

Effects of

Ballistic Training on

The Muscular Ability

And Digital Level

Of Long Jump Athletes

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Abstract

The current research aims at designing a ballistic training program for long jumpers, identifying the effects of a ballistic training program on the digital level of long jump and identifying the difference between the experimental and control groups on the digital level of long jump. The researchers used the quasi-experimental approach (two-group design) with experimental and control groups. Research community includes long jumpers from Kafr Al-Shaikh Sports Club, Kafr Al-Shaikh Youth Center and Meet Elwan Youth Center during 2012 season. Sample included (20) athletes divided into two groups (10 athletes each). Another (14) athletes from the same research community and outside the main sample were chosen as a pilot sample. The researchers conclude that the ballistic training overcomes the defects of lack of velocity due to traditional weight training. In addition, the nature of performing ballistic training is closer to real long jump performance. The recommended ballistic training program has positive effects on the maximum muscular ability of leg muscles. The recommended ballistic training program has positive effects on the digital record of the experimental group, compared to the control group

Background and Research Problem:

Advances in the results of international and Olympic championships is clear through the international achievements of champions of various sports, especially digital sports – against either time or distance. It is also clear through modern methods of sports training.

Esam Abd El-Khalek (1990) indicated that sports' training is an educational process based on scientific bases and educational rules that aim at reaching the highest possible levels in the athletic activity and improving the physical, motor, psychological and mental abilities of the athlete (9)

Mohamed Abd El-Ghany Othman (1994) indicated that sports training is “a well-planned process, performed through repetitive muscular work (physical load) and aims at improving the performance level. This process results in physical, functional, psychological and mental changes as load intensity vary from one person to another”. Accordingly, Ali Al-Beek (1988) indicated that planned training is a means through which we can evaluate the athlete's condition to set goals, methods and equipments needed, in addition to identifying the program components

and follow-up tests to achieve the set goals (15, 10).

Mohamed Abd El-Ghany Othman (1990) and Kasem Hasan Hussain (1990) agreed that specific physical abilities of jumping events are speed strength, maximum power and speed (14, 12).

Stone (1998) indicated that muscular strength is one of the physical elements that influence the performance characteristics for each of the performance phase. The body moves by these muscles that contract to direct the limbs from one place to another. The more powerful these muscles are, the more efficient the counteractions are. Improving strength can be done through two methods; first, increasing the physiological cross-section and the second is improving the contraction speed through improving coordination level of the agonist and antagonist muscles towards improving the synchronization of muscle fibers (21).

Burke (2001) showed that any sports movement is characterized by a muscular contraction phase with elongation, followed by a muscular contraction phase with shortening. This includes throwing and jumping skills. To train muscular strength, we should maintain the internal motor energy, through which we switch to muscular contraction phase with shortening as fast as possible. This switch is called maximal muscular power. The ability to generate this kind of muscular power is related, in the first place, with the methods of improving speed strength, among which is the ballistic training (18).

This is in agreement with Mohamed Hassan Allawy (1994) and Adel Abd El-

Baseer (1992) in that muscular strength is closely related to improving motor skills. Strength training programs are the best ways to improve sports performance. Performance in all sports activities depends on the contractile efficiency of muscles as the more powerful the muscle is, the more efficient the contractions are. Strength training programs should include more than mere lifting more weights as it should include modern training methods suitable for various kinds of specific muscular work (13, 6).

Ballistic training is an effective training method that not less effective or less positive than other training methods (weight – plyometrics) on the muscular ability of track and field athletes in general, and especially long jumpers. It includes explosive movements against resistance with maximum speed. This includes light weight lifting with max speeds. This maintains the specific motor coordination ability of long jump (17).

Kent (1998) indicated that ballistic training goes through three phases (inward shortening contraction towards the center – smooth movement that depends on max pushing force during the beginning of a jump – decrease of speed concurrent with outwards elongating contraction away from the center) (22).

Newton et al (1996) and Kerry & Newton (1998) indicated that ballistic resistance training includes movements against resistance with maximum speed and is a relatively modern training method that links plyometrics with weight training as it includes lifting light weights with high speed (23, 20).

Ahmed Farouk (2003) indicated that ballistic training has no phase for speed decrease. Therefore, it maintains specific coordination for most sports. Ballistic training begins relatively late in the training plan as it needs specific preparation with light resistances to strengthen tendons and ligaments. Finally, there is a lack of understanding concerning the improvement of muscular strength in most sports as the main aim is not to increase muscular strength. On the contrary, the main aim is to improve the sports performance. Therefore, coaches should consider this when designing physical preparation programs for their athletes (1).

The current research problem is clear in that the research sample members practice regularly without any noticeable improvement in their performance level. The researchers think that this is due to the inconvenience of the designed training program for those athletes' physical needs that help improving their digital level. This led the researchers to use ballistic training to improve muscular strength through a well-designed training program in a try to improve the digital level of long jumpers.

Research Aims:

The current research aims at:

Designing a ballistic training program for long jumpers.

Identifying the effects of a ballistic training program on the digital level of long jump.

Identifying the difference between the experimental and control groups on the digital level of long jump.

Research Hypotheses:

There are statistically significant differences between the pre- and post-measurements of the control group on all physical variables and the digital level in favor of the post-measurements.

There are statistically significant differences between the pre- and post-measurements of the experimental group on all physical variables and the digital level in favor of the post-measurements.

There are statistically significant differences between the post-measurements of the control and experimental groups on all physical variables and the digital level in favor of the experimental group.

Methods:

Approach:

The researchers used the quasi-experimental approach (two-group design) with experimental and control groups.

Subjects:

Research community includes long jumpers from Kafr Al-Shaikh Sports Club, Kafr Al-Shaikh Youth Center and Meet Elwan Youth Center during 2012 season. Sample included (20) athletes divided into two groups (10 athletes each). Another (14) athletes from the same research community and outside the main sample were chosen as a pilot sample.

Table (1)
Homogeneity between the two groups on all research variables (n=20)

Variables	Measurement	Mean	Median	SD	Sqewness
Growth Indicators					
<i>Age</i>	<i>Year / month</i>	<i>19.80</i>	<i>19.90</i>	<i>1.42</i>	<i>- 0.21</i>
<i>Training period</i>	<i>Year / month</i>	<i>7.16</i>	<i>7.00</i>	<i>0.83</i>	<i>0.77</i>
Physical variables					
<i>Vertical jump</i>	<i>Cm</i>	<i>29.80</i>	<i>29.62</i>	<i>2.89</i>	<i>0.18</i>
<i>Wide jump</i>	<i>M</i>	<i>1.98</i>	<i>1.85</i>	<i>0.76</i>	<i>0.51</i>
<i>30m running from flight</i>	<i>Sec</i>	<i>4.31</i>	<i>4.38</i>	<i>0.87</i>	<i>-0.24</i>
<i>3 hops right</i>	<i>M</i>	<i>4.23</i>	<i>4.13</i>	<i>0.84</i>	<i>0.35</i>
<i>3 hops left</i>	<i>M</i>	<i>4.05</i>	<i>3.91</i>	<i>0.76</i>	<i>0.55</i>
<i>30 sec sit-up</i>	<i>N</i>	<i>29.84</i>	<i>29.93</i>	<i>2.88</i>	<i>-0.10</i>
Anthropometric variables					
<i>Height</i>	<i>M</i>	<i>1.76</i>	<i>1.79</i>	<i>1.65</i>	<i>-0.05</i>
<i>Lower limb length</i>	<i>M</i>	<i>1.06</i>	<i>1.11</i>	<i>0.83</i>	<i>-0.18</i>
<i>Weight</i>	<i>Kg</i>	<i>76.84</i>	<i>75.74</i>	<i>6.84</i>	<i>0.48</i>
<i>Digital record</i>	<i>M</i>	<i>4.91</i>	<i>4.87</i>	<i>0.64</i>	<i>0.19</i>

Table (1) : indicates that sqewness values were between (3±). This indicates sample homogeneity.

Table (2):

Difference significance between the two groups on all research variables (pre-measurements)

Variables	Experimental		Control		Difference	(t)
	Mean	SD	Mean	SD		
Growth Indicators						
Age	16.75	1.12	16.85	1.32	0.10	0.17
Training period	3.14	0.49	3.18	0.62	0.04	0.15
Physical variables						
Vertical jump	30.13	2.42	29.46	3.18	0.67	0.50
Wide jump	1.85	0.64	2.05	0.45	0.20	0.77
30m running from flight	4.36	0.49	4.26	0.52	0.10	0.41
3 hops right	4.25	0.52	4.20	0.38	0.05	0.23
3 hops left	4.00	0.44	4.10	0.51	0.10	0.45
30 sec sit-up	30.14	2.78	29.54	2.51	0.60	0.41
Anthropometric variables						
Height	1.77	1.23	1.75	1.38	0.02	0.03
Lower limb length	1.05	0.59	1.07	0.49	0.02	0.25
Weight	76.61	5.55	77.06	5.71	0.45	0.17
Digital record	4.90	0.40	4.92	0.49	0.02	0.09

Table (2)

indicates no statistically significant differences between the two groups on all research variables for the pre- measurements as (t) table value (2.10) was higher than its calculated values (between 0.03 and 0.77). This indicates sample homogeneity.

Tools and equipments:

The researchers used the following tools and equipments:

A medical balance for measuring weights

A restameter for measuring heights

Jumping hole

Measuring tape

Free weights

Weight machines

Data recording form

Stop watch

The recommended program

Physical Measurements:

Through review of literature (Al-Sisy 2002, Fleck & Kramer 2004, Mahrous 2004), the researchers found out that the most important physical components for long jump are Speed strength, Transitive speed, Maximum strength and Agility (2, 19, 8, 16).

The researchers identified he physical tests for measuring the specific characteristics of long jump through reviewing the studies of Ahmed Maher (1983), Mo-

hamed Gaber (1994) and Ahmed Ebraheem (2004) (20, 21, 22). These tests are as follows:

- 1- Vertical jump from stance
- 2- Wide jump from stance (for measuring explosive power)
- 3- 30m running from flight (for measuring speed)
- 4- 3 consecutive hops with right leg
- 5- 3 consecutive hops with left leg
- 6- 30 seconds setups

Table (3):
difference significant between the distinguished and non-distinguished groups for calculating distinguishing validity for the pilot sample

(n1 = n2 = 7)

Variables	distinguished		non-distinguished		Difference	(t) value
	Mean	SD±	Mean	SD±		
Vertical jump	35.15	1.68	27.32	2.16	7.83	7.75*
Wide jump	2.42	0.41	1.61	0.53	0.81	3.01*
30m running from flight	3.91	0.33	4.77	0.37	0.86	4.30*
3 hops right	4.83	0.48	3.93	0.58	0.90	3.00*
3 hops left	4.46	0.32	3.72	0.44	0.74	3.36*
30 sec sit-up	37.89	2.84	28.33	2.36	9.56	6.37*

(t) table value on $P \leq 0.05 = 2.17$

Table (3) indicates statistically significant differences on all physical tests between the two groups in favor of the distinguished group as (t) table value was

less than the calculated values (ranging between 3 and 7.75). this indicates the tests validity.

Table (4):

correlation coefficient between test and re-test for calculating tests reliability on the pilot sample

(n=14)

Variables	Test		Re-test		R
	Mean	SD±	Mean	SD±	
Vertical jump	31.24	2.03	31.36	1.73	0.89*
Wide jump	2.02	0.64	2.06	0.72	0.91*
30m running from flight	4.34	0.42	4.29	0.38	0.92*
3 hops right	4.38	0.53	4.44	0.64	0.88*
3 hops left	4.09	0.57	4.15	0.56	0.90*
30 sec sit-up	33.11	3.25	33.45	2.61	0.87*

(r) table value on $P \leq 0.05 = 0.53$

Table (4)

indicates statistically significant correlations between test and re-test as (r) calculated values (0.87 to 0.92) was higher than its table value. This indicates tests reliability.

Aims of the training program:

- 1- Improving physical fitness
- 2- Improving technical performance of long jump phases
- 3- Increasing the beginners' abilities and facilitating their moves during technical performance
- 4- Strengthening most body muscles to work as far as possible
- 5- Acquiring special endurance strength and the feel of speed
- 6- Improving the flight trajectory and good landing

Bases of the training program:

Considering the continuous relations among load variables (intensity – volume – rest)

Prioritizing the training unit's aims and duties

Considering coordination and correlation among training units

Considering the gradual progression of loads and rotation between high and low loads according to progression principle

Mohamed H. Alaawy (1994), Talha Hosam El-Din (1997), Turner et al (2003) and Emad El-Din Abbas & Ali

Fahmy Al-Beek (2003) agreed that muscular strength evolves quickly as training for several weeks helps in increasing and improving it. Eight weeks of training is enough for reaching a measurable level of muscular strength. They indicated that duration of 60-90 minutes for the training unit is enough according to the number of weeks mentioned above (13, 5, 24, 11).

Fleck & Kramer (2004) indicated that the ballistic training units should not exceed 3 units per week so that muscles and joints can get full recovery before the following unit as this type of training is characterized by high intensity that overloads all parts of the body (19)

Accordingly, the researchers applied the training program for eight weeks (3 units per week) so that total number of units is (24) and each unit's duration is between 75 and 90 minutes. The researchers considered improving the maximum muscular strength before applying the program through a set of weight exercises as a condition for effective use of ballistic training. Through these exercises, the muscles become more able to tolerate any sudden changes in both power and speed.

Table (5):
load intensity of the training program

<i>Load intensity</i>	<i>Intensity (%)</i>	<i>Repetitions</i>
<i>Maximum</i>	<i>95 : 100</i>	<i>1 – 2</i>
<i>Sub-maximum</i>	<i>85 : 94</i>	<i>2 – 4</i>
<i>High</i>	<i>75 : 84</i>	<i>4 – 6</i>
<i>Moderate</i>	<i>65 : 74</i>	<i>6 – 8</i>
<i>Light</i>	<i>55 : 64</i>	<i>8 – 12</i>
<i>Low</i>	<i>More than 30</i>	<i>12 - 20</i>

Training loads for the recommended program:

Intensity:

Fleck & Kramer (2004) indicated that intensity of ballistic training should be between 30% and 40% of 1RM of weight training so that this weight does not affect the speed of muscle contraction negatively, causing injuries. For free weights, they also indicated that training intensity is identified through the weight of tool itself. As for medical balls this weight is between 2 to 6 kg and for kettle-bells this weight is between 5 to 10 kg (19).

Volume:

The suitable volume of ballistic training is 10:12 reps for 3:5 sets with rest intervals 2:3 minutes between sets. As for free weights, they indicated that the suitable volume is 10:15 reps for 1:3 sets with rest intervals 2:3 minutes between sets.

The researchers considered the age group of sample and their fitness levels. They also considered the progression principle. Intensities are set according to the following table:

The Training Unit:

Warm-up:

This part is to prepare the muscles and cardio-pulmonary system to the type of work to be performed during the unit, with special attention to stretches and flexibility exercises. This part takes (15-20 minutes with load 20-30% of the main unit load.

Main part:

This part includes ballistic exercises (the main aim of the unit) that work on improving muscular ability and some mechanical characteristics of the spear throwing arm. This part represents 75% of the unit duration. There will be (15) minutes at the beginning for training spear throwing techniques in only one unit each week.

Concluding part:

This part includes cool down through jogging and relaxation exercises for 5-10 minutes, according to the load intensity used. Appendix (2) includes the full recommended ballistic training program.

Main application:

The researchers applied the recommended program to the study groups from 15-6-2012 to 10-8-2012 (8 weeks / 3 units per week). Application was done in Kafr El-Shaikh Stadium.

Statistical treatments:

The researchers used SPSS software to calculate the following: mean – median – standard deviation – skewness – correlation coefficient – (t) test – percentage.

Results and Discussion:

Table (6):

difference significant between the pre- and post-measurements on all research variables for the experimental group

Variables	Pre-		Post-		Difference	Error	(t) value	Improvement percentage (%)
	Mean	SD±	Mean	SD±				
Vertical jump	30.13	2.42	36.31	1.38	6.18	2.26	2.73*	20.51
Wide jump	1.85	0.64	2.50	0.37	0.65	0.21	3.1*	35.14
30m running from flight	4.36	0.49	3.88	0.32	0.48	0.08	6.00*	11.01
3 hops right	4.25	0.52	4.80	0.47	0.55	0.15	3.67*	12.94
3 hops left	4.00	0.44	4.50	0.31	0.50	0.11	4.55*	12.50
30 sec sit-up	30.14	2.78	39.02	4.52	8.88	2.28	3.89*	29.46
Digital record	4.90	0.40	5.94	0.54	1.04	0.12	8.66*	21.22

The Muscular Ability And Digital Level Of Long Jump Athletes

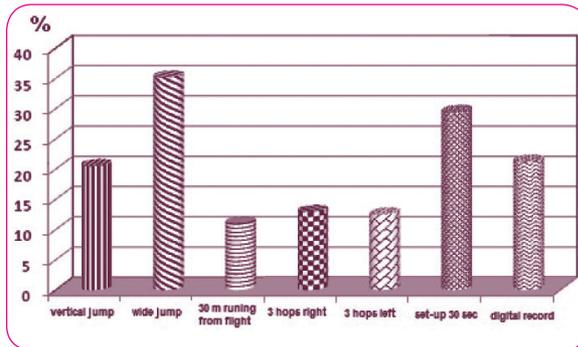


Fig.1: improvement percentages between the pre- and post- measurements on all research variables for the experimental group

Table (6) and figure (1) indicate statistically significant differences between the pre- and post-measurements of the experimental group on all research variables in favor of the post-measurements. The percentage of improvement ranged between (11.01%) (30m running from flight) and (35.14%) (Wide jump). The digital record improvement percentage was (21.22%). This is due to the ballistic training program. The researchers think that these results indicate the effectiveness of ballistic exercises in improving muscular ability of

legs muscles and the digital record of long jump athletes. Each phase has a relative importance in jumping distance and the approach and take off phases are the most important (3, 4).

Fulfilling the specific mechanical criteria (speed – angle – height) of the start has specific importance in identifying the total jumping distance (3, 16, 7)

Physical variables play a major role in improving the digital record. This is clear from the differences between the pre- and post-measurements.

Table (7): difference significant between the pre- and post-measurements on all research variables for the control group

Variables	Pre-		Post-		Difference	Error	(t) value	Improvement percentage (%)
	Mean	SD±	Mean	SD±				
Vertical jump	29.46	3.18	33.03	2.37	3.57	1.37	2.6*	12.12
Wide jump	2.05	0.45	2.22	0.32	0.17	0.12	1.41	8.29
30m running from flight	4.26	0.52	4.09	0.33	0.17	0.31	0.54	4.00
3 hops right	4.20	0.38	4.45	0.41	0.25	0.10	2.50*	5.95
3 hops left	4.10	0.51	4.20	0.39	0.10	0.05	2.00*	2.44
30 sec sit-up	29.54	2.51	33.00	4.28	3.46	2.01	1.72	11.71
Digital record	4.92	0.49	5.38	0.53	0.46	0.09	5.11*	9.35

(t) table value on $P \leq 0.05 = 1.83$

Fig.2:
improvement percentages between the pre- and post- measurements on all research variables for the control group

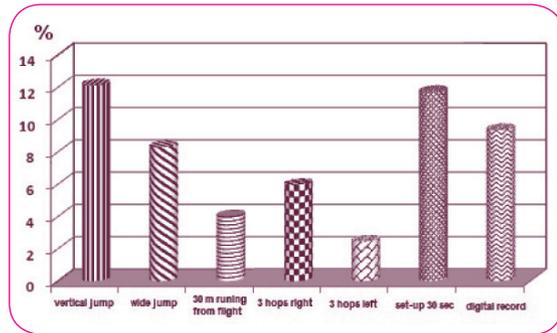


Table (7) and figure (2) indicate statistically significant differences between the pre- and post-measurements of the control group on all research variables in favor of the post-measurements as (t) calculated values ranged between (0.54 and 2.6) while its value was (5.11) for the digital record. This indicates that 30m running from flight and set-up for 30 seconds did not improve as the positive effect of the program was not complete. The percentage of improvement ranged between (2.44%)

(3 hops left) and (12.12%) (vertical jump). The digital record improvement percentage was (9.35%). This is due to the regular training program. The researchers think that the regular training program used for the control group has some positive effects due to athletes' punctuality and the coach's directions about the technical steps of performing the skill. These differences can also be due to the sound bases of designing the regular program. This is in agreement with Esam Abd El-Khalek (9).

Table (8):
difference significant between the post-measurements on all research variables for the experimental and control group

Variables	Experimental		Control		Difference	(t) value	Improvement percentage (%)
	Mean	SD±	Mean	SD±			
Vertical jump	36.31	1.38	33.03	2.37	3.28	3.60*	8.39
Wide jump	2.50	0.37	2.22	0.32	0.28	1.75*	26.85
30m running from flight	3.88	0.32	4.09	0.33	0.21	1.40	7.01
3 hops right	4.80	0.47	4.45	0.41	0.35	1.74*	6.99
3 hops left	4.50	0.31	4.20	0.39	0.30	1.87*	10.06
30 sec sit-up	39.02	4.52	33.00	4.28	6.02	2.90*	17.75
Digital record	5.94	0.54	5.38	0.53	0.56	2.24*	11.87

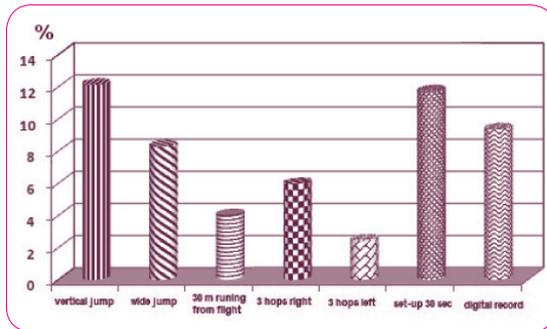


Fig.3:
*improvement percent-
ages between the post-
measurements on all
research variables for the
experimental and control
groups*

Table (8) and figure (3) indicate statistically significant differences between the post-measurements of the experimental and control groups on all research variables in favor of the experimental group. (t) values ranged between (1.40 and 3.60) and (2.24) for the digital record. This indicates no statistically significant differences on 30m running from flight. The percentage of improvement ranged between (6.99%) (3 hops right) and (26.85%) (Wide jump). The digital record improvement percentage was (11.87%). This is due to the ballistic training program and its superiority over the regular program. The researchers think that these results indicate the effectiveness of ballistic exercises in improving muscular ability of legs muscles and the digital record of long jump athletes. This is in agreement with various previous studies (2, 1, 19, 8).

Conclusions:

The researchers conclude that:

1- The ballistic training overcomes the defects of lack of velocity due to traditional weight training. In addition,

the nature of performing ballistic training is closer to real long jump performance

2- The recommended ballistic training program has positive effects on the maximum muscular ability of leg muscles

3- The recommended ballistic training program has positive effects on the digital record of the experimental group, compared to the control group.

Recommendations:

The researchers recommend the following:

1- Using the ballistic training program for long jump as it very important in improving maximum power

2- Using the content of the ballistic recommended program to design similar programs using various tools and calibrating the training loads of this type

3- Providing necessary equipments for ballistic training according to safety rules and regulations.

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