Effect of Using Cross-Training on Improving Power Endurance, Aerobic Endurance and the Digital Records of Long-Distance Runners

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Abstract: The current research aims at designing a training program using cross-training and identifying the effects of using cross-training on improving the strength endurance, aerobic endurance and the technical performance level of long distance runners at The Northern Borders University, Saudi Arabia. The researcher used the quasi-experimental approach (one-group design) with pre and post- measurements. Sample (n=10) was randomly chosen from long distance runners at The Northern Borders University. The researcher concluded that the recommended training program improved the power endurance rates that ranged between 23.64% and 69.35% (for bent-knees sit up and leg curl respectively). The recommended training program improved the aerobic endurance rates that ranged between 30.77% and 50% (for VO2 max [absolute] test and Cooper test respectively). The recommended training program improved the aerobic endurance rates (33.89% for absolute values and 43.36% for relative values), power endurance rates came first and then came aerobic endurance rates. The recommended training program improved the digital records between pre and post- measurements (11.25%)

Key words: Cross-Training %Power Endurance %Aerobic Endurance %Long Distance Runners

INTRODUCTION

Sports training is a major part of the sports preparation process as it is a physical and educational process based on exercises to improve the physical preparation components necessary for achieving the highest possible level in sports, through various methods of training and various means of load formation and rest intervals. It concentrates on specific physical and psychological aspects in each sport [1].

The transitive phase enables the athlete to continue training in the future. When the athlete enjoys the alternative activities, his/ her body will be stronger, his/her mind will be clearer and, in the up-coming training season, his/her motor performance will be higher [2-4]. Training interruption has passive effects over training, especially in competitive sports that depend on muscular strength, flexibility, reaction speed, agility and power. Athletes in such sports may lose, in a very short period of activity or training technique other than the main sport of time, a high percentage of their physical and technical adaptations that were built with regular training for prolonged periods of time [5, 6].

Among the various methods of sports training, cross-training is relatively new. Some advocates of this type of training argued that it is the ideal and most plausible solution according to its inclusiveness and variance. Other thinks that it contradicts with the training specialty principle. But most authors agreed that it can be used during the preparation and competition (transitive) phases to break the stillness of specific training programs as this type of training depends on various integrative activities that enables more mental relaxation. Cross-training is a type of training that includes various sports activities that can be planned to improve the physical level and other physiological variables through variety and decreasing injury risks in addition to excitement [7]. It is a prolonged type of training that includes various sports activities that aim at increasing variation and decreasing injury risks while improving physical fitness components. This is done through using another sport, activity or training technique other than the main sport of the athlete to help him/her improving the main sport [3, 4, 8]. It has enormous positive effects on aerobic and anaerobic endurance of athletes in addition to improving...
strength, flexibility and agility. These components improve the original performance of the main sport. It also improves the cardio-vascular capacity to provide muscles with necessary oxygen [4].

Sports activities vary in energy demands and the speed of using such energy like long-distance running and long-distance swimming that depend on aerobic power system. On the other hand, there are activities that depend on huge amounts of energy in very short durations that is they depend on anaerobic power system [3]. Due to the importance of muscular strength and flexibility, that most sports activities with explosive moves depend on, there are various cross-training activities that can overload muscles through exposing them to higher-than-normal exertion [8]. Cross-training is a training method that helps improving competitiveness of the main sport in addition to avoiding over training and burn-out. Integrating cross-training in daily training routine increases the working power and muscular balance, in addition to increasing the total volume of aerobic and anaerobic training and improving the cardio-vascular capacity, muscle strength, flexibility and speed [7, 9, 10].

As a lecturer at The Northern Borders University, the researcher noticed that students are not willing to involve in track and field competitions due to the lack of sports culture at this area and the lack of sports facilities as there is only one sports club. In addition, the training programs of track and field lack excitement and this led students to leave training.

Aims: The current research aims at:

C Designing a training program using cross-training.
C Identifying the effects of using cross-training on improving the strength endurance and aerobic endurance of long distance runners at The Northern Borders University.
C Identifying the effects of using cross-training on improving technical performance level of long distance runners at The Northern Borders University.

Hypotheses: There are statistically significant differences among the pre- and post- measurements of the strength endurance, aerobic endurance and the technical performance level of long distance runners at The Northern Borders University in favor of the post-measurements.

MATERIALS AND METHODS

Approach: The researcher used the quasi-experimental approach (one-group design) with pre and post-measurements.

Research Sample: It was randomly chosen from long distance runners at The Northern Borders University (n=10). Tables 1 and 2 show sample description.

Table 1 indicates that Squeness values are between ±3 on all variables as the highest value was 1.051 for weight and the lowest value was 0.028 for height. This indicates sample homogeneity.

Table 2 indicates that standard deviation values are below means. All Squeness values are between ±3. This indicates sample homogeneity.

Data Collecting Tools: The researcher identified the tests of this researcher through review of literature. Review of literature indicated the following tests: Leg press - Leg curl - Heel raise - Bench press - Lateral pull down - Bent-knee sit-up - Back hyperextension - Military press - Cooper test - VO2max (absolute) - VO2max (relative) - the digital record [4, 6, 8, 11-17].

Pilot Study: The researcher held a meeting with sample members at the weight training hall of ARAR Sports Club to explain the aims of this researcher and how to measure the maximum weight a player can lift (15 RM), in addition to the performance of tests. The pilot study revealed that:

C Sample members understood how to perform tests.
C Assistants understood how to take and record measurements.

Pre-Measurements: Pre-measurements were taken on 17-18/9/2011 and included:

C 10-minutes stretches: for all body muscles.
C Warm-up (5 min): running with regular steps as previous research indicated that 3-5 minutes of regular running organizes the body systems work.
C Day one measurements: 40 yards running - 15 minutes Cooper test.
C Day two measurements: muscular fitness.
C Cool down (3 min): relaxations exercises for returning body systems to normal conditions.
Table 1: Sample homogeneity on age, height and weight (n=10)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Measurement</th>
<th>Mean</th>
<th>SD±</th>
<th>Median</th>
<th>Squewness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Year</td>
<td>20.3</td>
<td>0.8233</td>
<td>20</td>
<td>0.806</td>
</tr>
<tr>
<td>Height</td>
<td>Cm</td>
<td>168.9</td>
<td>2.7669</td>
<td>169.5</td>
<td>-0.028</td>
</tr>
<tr>
<td>Weight</td>
<td>Kg</td>
<td>60.7</td>
<td>2.6268</td>
<td>60</td>
<td>1.051</td>
</tr>
</tbody>
</table>

Table 2: Pre-measurements of strength endurance and aerobic endurance of the sample (n=10)

<table>
<thead>
<tr>
<th>Test</th>
<th>Mean</th>
<th>Median</th>
<th>SD±</th>
<th>Squewness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Strength endurance</td>
<td>Leg press</td>
<td>69.50</td>
<td>69</td>
<td>4.79</td>
</tr>
<tr>
<td>2-</td>
<td>Leg curl</td>
<td>24.80</td>
<td>24.50</td>
<td>3.79</td>
</tr>
<tr>
<td>3-</td>
<td>Heel raise</td>
<td>60.70</td>
<td>60.50</td>
<td>2.90</td>
</tr>
<tr>
<td>4-</td>
<td>Bench press</td>
<td>43.50</td>
<td>43.50</td>
<td>3.10</td>
</tr>
<tr>
<td>5-</td>
<td>Lateral pull down</td>
<td>31</td>
<td>30.50</td>
<td>2.62</td>
</tr>
<tr>
<td>6-</td>
<td>Bent-knee sit-up</td>
<td>27.50</td>
<td>28.50</td>
<td>3.62</td>
</tr>
<tr>
<td>7-</td>
<td>Back hyperextension</td>
<td>22.10</td>
<td>21.50</td>
<td>2.55</td>
</tr>
<tr>
<td>8-</td>
<td>Military press</td>
<td>26.10</td>
<td>25</td>
<td>3.69</td>
</tr>
<tr>
<td>9-</td>
<td>Cooper test</td>
<td>2</td>
<td>2</td>
<td>0.816</td>
</tr>
<tr>
<td>10-</td>
<td>VO2max (absolute)</td>
<td>2.60</td>
<td>2.50</td>
<td>0.699</td>
</tr>
<tr>
<td>11-</td>
<td>VO2max (relative)</td>
<td>37.10</td>
<td>37.50</td>
<td>2.51</td>
</tr>
</tbody>
</table>

Table 3: the Recommended Training Program

<table>
<thead>
<tr>
<th>Week</th>
<th>Training units</th>
<th>Load percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>55:60</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>55:60</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>60:65</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>65:70</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>70:75</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>75:80</td>
</tr>
</tbody>
</table>

The Recommended Training Program: The recommended training program was designed according to literature review [4, 8, 12, 14, 15, 20, 21]. The main aim of the program was to maintain the muscular fitness and energy fitness levels for long-distance runners at The Northern Borders University, through cross-training. The main bases of establishing the program are:

C To achieve its aims
C To be suitable for the age group
C To be designed according to sports training scientific bases
C To be flexible

Program Planning: Table 3 shows the program plan.

Table 3 Shows That:
C Training units are 4 units per week (Saturday - Sunday - Wednesday - Thursday)
C Unite duration: 90 minutes
C Load intensity, work rate, rest and weekly load cycle were distributed.
C Load intensity: 55: 85% of maximum load.
C Weekly load cycle: 1:1

Main Application: The recommended training program was applied from 17/10/2011 to 5/12/2011 (6 weeks - 4 units per week).

Post-Measurements: Post-measurements were taken on 6-7/12/2011 following the same protocol of pre-measurements.

Statistical Treatments: The researcher used the following statistical treatments: mean - median - standard deviation - Squewness - t. test - improvement percentage (%).

RESULTS AND DISCUSSION

Table 4 indicates statistically significant differences between the pre- and post- measurements on strength endurance variables as t. table vale (2.26) was lower than its calculated values (between 6.90 and 23.29).

Table 5 indicates statistically significant differences between the pre- and post- measurements on aerobic endurance variables as t. table vale (2.26) was lower than its calculated values (between 2.35 and 7.25).

Table 6 indicates statistically significant differences between the pre- and post- measurements on digital record variable as t. table vale (2.26) was lower than its calculated values (6.142).

DISCUSSION

Table 4 indicates that improvement percentage for strength endurance variables ranged between (23.64%) for bent-knee sit-up and (69.35%) for leg curl. The researcher thinks that this is due to the effects of the recommended
Table 4: Means, SD and t. values between the pre- and post-measurements on strength endurance variables (n=10)

<table>
<thead>
<tr>
<th>Test</th>
<th>Pre-measurements</th>
<th>Post-measurements</th>
<th>Difference mean</th>
<th>t. value</th>
<th>Improvement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Leg press</td>
<td>69.50 ± 4.79</td>
<td>107.50 ± 3.14</td>
<td>-38</td>
<td>-19.85*</td>
<td>54.68</td>
</tr>
<tr>
<td>2- Leg curl</td>
<td>24.80 ± 3.79</td>
<td>42 ± 3.06</td>
<td>-17.20</td>
<td>-9.69*</td>
<td>69.35</td>
</tr>
<tr>
<td>3- Heel raise</td>
<td>60.70 ± 2.90</td>
<td>95.10 ± 2.69</td>
<td>-34.40</td>
<td>-23.29*</td>
<td>56.67</td>
</tr>
<tr>
<td>4- Bench press</td>
<td>43.50 ± 3.10</td>
<td>54.30 ± 2.79</td>
<td>-10.8</td>
<td>-8.21*</td>
<td>24.83</td>
</tr>
<tr>
<td>5- Lateral pull down</td>
<td>31 ± 2.62</td>
<td>42.20 ± 2.97</td>
<td>-11.20</td>
<td>-9.41*</td>
<td>36.13</td>
</tr>
<tr>
<td>6- Bent-knee sit-up</td>
<td>27.50 ± 3.62</td>
<td>34 ± 2.16</td>
<td>6.5</td>
<td>-10.81*</td>
<td>23.64</td>
</tr>
<tr>
<td>7- Back hyperextension</td>
<td>22.10 ± 3.55</td>
<td>36.10 ± 2.81</td>
<td>-14</td>
<td>-11.07*</td>
<td>63.35</td>
</tr>
<tr>
<td>8- Military press</td>
<td>26.10 ± 3.69</td>
<td>36 ± 3.33</td>
<td>-9.09</td>
<td>-6.90*</td>
<td>37.93</td>
</tr>
</tbody>
</table>

* t. table value on p<0.05 = 2.26

Table 5: Means, SD and t. values between the pre- and post-measurements on aerobic endurance variables (n=10)

<table>
<thead>
<tr>
<th>Test</th>
<th>Pre-measurements</th>
<th>Post-measurements</th>
<th>Difference mean</th>
<th>t. value</th>
<th>Improvement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9- Cooper test</td>
<td>2 ± 0.816</td>
<td>3 ± 1.05</td>
<td>-1</td>
<td>-2.35*</td>
<td>50</td>
</tr>
<tr>
<td>10- VO2\text{max} (absolute)</td>
<td>2.60 ± 0.699</td>
<td>3.40 ± 0.52</td>
<td>-0.8</td>
<td>-4*</td>
<td>30.77</td>
</tr>
<tr>
<td>11- VO2\text{max} (relative)</td>
<td>37.10 ± 2.51</td>
<td>52.30 ± 6.46</td>
<td>-15.20</td>
<td>-7.25*</td>
<td>40.97</td>
</tr>
</tbody>
</table>

* t. table value on p<0.05 = 2.26

Table 6: Means, SD and t. values between the pre- and post-measurements on digital record variable (n=10)

<table>
<thead>
<tr>
<th>Test</th>
<th>Pre-measurements</th>
<th>Post-measurements</th>
<th>Difference mean</th>
<th>t. value</th>
<th>Improvement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12- Digital record</td>
<td>21.6 ± 1.0649</td>
<td>19.17 ± 0.558</td>
<td>-2.43</td>
<td>6.142*</td>
<td>11.25</td>
</tr>
</tbody>
</table>

* t. table value on p<0.05 = 2.26

A well-planned weight training program as it includes weight exercises for legs, trunk and arms muscles. These exercises are measured according to max weight that can be left for 15 times and 3 repetitions (15 RM). This type of load improves strength endurance and using (15RM) loads has positive effects on strength endurance as this type of endurance can be improved greatly with nearly (50%) during a few weeks [10]. Well-planned weight training programs can improve strength endurance and muscular power as it increases the muscle fibers volume and the physiological cross-section. This, in turn increases blood flow to blood vessels [20-23].

Table 5 indicates that improvement percentage for strength endurance variables ranged between (30.77%) for absolute VO2\text{max} test and (50%) for Cooper test. The researcher thinks that this improvement in aerobic endurance after the basic phase of the training program is due to the aerobic training program that is considered the first phase of energy fitness training that includes various running drills and rope jumping with intensities between (45 - 70%) from HR reserve with pulse rate (120-160 BPM) using cross-training for 30-60 minutes without rest intervals. This led to increasing the cardiovascular capacity in providing oxygen for all body parts and increasing hemoglobin, metabolic processes and production of aerobic energy. Cross-training increases oxygen intake in the muscles through increasing the cardiac output. It also increases the muscle content of fibrins, mitochondria, aerobic energy enzymes and blood vessels. This, in turn, increases the muscle efficiency in consuming oxygen and producing aerobic energy. This helps the muscle to work for a prolonged period of time without fatigue [13, 14, 19, 23].

Aerobic training improves and regulates slow-twitch red muscle fibers in energy production, in addition to improving the functional efficiency of the cardio-pulmonary system and the hear. It delays fatigue and prevents injuries. This leads to aerobic fitness that plays a major role in high-intensity performance. Aerobic training improves aerobic endurance (cardio-pulmonary endurance) and elevates VO2\text{max} [6, 24-30].
Table 5 indicates that improvement percentage for the digital record was (11.25%). This indicates that cross-training during the transitive phase has positive effects on the digital records of the sample. This indicates the importance of the transitive phase as a major phase in planning the whole season training program as neglecting this phase leads to limitations over the improvement of the performance level and potentiality of injuries at the beginning of the up-coming season. Through results of this research, the best methods for maintaining the aerobic endurance and strength endurance levels is to participate in another sports activity during the off-season period. This is called cross-training. This type of training provides the cardiac, pulmonary and musculoskeletal systems the opportunity to improve through various non-routinely ways of exercising that work on improving aerobic and muscular endurance, in addition to muscle- nervous coordination and flexibility. This, in turn, has positive effects on the digital records of the athlete [4, 6, 8, 14, 18].

CONCLUSION

C The recommended training program improved the power endurance rates that ranged between 23.64% and 69.35% (for bent-knees sit up and leg curl respectively).
C The recommended training program improved the aerobic endurance rates that ranged between 30.77% and 50% (for VO2_max [absolute] test and Cooper test respectively)
C The recommended training program improved the aerobic endurance rates (33.89% for absolute values and 43.36% for relative values)
C Power endurance rates came first and then came aerobic endurance rates.
C The recommended training program improved the digital records between pre and post measurements (11.25%)

RECOMMENDATION

C Using the recommended training program for improving aerobic endurance and VO2_max for long distance runners.
C The importance of drinking more water before and during the training to compensate the amount lost of body fluids during training and increasing water volume in the body.
C Using POLAR watches with all its various models to measure heart rate during training.
C Including power fitness exercises, along with muscular fitness exercises in the physical preparation program.

REFERENCES