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Effects of a Specific Training Program, in the Light of Kinematic Analysis of the Throwing Arm, on Javelin Throwing Distance among Disabled Athletes Class F58

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Abstract: The current study aims at improving javelin throwing distance among disabled athletes class F58 through identifying kinematic criteria of the throwing arm. The criteria have been identified through existing literature and performance analysis of the World Champion. The study proposes a set of specific exercises according to kinematic criteria of the throwing arm and identifies the effects of these recommended exercises on throwing distance among disabled athletes F58. The researchers employed the quasi-experimental approach on a sample of 8 javelin throwers F58, enrolled in Al-Erada Wa Al-Tahady Sports Club, Kafr El-Shaikh, Egypt. The participants undertook the proposed program and the kinematic criteria and digital level were measured. Results showed that the program led to statistically significant improvement in the digital level (p#0.05), in resultant velocity and resultant acceleration of the throwing arm center of gravity and center of gravity of the arm hand in the throwing arm during movement phases (preliminary - main - end). The study also showed statistically significant improvement in the angular velocity and the angular acceleration of elbow joint and in angular acceleration of shoulder joint during the preliminary phase. In addition, the program led to statistically significant improvement in angular velocity of elbow joint and in angular acceleration of shoulder joint during the main phase. Moreover, the program led to statistically significant improvement in the angular velocity of elbow joint and the angular velocity and angular acceleration of shoulder joint during the end phase. The program led to statistically significant improvement in Projection Velocity, Projection angle and the height of Javelin Projection point between pre- and post- test in favor of post-tests, at all levels.

Key words: Kinematic analysis % Specific training % Disabled athletes (F58)

INTRODUCTION

Throwing competitions are an important field, in which the body movement and its capability of motor achievement are linked to the thrown or pushed tool, thus the achieved distance represents the individual's ability of motor achievement. Such competitions are classified under competitive sports for the disabled athletes where they need to connecting the motor path of the body parts, aiming at using muscular work to generate a massive pushing power, consistent with the motor path and the motor level, without causing any contradicting power sources, that could affect the resultant power of the working muscle groups [1].

Mastering and refining the technical performance depends on details of the partial movements and how they combine. During performance, the athletes control and direct these partial movements. So, it is important to understand, not only how to build a movement system for technical performance, but also how to direct and control such a system to make use of its architecture. Thus, we might say that different body parts are joined and unified in a holistic unified system which directs all movements to become complete motor performances or behaviors [2].

Thorough understanding of information related to human body: anatomy, physiology, biology and bio-mechanics, is an essential element in developing and improving motor performance. Studying the mechanical

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aspect is one of the most important sciences for those who are interested in sports. Using bio-mechanical analysis for sports performances and skills is the scientific basis for developing training and performance programs [3]. In addition, the specification in training refers to focusing on developing the strength of the working muscles in a specific activity. This requires a comprehensive knowledge of the working muscles and requires selecting the suitable training for them. Such training should be similar to real performance [4]. Thus, specific training is a type of training characterized by its specific power in developing physical abilities and technical performance. It is considered one of the most intensive degrees of specification directed, quantitatively, qualitatively and timely, towards instant use of the muscles during the technical performance. Therefore, it is considered a conclusive factor in the successful use of neuro-muscular work involved in this performance [5].

So, the researchers believe that, on the basis of many studies in this field [6-10] despite the recent advances in track and field competitions for disabled athletes, especially Javelin throwing, huge efforts are still needed to reach international levels. This might be achieved in two ways, first by maintaining the highly achieving athletes and second, by spotting and training new athletes using modern technologies and scientific knowledge e.g. analyzing and using the champions' performance as a basis in designing specific training programs.

Since the researchers believe that coaches do not depend on bio-mechanical (kinematic) analysis in designing specific training programs, it might be claimed that there is a lack of designing training programs for motor disabled (F58) in Javelin throwing. Consequently, the researchers proposed a specific training program for motor disabled in Javelin throwing (F58) according to some kinematic criteria and identifying its effect on the Javelin throwing distance.

The current study aims at improving the Javelin throwing distance of motor disabled Athletes (F58) through:

- Identifying the kinematic criteria of the throwing arm in Javelin throwing (F58).
- Proposing a set of specific training, in the light of the kinematic criteria of the throwing arm in Javelin throwing (F58).
- Identifying the effects of specific training on the throwing distance and improving some kinematic criteria for Javelin throwing (F58).

Hypotheses: the Researchers Propose That:

- There are statistically significant differences between the pre- and post- tests on the digital level of throwing distance among motor disabled athletes in Javelin throwing (F58).
- There are statistically significant differences between the pre- and post- tests on some kinematic criteria of Javelin throwing (F58).

MATERIALS AND METHODS

Design: The researchers used a quasi-experimental design: one group (pre-/post-tests design) as it was thought the most suitable for the current study.

Subjects: Athlete "Mahmoud Ramadan El-Attar" (World Champion in Javelin throwing F58 for disabled athletes) was selected to use some of his kinematic criteria in designing the specific training program.
- 8 Javelin throwers F58 from Al-Erada Wa Al-Tahady Sports Club - Kafr El-Shaikh, were purposefully selected to participate in the study.

Data Collection Methods: Special tools for photography and analysis of motor, special tools of javelin throwing and measuring some of the variables under studying and the physical tests.

The Pilot Study: The researchers conducted a pilot study on 3-4/4/2010 to a sample (4 athletes) of the same class (F58) to check on the suitability of the program and the data collection methods for the sample and to check on video taping equipments to be used for kinematic analysis.

Procedures of the Main Study:
Videotaping and Analysis: The researchers videotaped the selected sample at Al-Erada Wa Al-Tahady Sports Club - Kafr El-Shaikh, according to the requirements and needs of kinematic analysis program as the athletes were prepared and phosphoric marks were attached to joint points. The scale was put horizontally inside the shooting range during trials. The researchers used a Panasonic 3000M camera (30 frames/second) fixed on a tripod in the direction of the throwing arm so that the athlete is clearly shown in the cadre. Lens height from the floor was 1.40m and camera distance from athletes was 10m. The researchers also used a video cassette device Panasonic 4700 and raw tapes. After shooting, the best trial for each athlete was chosen for analysis.

Identifying the Kinematic Criteria: Kinematic criteria were identified based on performance analysis of Javelin throwing (F58) and on the existing related literature [6, 10,11-14].

Pre-Tests: for the study variables were conducted on 10-11/4/2010. The researchers applied all pre-conditions for video taping. Each athlete scored three legal trials and the best trial (digital level) was analyzed. All physical measurements of the sample were taken on the day after shooting, so that all athletes have had enough time for recovery before physical measurements.

The Proposed Program: The proposed specific training program was designed based on performance analysis of Javelin throwing (F58) and on existing related literature. The program consisted of 24 units (3 units per week) for 8 weeks. Unit duration ranged from 75-90 minutes] 5,15,16[. The program was applied under direct supervision of the researchers from 17/4/2010 to 9/6/2010 (Appendix 1-3).

Post-Measurements: Post-measurements for the study variables were conducted on 12/6/2010 using the same protocols applied to pre-tests. Row data were collected, stored and statistically analyzed using means, median, SD, squewness, t-test and improvement percentage.

Appendix 1: A model for a weekly specific training program in the javelin throwing for the disabled F58
- Preliminary Part: slowly run from 200 to 300 meters + lengthen and flexible exercises.
- The Main Part: As shown in the table.
- End Part: slowly run + relaxation exercises.

		Variables			
Days	Physical exercises	Intensity	Frequency	Relax	Skill
Saturday	- Carry the Bar on the shoulders from the seating position on the throwing chair and then the player rotates the trunk on both sides.	70%	2 -3 groups	1- 2 minutes	Exercise: 1, 2, 4 from 10-15 numbers
	- A sleep on the back of their hands up in the hands of the Weight and then lift their hands up in front of the chest.		2 -3 groups	1.5- 3 minutes	and of 3- 4 groups
	- Standing, carry weight in hands and the arm is in flexion in the shoulder joint and the elbow joint, then extending the elbow joint to reach the launch position.		3 -4 groups	1- 2 minutes	
Monday	- Carry the Bar on the shoulders from the seating position on the throwing chair and then bend the trunk on both sides.	75%	2 -3 groups	1- 2 minutes	Exercise: 2, 3, 4, 5 from 10- 15 Numbers
	- Asleep on the back of their hands up in the hands of the Weight and then lift their hands up in front of the chest.		2 -3 groups	1.5- 3 minutes	and of 3- 4 groups
	- Standing, carry weight in hands and arm is in the flexion state in the shoulder joint and the elbow joint, then extend the elbow joint to reach the launch position.		3 -4 groups	1- 1.5 minutes	
	- Standing, bending the trunk forward and down keeping the Bar hand is on the ground, then doing the movement of abduction (reaching the high standing arm position).		2 -3 groups	2- 3 minutes	
Wednesday	- Carry the Bar on the shoulders from the seating position on the throwing chair, then the player rotates of the trunk on both sides, with doing the movement of the brake.	80%	2-3 groups	1- 2 minutes	Exercise: 3,5, 6, 7, 8, 10 from 10-15 Numbers andof
	- Standing, carry weight in hands and arm is in the development of arresting on the shoulder joint and the elbow joint, then extend the elbow joint to reach the launch position.		3-4 groups	1- 1.5 minutes	2- 3 groups
	- Standing, carry the Bar on the shoulders, then the player rotates the trunk in the direction of the throwing arm, with folding the knees, then extend the leg wholly with the rotation in the other direction.		3-4 groups	2- 3 minutes	

Appendix 2: The proposed specific trainings in the javelin throwing for the disabled F58
- Trainings for the high of launch point and the angle of the elbow and shoulder:

1- Sitting on the throwing chair, Handle rubber acetic from the behind extended arm, then pull the arm with an emphasis on that the elbow joint leads the movement and not far from the head during the withdrawal of the arm from back to front.
2- The same previous exercise, but with folding the trunk behind during the primary part.
3- The same previous exercise, but with touching the elbow joint to the rubber acetic placed in front of the player at a convenient height (the maximum height can the elbow of the throwing arm reaches at during pulling the arm from back to front).
4- Sitting on the throwing chair-holding the Bar from the position of extending the arm behind, then pulling the arm, with an emphasis on the elbow to lead the movement and not far from the head during the movement from back to front and finish the movement in the flexion of shoulder and elbows' joint.
5- Throwing the Bars from a sitting position on the throwing chair when the arm is behind extended in a try to pass it over a rope in front of the player away of a distance from 5-7 meters.

6- Throw balls of different weights from a sitting position on the throwing chair when the arm is extended behind in a try to pass it over a rope in front of the player away from 5-7 meters
7- Holding a javelin which has been entered from the back into rubber acetic where the other and of the acetic is holding behind the player along the javelin, moving the arm to behind, then pulling the arm and the elbow close to the head referring high slightly with the rotation of the pelvis forward until the end of the movement whereas the carrying arm of the javelin is in the position of flexion in the joints' shoulder and elbow.
8- The player is holding the javelin which is related with the rubber acetic, then from behind extended arm position, he pulls the arm and the elbow close to the head and pointing high slightly then extends the elbow in a related movements until reaching the launch point.
9- Throwing the javelin from the sitting positing on the throwing chair with an emphasis on the withdrawal of the arm from behind and trying to pass the javelin over the rope which is placed in front of the player in the throwing section from 5-7 meters.

Trainings on Launch angle:

10- Throw Bars from a sitting position on throwing arm chair from the position of the behind extended arm in a try to pass it over the high jump bar (setting in the bowling section at a distance of 3-5 meters).
11- Throw Bars from a sitting position on the throwing chair when the arm is extended behind in a try to pass it over a rope in front of the player from 5 to 7 meters.
12- The player is holding the javelin which is related rubber acetic, then extends the arm behind and pulling the arm and elbow near the head, pointing high slightly, then extend the elbow in a related movement until reaching the launch point, to entering the tip of the javelin between two ropes in front of the player and the distance between them is 50 cm.
13- Throwing javelin between two ropes in the front of the player on distance from 3-5 meters, at a convenient height.
14- Throwing javelin in the hanging hoops in front of the player at a distance of 3-5 meters, at a convenient height.

Trainings to speed the movement of the throwing arm:

15- The player is holding rubber acetic from a sitting position on the throwing chair, extend the arm behind and then withdraw the arm quickly from the back to front.
16- Throw lightweight balls with the throwing arm with an emphasis on the speed of withdrawal from back to front.
17- Throwing a light weight javelins with an emphasis on the speed of withdrawing the arm from back to front and the speed of pushing the leg based on the land.
18- Throwing a light weight javelins with an emphasis on the speed of pushing the leg based on the land with the observation of (the full extending of the joints of the leg and entering the pelvis forward) with a quick withdrawal of the arm when the elbow is near the head and points high slightly, such that the movement ends with a great rapid.

Appendix 3: A- some kinematic criteria to champion of the world (Mahmoud Ramadan Al-Attar) in the javelin throw - disabled F58, during the phases of performance

Variable	Measurement	m. preliminary phase	m. Main phase	m. End phase
Resultant velocity of throwing arm	m/s	0.721055	2.722008	1.109638
Resultant acceleration of throwing arm	m/s^2	2.825548	15.19867	21.98187
Resultant velocity of throwing arm hand	m/s	0.806465	3.788892	2.6832
Resultant acceleration of throwing arm hand	m/s^2	3.513255	25.04517	50.13083
Elbow joint angle	deg	179.5871	139.5583	120.6375
Elbow angular velocity	*rad* /sec	4.333333	-86.9792	-274.821
Elbow angular acceleration	*rad* $/sec^2$	-134.698	2212.24	-4078.12
Shoulder joint angle	deg	114.2574	105.1942	109.3375
Shoulder angular velocity	*rad* /sec	32.25	-40.7292	7.142857
Shoulder angular acceleration	*rad* $/sec^2$	-212.716	-227.865	1361.979

B- some kinematic criteria to champion of the world (Mahmoud Ramadan Al-Attar) of the throwing moment and Digital level

Variable	Measurement	The moment of Projection and Digital level
Projection Velocity	m/s	14.46
Projection angle	*O*	37.06
The height of Javelin Projection point	m	1.85
Digital level	m	45.00

RESULTS AND DISCUSSION

The researchers confirmed data moderation on weight, age, training period, digital level, physical variables and kinematic variables at throwing moments besides kinematic criteria of throwing arm movement phases (preliminary - main - end) as shown in Tables 1 and2. It is clear that squewness values ranged between ± 3, indicating data moderation.

Tables 5-7 and Figures 1-3 indicate an improvement percentage between pre- and post- tests on all research variables on p#0.05 for the following criteria: resultant velocity and resultant acceleration of the throwing arm center of gravity - resultant velocity and resultant acceleration of the throwing arm/hand junction. These improvements were clear in all phases of movement (preliminary - main - end). The researchers attributes the results to the importance of these criteria

Table 1: Data moderation on weight, age, training period, digital level, physical variables and kinematic variables at throwing moments

Variable	Measurement	Means	Median	SD	Squewness
Weight	Kg	79.500	79.000	4.175	-0.251
Age Year	20.000	19.500	2.070	1.159	
Age of Training	Year	3.225	3.000	1.211	0.685
Digital level	M	25.138	24.400	2.838	0.649
Upper limp length	cm	93.500	92.500	4.071	0.568
Throwing arm length	cm	79.288	79.325	2.524	0.003
Maximum fist strength	Kg	57.303	56.500	4.542	0.223
Throwing a softball	M	32.678	31.605	3.551	1.398
Arm movement velocity (horizontal)	Number	58.375	57.500	3.889	0.575
Shoulder flexibility	cm	57.125	56.500	4.612	0.616
Trunk turns on both sides	cm	28.000	28.000	2.449	0.233
Trunk backward bend from standing	cm	47.125	46.000	3.758	1.550
Aiming at rectangles with hand	Number	4.625	5.000	0.518	-0.644
Projection velocity	m/s	12.309	12.450	1.094	-0.984
Projection angle	Degree	35.304	35.340	2.777	1.125
The height of Javelin Projection point	M	1.651	1.665	0.090	-0.918

Table 2: Data moderation on kinematic variables

		Preliminary phase				Main phase				End phase			
Variable	Measurement	Means	Median	SD	Squewness	Means	Median	SD	Squewness	Means	Median	SD	Squewness
Resultant velocity of throwing arm	m/s	0.546	0.524	0.175	-0.766	1.884	1.799	0.251	0.384	1.367	1.375	0.234	0.144
Resultant acceleration of throwing arm	m/s^2	2.172	2.083	0.771	0.723	12.289	12.260	1.740	-0.308	17.383	18.761	4.056	-1.032
Resultant velocity of throwing arm hand	m/s	0.608	0.631	0.185	-0.869	2.915	2.841	0.498	1.033	2.137	2.004	0.514	1.072
Resultant acceleration of throwing arm hand	m/s^2	2.890	2.744	0.487	0.648	18.171	17.293	3.290	0.621	31.336	31.525	7.205	0.310
Elbow joint angle	deg	163.746	163.479	9.503	1.280	128.719	127.563	12.174	0.125	157.058	160.675	11.224	-0.797
Elbow angular velocity	*rad* / sec	3.487	3.089	2.063	0.670	20.148	19.105	6.879	-0.046	61.429	59.861	17.107	0.516
Elbow angular acceleration	*rad* / sec^2	48.811	53.257	17.035	-0.850	1489.250	1419.470	368.760	-1.056	2363.990	2258.290	769.82	-0.108
Shoulder joint angle	deg	97.539	96.585	9.952	-0.275	99.706	98.735	4.635	0.675	94.397	99.470	16.032	-0.368
Shoulder angular velocity	*rad* / sec	32.309	32.555	6.122	0.135	56.040	52.708	16.429	2.210	38.165	25.336	32.022	0.615
Shoulder angular acceleration	*rad* / sec^2	115.993	110.225	19.964	0.607	249.634	205.140	100.940	1.518	337.654	281.137	162.17	1.406

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Table 4: Some kinematic criteria to champion of the world (Mahmoud Ramadan Al-Attar) of the throwing moment and digital level

Variable	Measurement	The moment of Projection and Digital level
Projection Velocity	m/s	14.46
Projection angle	*O*	37.06
The height of Javelin Projection point	m	1.85
Digital level	m	45.00

Table 5: Means, SD, (t) test and improvement percentage on some kinematic criteria between pre- and post- tests (preliminary phase)

		Pre-test		Post-test		Means difference			
Variable	Measurement	Means	SD	Means	SD	Means	SD	(t)	%
Resultant velocity of throwing arm	m/s	0.546	0.175	0.751	0.087	0.205	0.217	2.662*	37.469
Resultant acceleration of throwing arm	m/s^2	2.172	0.771	3.321	0.854	1.150	1.065	3.053*	52.936
Resultant velocity of throwing arm hand	m/s	0.608	0.185	0.797	0.081	0.189	0.201	2.653*	31.003
Resultant acceleration of throwing arm hand	m/s^2	2.890	0.487	3.522	0.609	0.632	0.646	2.765*	21.858
Elbow joint angle	deg	163.746	9.503	171.615	9.258	7.869	10.577	2.104	4.805
Elbow angular velocity	*rad* / sec	3.487	2.063	14.128	6.798	10.640	8.147	3.694*	305.122
Elbow angular acceleration	*rad* / sec^2	48.811	17.035	186.485	37.846	137.670	37.855	10.287*	282.055
Shoulder joint angle	deg	97.539	9.952	106.011	10.622	8.472	15.944	1.503	8.686
Shoulder angular velocity	*rad* / sec	32.309	6.122	35.507	12.613	3.198	12.995	0.696	9.897
Shoulder angular acceleration	*rad* / sec^2	115.993	19.964	180.559	28.459	64.567	40.770	4.479*	55.665

*Significance on p# 0.05 = 2.36

Table 6: Means, SD, (t) test and improvement percentage on some kinematic criteria between pre- and post- tests (main phase)

		Pre-test		Post-test		Means difference			
Variable	Measurement	Means	SD	Means	SD	Means	SD	(t)	%
Resultant velocity of throwing arm	m/s	1.884	0.251	2.423	0.347	0.540	0.478	3.197*	28.663
Resultant acceleration of throwing arm	m/s^2	12.289	1.740	17.037	2.859	4.748	1.927	6.969*	38.634
Resultant velocity of throwing arm hand	m/s	2.915	0.498	3.662	0.512	0.747	0.617	3.423*	25.633
Resultant acceleration of throwing arm hand	m/s^2	18.171	3.290	25.206	3.284	7.035	4.990	3.987*	38.717
Elbow joint angle	deg	128.719	12.174	144.086	14.994	15.367	23.176	1.875	11.938
Elbow angular velocity	*rad* / sec	20.148	6.879	55.954	21.108	35.807	23.704	4.272*	177.722
Elbow angular acceleration	*rad* / sec^2	1489.250	368.750	1927.060	569.005	437.810	647.610	1.912	29.398
Shoulder joint angle	deg	99.706	4.635	97.898	9.037	1.808	8.251	0.620	1.813
Shoulder angular velocity	*rad* / sec	56.040	16.429	55.932	20.733	0.108	23.287	0.013	0.192
Shoulder angular acceleration	*rad* / sec^2	249.634	100.940	1017.170	315.720	767.540	276.930	7.839*	307.468

*Significance on p#0.05 = 2.36

Table 7: Means, SD, (t) test and improvement percentage on some kinematic criteria between pre- and post- tests (end phase)

		Pre-test		Post-test		Means difference			
Variable	Measurement	Means	SD	Means	SD	Means	SD	(t)	%
Resultant velocity of throwing arm	m/s	1.367	0.234	2.502	0.956	1.135	1.063	3.018*	82.969
Resultant acceleration of throwing arm	m/s^2	17.383	4.056	26.065	9.767	8.683	10.720	2.291*	49.950
Resultant velocity of throwing arm hand	m/s	2.137	0.514	4.475	2.098	2.338	2.184	3.029*	109.425
Resultant acceleration of throwing arm hand	m/s^2	31.336	7.205	51.917	17.149	20.580	17.823	3.266*	65.675
Elbow joint angle	deg	157.058	11.224	159.443	24.226	2.384	25.381	0.266	1.518
Elbow angular velocity	*rad* /sec	61.429	17.107	190.605	62.697	129.170	69.914	5.226*	210.287
Elbow angular acceleration	*rad* /sec^2	2363.990	769.810	2713.900	1113.150	349.910	1247.90	0.793	14.802
Shoulder joint angle	deg	94.397	16.032	113.288	15.546	18.891	28.822	1.854	20.012
Shoulder angular velocity	*rad* /sec	38.165	32.022	148.670	56.734	110.510	64.661	4.834*	289.550
Shoulder angular acceleration	*rad* /sec^2	337.654	162.170	1244.920	307.425	907.270	275.68	9.308*	268.698

*Significance on p#0.05 = 2.36

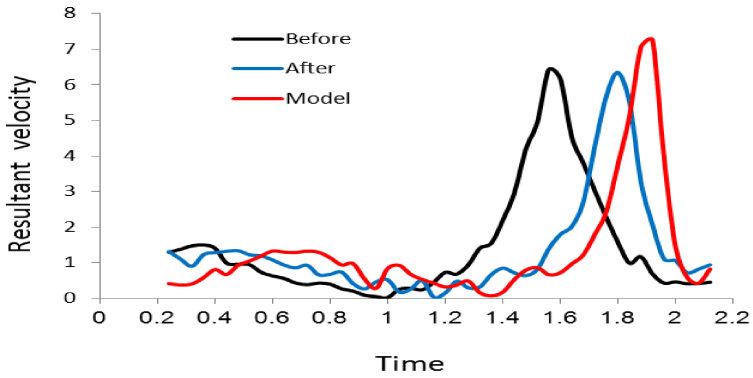

Fig. 1: Resultant velocity dynamics for throwing arm center of gravity (pre-test- post-test - ideal performance)

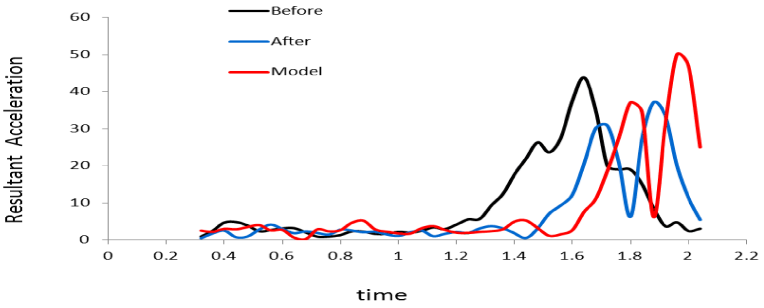

Fig. 2: Resultant acceleration dynamics for throwing arm center of gravity (pretest- post-test - ideal performance)

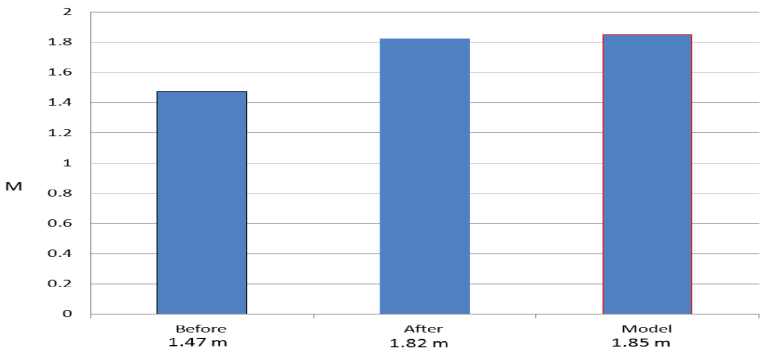

Fig. 3: The height of Javelin Projection point (pre-test - post-test - ideal performance)

during the motor path, as the proposed training program included exercises performed on the same movement path of Javelin throwing, but performed with various tools that affect the throwing arm velocity and acceleration. These results are consistent with previous studies [11, 17] which indicated that the resultant velocity and the resultant acceleration of the throwing arm are very important kinematic criteria affecting the throwing distance. This result is also equivalent with some researches [13, 18, 19] that indicated that the exercises which include throwing light and various tools at the same motor path of Javelin throwing have a very important effect on improving the resultant velocity and resultant acceleration of the throwing arm.

Table 5 shows statistical significant differences between the pre- and post- tests on angular velocity and angular acceleration of the elbow joint and angular acceleration of the shoulder joint during the preliminary phase, in favor of post tests. Table 6 shows statistically significant differences between the pre- and post- tests on angular velocity of the elbow joint and angular acceleration of the shoulder joint during the main phase, in favor of post tests. Table 7 indicates statistically significant differences between the pre- and post- tests on angular velocity of the elbow joint and angular velocity and angular acceleration of the shoulder joint during the end phase, in favor of post tests. This is due to the exercises performed on the same movement path of

Table 8: Means, SD, (t) test and improvement percentage on some kinematic criteria of the throwing moment and digital level between pre- and post- tests

		Pre-test		Post-test		Means difference			
Variable	Measurement	Means	SD	Means	SD	Means	SD	(t)	%
Projection Velocity	m/s	12.309	1.094	14.766	1.379	2.458	1.864	3.728*	19.965
Projection angle	*O*	35.304	2.777	39.799	2.403	4.495	3.606	3.526*	12.732
The height of Javelin Projection point	m	1.651	0.090	1.943	0.161	0.291	0.202	4.082*	17.638
Digital level	m	25.138	2.838	29.988	3.780	4.850	3.837	3.575*	19.294

*Significance on p#0.05 = 2.36

Javelin throwing in the proposed program that helped improving angular velocity and angular acceleration of both elbow and shoulder joints. This result is in consistence with previous studies [18, 19, 20] which indicated that training with light and various tools on the same motor path of Javelin throwing like throwing over ropes fixed on suitable heights, or throwing through hops improves the throwing arm angles and, thus improves angular velocity and angular acceleration of arm joints.

Table 8 shows statistical significant differences between the pre- and post- tests on p#0.05 for projection velocity, projection angle, height of Javelin projection point and digital level, in favor of the post-tests. This is due to the included specific exercises. These results are in consistence with previous researches [18, 20] which indicated that training exercises on the same motor path of Javelin throwing like throwing over ropes fixed on suitable heights, or throwing through hops improves the launch velocity and digital level. This is also in consistence with Al-Sokary [19] which indicated that training with light and various tools on the same motor path of Javelin throwing improves the performance technique and this, in turn, increases throwing arm velocity and consequently launch velocity. All this improve the digital level of Javelin throwing.

CONCLUSION

Based on the above mentioned information, the researchers concluded the following:

- Using the proposed specific training program, based on kinematic analysis led to significant improvements on the digital level between pre- and post-tests, in favor of post-tests of the study sample.
- Using the proposed specific training program, based on kinematic analysis led to significant improvements on the resultant velocity and resultant acceleration of the throwing arm center of gravity and resultant velocity and resultant acceleration of the throwing arm/hand junction between pre- and post-tests, in favor of post-tests of the study sample.
- Using the proposed specific training program, based on kinematic analysis led to significant improvements on angular velocity and angular acceleration of elbow joint and angular acceleration of shoulder joint (preliminary phase), angular velocity of elbow joint and angular acceleration of shoulder joint (main phase) and angular velocity of elbow joint and angular velocity and angular acceleration of shoulder joint (end phase), in favor of the post-tests of the study sample.
- Using the recommended training program, based on kinematic analysis led to significant improvements on Projection velocity, Projection angle and height of Javelin Projection point, in favor of post-tests of the study sample.

Recommendations:

Based on the study results, the researchers recommend the following:

- Using the kinematic criteria of the throwing arm during performance phases (preliminary - main - end) of Javelin throwing, as indicators in Javelin throwing for the motor disabled athletes (sitting).
- Using specific training in Javelin throwing of motor disabled athletes at different classes (beginners-advanced).
- Using the proposed specific training program, based on kinematic analysis as a guide for developing similar programs in Javelin throwing of motor disabled athletes.

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