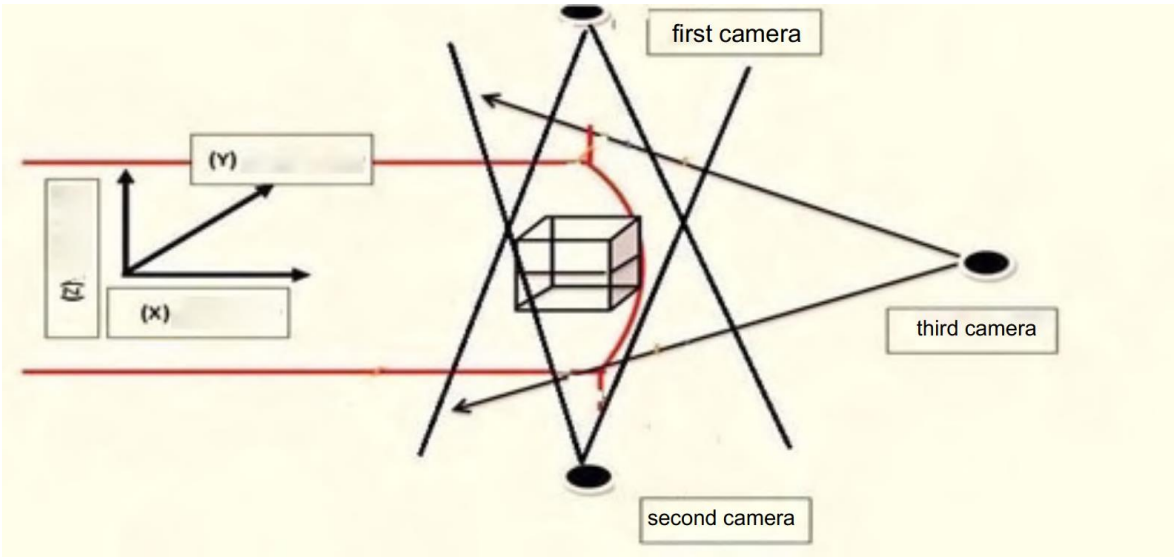


Fig 2 show Positioning the cameras

Statistical Analysis.

All statistical analyses were calculated by the SPSS statistical package. The results are reported as means and standard deviations (SD). Differences between pre and post tests were reported as mean difference ±95% confidence intervals (meandiff ± 95% CI). Student's t-test for dependent samples was used to determine the differences in vision parameters between the pre and posttests. The $p<0.05$ was considered as statistically significant.

Results.

Table 1. Age, anthropometric Characteristics and Training experience of the experimental Group (Mean ± SD)

Group	N	Age [years]	Weight [kg]	Height [cm]	Training experience
Experimental	10	24.17 ± 0.20	86.90 ± 1.44	183.90 ± 1.37	6.80 ± 0.25

Table 1. shows the age, anthropometric characteristics and Training experience of the subjects. There were no significant differences were observed in the age, anthropometric characteristics and Training experience for the subjects.

Table 2. Mean ± SD and (T)Test between pre – tests and post - tests in physical variables for experimental group.

Variables	Meas. Unites	experimental group		Change rate %	Sig.
		Before	After		
Maximum leg strength	Kg	**220±3.46**	**237.70±3.59**	**8.05**	**Sig.**
Throwing a 3kg medicine ball with hands	Meter	**12.42±0.40**	**14.77±0.27**	**18.92**	**Sig.**

Maximum core strength	Kg	**186.00±6.75**	**206.70±5.25**	**11.13**	**Sig.**
Shoulder flexibility	Cm	**50.32±0.39**	**54.55±0.59**	**8.40**	**Sig.**
Back flexibility	Cm	**40.45±0.43**	**44.65±0.52**	**10.38**	**Sig.**
Side to side trunk rotation	Cm	**26.35±0.47**	**30.85±0.74**	**17.07**	**Sig.**
30m flying sprint	Second	**3.96±0.01**	**3.25±0.02**	**17.92**	**Sig.**

Table 2. shows Significant Difference between pre – tests and post - tests in all physical variables. Highest Change rate was 18.92% and lowest Change rate was 8.5%.

Table 3. Mean ± SD and (T)Test between pre – tests and post - tests in mechanical braking for experimental group.

Phases	**Variables**	**Meas. Unites**	**experimental group**		**Change rate %**	**Sig.**
			Before	**After**		
1	Resultant acceleration of the center of gravity of the body	m/ sec^2	8.60±0.74	3.35±0.41	61.05	**Sig.**
	Resultant force of the center of gravity of the body	Kg/m/ sec	12.39±0.16	17.12±0.56	38.22	**Sig.**
	Resultant acceleration of the throwing arm	m/ sec^2	0.96±0.16	2.46±0.14	155.78	**Sig.**
2	Resultant acceleration of the center of gravity of the body	m/ sec^2	24.80±0.92	43.20±0.63	74.19	**Sig.**
	Resultant force of the center of gravity of the body	Kg/m/ sec	256.17±0.16	265.13±2.65	3.50	**Sig.**
	Resultant acceleration of the throwing arm	m/ sec^2	75.09±0.14	85.06±0.39	13.28	**Sig.**
3	Resultant acceleration of the center of gravity of the body	m/ sec^2	16.00±0.82	12.80±0.63	20.00	**Sig.**
	Resultant force of the center of gravity of the body	Kg/m/ sec	177.37±0.16	184.09±4.11	3.65	**Sig.**
	Resultant acceleration of the throwing arm	m/ sec^2	43.90±1.03	50.92±0.69	15.98	**Sig.**
4	Resultant acceleration of the center of gravity of the body	m/ sec^2	4.89±0.57	23.00±0.67	370.83	**Sig.**
	Resultant force of the center of gravity of the body	Kg/m/ sec	172.30±0.38	181.56±0.91	5.38	**Sig.**
	Resultant acceleration of the throwing arm	m/ sec^2	69.36±0.31	73.73±0.47	6.29	**Sig.**
	Takeoff velocity	m/ sec^2	20.77±0.69	23.27±0.29	12.07	**Sig.**
	Takeoff angle	Degree	65.34±0.33	56.10±2.01	14.14	**Sig.**
	Discharge point height	Meter	1.60±0.15	2.20±0.21	37.58	**Sig.**

Table 3. shows Significant Difference between pre – tests and post - tests in all mechanical braking variables. Highest Change rate was 370.83% and lowest Change rate was 3.50%.

Table 4. Mean ± SD and (T)Test between pre – tests and post - tests in digital level of javelin throw for experimental group.

Variable	Meas. Unites	experimental group		Change rate %	Sig.
		Before	After		
Digital level of javelin throw	Meter	**58.30±0.82**	**61.70±0.48**	**5.83**	**Sig.**

Table 4. shows Significant Difference between pre – tests and post - tests in digital level of javelin throw for experimental group. Change rate was 5.83%.

Discussion.

We attribute these statistically significant differences between the pre- and post-measurements in favor of the post-measurement of the sample in special physical abilities to the effectiveness of using functional strength training due to the similarity of the muscle work in the exercises used with the stages of technical performance of javelin throwing. Therefore, functional strength training leads to the development of the working muscle groups during the stages of technical performance of the javelin and works to develop the technical aspect of performance in terms of the movement path, the time required for performance, and the amount of force. This means that functional strength training works to develop the physical and technical aspects side by side, which leads to improving the stages of performance. The researcher also attributes these results to the specificity of training, which was one of the most important causes of these positive results from the players, because the researcher's consideration of the principle of specificity helped to consider individual differences during the application of the training program. The researcher also believes that high achievement requires focusing all training forces on the javelin throwing competition in a manner that is consistent with the player's capabilities. We also agree with Fabio Comana (2009) stated that functional strength exercises are integrated and multi-level movements (frontal - transverse - sagittal) that include acceleration, stabilization and deceleration with the aim of improving motor ability and central strength (spine - mid-body). Functional strength exercises are one of the forms of physical exercises used in the modern era, as they focus on strengthening the muscles of the center as well as the upper and lower extremities. These muscle groups are completely linked to the spine and pelvis, and there must be a stable base to strengthen them, thus increasing muscle strength and limb movement.

We believe that functional strength exercises have a positive effect on the lower extremities, and that the basic rule for improving the physical level of javelin throwers depends on the strength of the leg muscles and control and control during the performance of all stages of performance, especially the braking stage, which is one of the most important stages of controlling the body and the tool. The interest in this stage and the development of scientifically standardized functional exercises that suit all players led in turn to improving the level of the special physical abilities of the sample under study.

We also agree with what Maryg Reynolds (2003) indicated that functional training as one of the modern trainings works to improve motor ability by focusing on the three dimensions or levels of movement (horizontal - sagittal - vertical) and improves the form of performance and the sense of the force produced to achieve the goal of the performed movement. It improves natural movements, general strength and coordination in motor performance. It works to increase the body's motor sense and the integrated participation of different body parts when performing and improves the relationship between the nervous system and muscles. It works to benefit from the acquired strength to achieve the requirements of other movements by influencing the entire neuromuscular system, as control or motor control training is one of the basics for training the individual muscles involved in the movement and has a major role in improving the functional strength of the central muscles, fixed and moving muscle balance and the functional efficiency of the different body parts.

The results agree with the results of the study of (Ahmed Mustafa, 2021; Abeer Mamdouh, 2019; Islam Muhammad, 2018; Menatallah Mahmoud, 2017; Cymara, et al. 2004) that functional training has a positive effect on physical variables.

The resulting acceleration index of the throwing arm was statistically significant and showed a percentage improvement between the pre- and post-measurement in favor of the post-measurement during different performance moments. The researcher attributes this improvement to the proposed training program using functional strength training, which had a positive effect on the throwing arm and led to clear differences in the acceleration of the arm. The researcher confirms that the throwing arm is subject to the rule of kinetic transfer and the open kinematic chain, where the movement of the arm begins from the upper arm to the forearm and then the palm. It is worth noting here that kinetic transfer does not occur in periods, but rather kinetic transfer occurs from one part to another without stopping and in a successive and overlapping manner, so the parts move one after the other and according to their role in the kinetic performance. The results here agree with the results of Ayman Ahmed (2014) that the training program had a positive effect on the acceleration of the throwing arm.

This is confirmed by Dyson Geoffrey (2000) based on Newton's second law, which states that "the acceleration with which a body moves are directly proportional to the force causing it and in the same direction and inversely proportional to the mass of the body." He adds that it is easy to show that the change in speed (acceleration) of anybody with a constant mass is proportional to the force and in the same direction, as the speed of the spear reflects the force that the muscles of the throwing arm affected on the spear as the spear moves in the direction of the force at the moment of release.

Considering the index of the resulting acceleration of the center of gravity of the body, it was statistically significant and there were percentages of improvement between the pre- and post-measurement in favor of the post-measurement during the different moments of performance. Which indicates the development in the resulting acceleration of the body's center of gravity. The researcher attributes this improvement to the proposed training program using functional strength training, which had a positive effect on the body, which led to clear differences in the acceleration of the body's center of gravity.

The results agree with the results of (Ihab Abdel Rahman ,2019; Ayman Ahmed, 2014) in that the resulting acceleration of the body's general center of gravity varies from one level to another according to the player's technical performance. Any sports movement can only be done with the participation of the whole body, but this participation does not occur at the same time, nor at the same speed, as the human body contains many joints that move the body in different directions and in different shapes.

As for the resulting force index of the body's center of gravity, it was statistically significant and there were percentages of improvement between the pre- and post-measurement, in favor of the post-measurement during different performance moments. This indicates the development in the resultant force of the body's center of gravity. The researcher attributes this improvement to the proposed training program using functional strength training, which had a positive effect on the body, which led to clear differences in the resultant force and the resultant force of the body's center of gravity.

The javelin throw is a projectile sport using a javelin, and unlike the other three throwing events (discus, shot put, and hammer), it generates a lot of power in a short period of time, so speed plays an important role (Young, 2007), and the records are determined by the kinetic energy before throwing the javelin and various variables after throwing it. The javelin throw motion is divided into three stages: approach, crossover step, and release within a set area of 35 m. When the leading foot is the right foot, the approach refers to the time from the landing of the left foot to the landing of the right foot, the crossover step refers to the time from the landing of the right foot to the last landing of the left supporting foot, and the release refers to the time from the landing of the left supporting foot to the moment of releasing the javelin. It has been reported that the movements in the approach and release sections have a great influence on the athlete's records (Antti, et al. 1994; Kim, et al. 2013).

Furthermore, three angle factors of the spear at the time of release are vital for performance improvement: attitude angle, release angle, and attack angle. Research indicates that when the attack angle is close to 0 degrees, it promotes efficient movement and positively affects the record (Kim, 2014).

The results agree with the results of (Basma Hosni, 2022; Ahmed Fathy, 2020; Islam Mohamed, 2020; Ehab Abdel Rahman, 2019; Ayman Ahmed, 2014) that the training program had a positive effect on the resultant force index of the body's center of gravity.

Conclusion.

The results of the present study indicate significant improvement in the mechanical braking of lower limb, physical variables and digital level of javelin throw Egyptian players after 8 weeks of functional strength training.

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