Implications of Resistance Training with Active and Controlled Muscle Action on Football Player's Aerobe Performance

Jemal Awel

M.Sc Coaching and Therapy, Department of Sport Science, Collage of Natural and Computational Sciences, Adigrat University, Ethiopia

Abstract: ***This study targets to identify the implications of resistance training with active muscle and controlled muscle action on football players performances. Twenty athletes were randomly distributed in to two groups, namely active muscle action group (AMAG) (n = 10), and controlled muscle action group (CMAG) (n = 10). Purposive sampling technique was used to select 20 interested football players from the five Adigrat town football club participants', aged between 20 to 27 years old. The duration of experimentation was eight consecutive weeks three times in a week, 60 minutes per session. Both experimental groups were taken part in resistance training. The results indicated that the AMAG showed a significant improvements reduced blood pressure and heart rate level (P < 0.001/ p< 0.003) and (P < 0.001) respectively also, increment in muscle hyperplasia (P < 0.000) and muscle strength (P < 0.000). Whereas the CMAG athletes showed a significant change an elevation in diastolic blood pressure (P < 0.000), increase in muscle hypertrophy (P < 0.000) and enhancement in muscle strength (P < 0.000). In conclusion, this study indicates that, resistance training with active muscle action mainly provides aerobic benefits but resistance training with controlled muscle action supports the body's anaerobic capacity. Thus, the capable of doing a sustainable or long duration physical exercise like football highly benefited from the resistance training with controlled muscle action.***

Key words: Active Muscle action, Controlled Muscle action, Blood Pressure, Heart rate, muscle hypertrophy, Resistance training

1. Introduction

Resistance training is a specialized method of conditioning designed to increase muscle strength and power. Both skeletal and cardiac muscles adapt themselves in response to this type of training. Resistance training results in hemodynamic alteration with marked elevation of blood pressure (BP), leading to pressure overload in the heart, resulting in the parallel addition of sarcomeres or increase in cardiomyocyte cell width and consequently to an increase in left ventricular wall thickness without reducing the size of the internal cavity in diastole, with the development of concentric left ventricular hypertrophy [1, 2, 3]. The increase in wall thickness induced by pressure overload is mainly due to an increase in cardiomyocyte cross-sectional area [4].

The quest to increase lean body mass is widely pursued by those who lift weights. Given the strong correlation between muscles cross-sectional area and muscular strength [5] increased muscle mass is a primary goal of athletes involved in strength and power sports such as football, rugby, and power lifting. Muscle mass is also vital to the sport of bodybuilding, where competitors are judged on both the quantity and quality of their muscle development. Genetic background, age, gender, and other factors have been shown to mediate the hypertrophic response to a training protocol, affecting both the rate and the total amount of gains in lean muscle mass [6].

In static or isometric physical exercise (e.g., weight lifting, weight and hammer throwing, wrestling and bodybuilding), strength is developed with little or no movement. This physical exercise, when chronically performed, is known as resistance training, which is a specialized method of conditioning designed to increase muscle strength and power. Both skeletal and cardiac muscles adapt themselves in response to this type of training [1, 2, and 3]. Muscle hypertrophy can be considered distinct and separate from muscle hyperplasia. During hypertrophy, contractile elements enlarge and the extracellular matrix expands to support growth. This is in contrast to hyperplasia, which results in an increase in the number of fibers within a muscle. Contractile hypertrophy can occur either by adding sarcomeres in series or in parallel [7].

The key factor for successful resistance training at any level of fitness is the appropriate program design. Program design entails proper exercise instruction (e.g., technique, breathing, correct use of equipment), goal setting (so the program can target specific areas of interest), a method of evaluation of training progress toward training goals, the correct prescription of the acute program variables, and the inclusion of specific methods of progression targeting particular areas of muscular fitness. It is important that resistance training should be supervised by qualified professionals for the prevention of injury and for maximizing the health and performance benefits [8]. Therefore, the aim of this study was identify the implications of resistance training with active muscle and controlled muscle action on football player's aerobe performance.

2. Materials and Methods

Subjects

The study used a random sampling technique to select a sample size of 20 participant athletes with predetermined criteria's from the total population of five football club male players. Having this size of the study was based on the reason that practical activities with large size of population is too difficult to manage during exercise that was affect the quality of data.

Experimental design

Twenty male football players aged between 20 - 27 years old had included by random sampling from five different football clubs. The participants were divided in to two groups of ten numbers each i.e. resistance training with active muscle action group (AMAG) (n = 10) and resistance training with controlled muscle action (CMAG) (n = 10) using a purposive group design. These football players were actively involved in eight weeks resistance training at a frequency of 3times/ week for 40 minutes duration per session. For this study, pre- and post-tests was conducted on the selected physiological variables for both groups (AMAG and CMAG) to measure the performance level of football players.

Data Collection method

All measurements and data were collected by quantitative method through appropriate selected test and measurements. In this study the data from the experimental variables such as systolic and diastolic blood pressure, heart rate, and muscle hypertrophy, hyperplasia and strength. The baseline measurements served as the pre-test while the measurements taken at the end of the training served as the post test.

Procedures of Data Collection

The investigator selected the following test items, which are standardized ideal for the chosen subjects.

Table 1: Experimental Variables and Their Test

No.	Criterion Variables	Test Items	Unit of Measurement
1	Blood pressure	Sphygmomanometer	MmHg
2	Heart rate	Counting the pulse rate	Numbers
5	Strength	1RM Bench press	Maximum lift in kg
6	Arm length (forearm) biceps brachii	Standard anthropometric test	Cm
7	Leg length (thigh- quadriceps femoris & hamstrings)	Standard anthropometric test	Cm
8	Biceps girth/ circumference	Standard anthropometric test	Cm
9	Thigh girth/ circumference	Standard anthropometric test	Cm

Blood Pressure

Attach the Blood Pressure Sensor to the blood pressure cuff if it is not already attached. There are two rubber tubes connected to the cuff. One tube has a black Luer-lock connector at the end and the other tube has a bulb pump attached. Connect the Luer-lock connector to the stem on the Blood pressure Sensor with a gentle half turn. Attach the Blood Pressure cuff to the upper arm, approximately 2 cm above the elbow. The two rubber hoses from the cuff should be positioned over the biceps muscle (brachial artery) and not under the arm. The subject should sit quietly in a chair and avoid moving his or her arm or hand during blood pressure measurements.

Heart rate (Measure Radial Pulse)

Pulse, or the tangible beating of the heart, is used by medical professionals to determine a patient's heart rate. It is measured in beats per minute (bpm) and can indicate the general health or fitness level of a patient. Resting heart rate is taken when a calm individual is sitting or lying down. A normal resting heart rate for an adult is between sixty and one hundred bpm. High resting heart rate may be caused by exercise, illness, certain medications, heart disease, and stress. On the other hand, various medicines and a high level of fitness can cause low resting heart rate. In order to measure radial pulse, the heart rate must be counted for at least fifteen seconds. However, it can also be measured for twenty, thirty, or sixty seconds. If you are measuring a pulse for fifteen, twenty, or thirty seconds, you must multiply the number you count by four, three, or two, respectively, to calculate the heart rate in bpm.

Leg length

A strict anatomical definition of leg length (LL) is the length of the femur + tibia. Due to the bipedal nature of the human species, "leg length" often is measured as: (femur + tibia + the height of the foot, from the tibia-talus articulation to the ground). Alternatively, the phrase "lower limb length" may be use to denote this linear dimension. The maximum length of the femur is measured from its head, at the proximal end, to its medial condoyle, at the distal end. In life, the femur and pelvic bones overlap and the head of the femur is difficult to assess due to its articulation within the acetabulum. A high degree of body fatness may make these bony landmarks difficult, or, impossible, to access [9].

Arm length:

The subjects stand with the arms hanging loosely by the side of the body, fingers are outstretched. A measurement is made from the acromial (lateral edge of the acromion process. Measurement is made from the right side, following the anthropometric standard, though a measurement of either side would be assumed to be the same in most cases. E.g. Bony tip of shoulder to the tip of the little finger.

Thigh girth

First mark the site to be measured. Thigh girth measurement is usually taken on the right side of the body. The subject stands erect with their weight evenly distributed on both feet and legs slightly parted. The circumference measure is taken at the level of the mid- point on the lateral (outer side) surface of the thigh, midway between trochaneterion (top of the thigh bone and femur) and tibialelaterale (top of the tibia bone). When recording, the tester to make sure the tape is not too tight or too loose, is lying flat on the skin and with the tape horizontal.

Biceps girth: (Arm Circumference)

The standing position (SP) is standing with the elbow relaxed so that the right arm hangs freely to the side. The examiner stands facing the SP's right side. The measuring tape is placed around the upper arm at the marked point perpendicular to the long axis of the upper arm (+ from upper arm length). The tape is again held so that the zero end is held below the measurement value. The tape rests on the skin surface, but is not pulled tight enough to compress the skin. The arm circumference is recorded to the nearest 0.1 cm. 3.3.

Thigh Circumference
The SP is standing with the right leg just in front of the left leg and the weight shifted back to the left leg. This instruction should be demonstrated by the examiner. The edge of the examining table may be used for the SP to hold onto to maintain his balance. The examiner stands on the SP's right side and the measuring tape is placed around the mid -thigh at the point that is already marked by a (+). The tape is positioned perpendicular to the long axis of the thigh with the zero end of the tape held below the measurement value. The tape rests firmly on the skin without compressing the skin. The recorder checks to make sure the tape is positioned correctly. The thigh circumference is measured to the nearest 0.1 cm. 3.

1-RM Bench-press Test
This test assesses upper-extremity strength using a fundamental upper-extremity movement. It is only suitable for individuals who demonstrate proper form in performing a bench press.

Statistical analysis
All data presented in this study were expressed as mean ± standard deviation and interpreted by descriptive statistical analysis of computerized statistical package for social studies software (SPSS). The paired t-test will be used to compare the pre- and post test data by calculating the t-value to compare the level of significance between control and experimental groups. A value of $p<0.05$ was considered significant.

3. Results

The data was analyzed through paired t-test. Therefore, the results for each variable are discussed as follow;

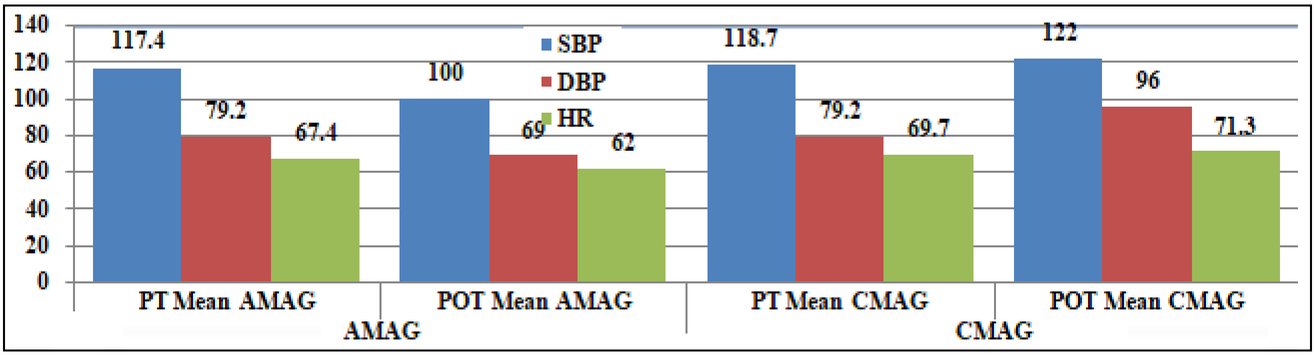

Figure 1: The pre and post training test mean values for blood pressure and heart rate, muscle of these AMAG and CMAG

Results of the above fig. 2 showed that the pre and post training test mean ± *SD (standard* deviation) values for systolic and diastolic blood pressure and heart rate between the experimental group I and II (AMAG and CMAG respectively).

The AMAG athletes showed a statistical change in systolic and diastolic blood pressure, (117.40 ± 6.89/79.20 ± 2.74 and 100.00 ± 7.07/69.00 ± 7.38 mmHg) and heart rate (67.40 ± 7.73 and 62.00 ± 5.66 bpm) respectively between their pre and post mean test values. The results indicated that the AMAG athletes achieved a significant change (reduction in systolic and diastolic blood pressure; $P \leq 0.001$/ $p< 0.003$) and reduction in heart rate level ($P < 0.001$)

In addition to this the above figure 2 indicated that the CMAG athletes showed statistical change in the variables of systolic and diastolic blood pressure (118.70 ± 6.68/79.20 ±2.29 and 122.00 ± 9.19/96.00 ±6.99 mmHg) and heart rate (69.70 ± 6.20 and 71.30 ± 5.01 bpm) respectively between pre and post test mean values. Therefore, the above table verified that the CMAG athletes were showed a significant change of (elevation in diastolic blood pressure; $P < 0.000$) whereas in the variables of systolic blood pressure and heart rate the CMAG athletes showed insignificant change ($P < 0.070$ and $P < 0.141$) respectively.

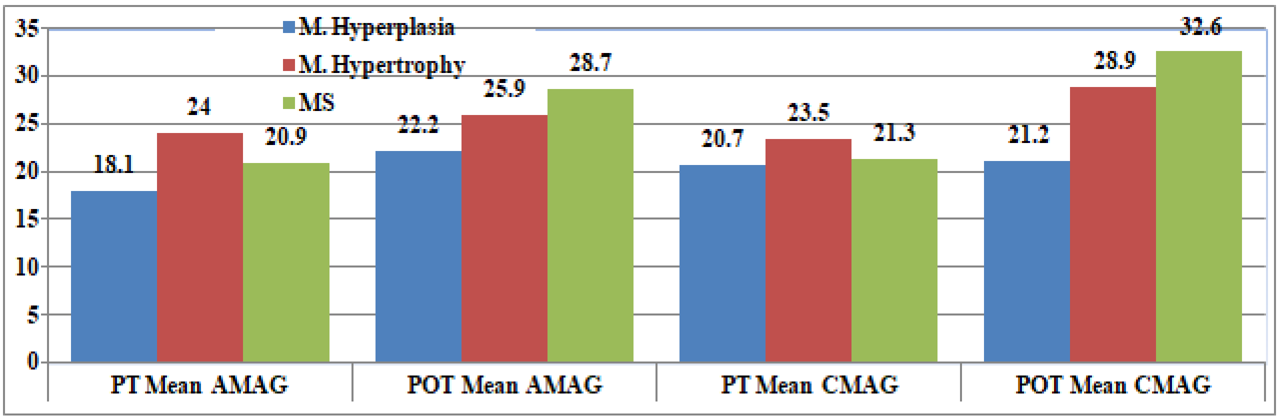

Figure 2: The pre and post training test mean values for muscle hypertrophy, muscle hyperplasia sand trength of these AMAG and CMAG

Results of the above fig. 2 showed that the pre and post training test mean ± *SD (standard* deviation) values for muscle hypertrophy , hyperplasia and strength of the experimental group I and II (AMAG and CMAG respectively).

The AMAG athletes showed a statistical change in muscle hyperplasia (18.10 ± 2.60 and 22.20 ± 1.93 cm) and muscle strength (20.90 ± 2.77 and 28.70 ± 3.27 1-RM) respectively between their pre and post mean test values. The results indicated that the AMAG athletes showed a significant increment in muscle hyperplasia (P < 0.000) and muscle strength (P < 0.000), but AMAG athletes showed insignificant changes in muscle hypertrophy (P < 0.070).

In addition to this the above figure 2 indicated that the CMAG athletes showed statistical change in the variables of muscle hypertrophy (23.50 ± 3.21 and 28.90 ± 2.60 cm) and in muscle strength (21.30 ± 2.75 and 32.60 ± 2.63 1-RM) respectively between pre and post test mean values. Therefore, the above table verified that the CMAG athletes were showed a significant change of increased muscle hypertrophy (P < 0.000), and muscle strength (P < 0.000), whereas in the variables of muscle hyperplasia the CMAG athletes showed in significant change (P < 0.440) respectively.

4. Discussion

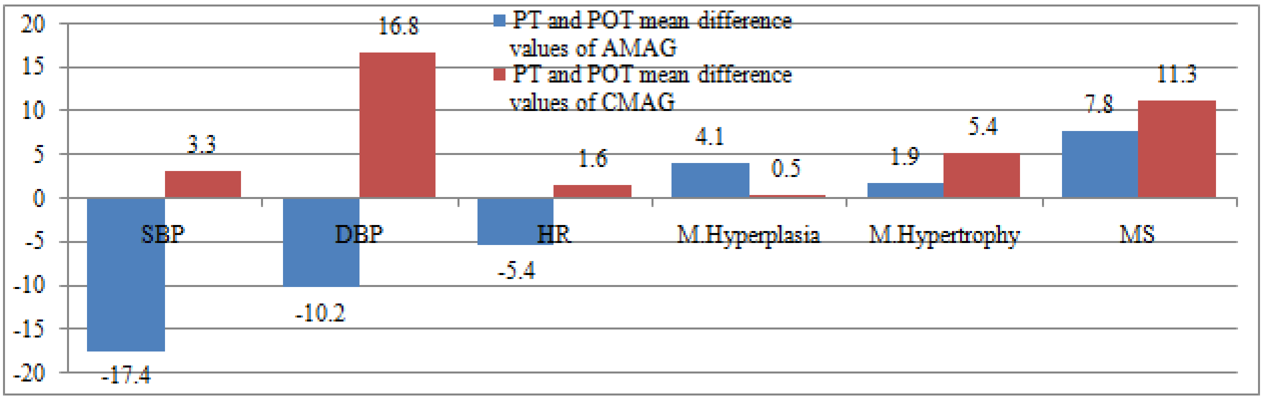

Figure 2: Pre and post test mean difference of CG and AMAG

The above table 3, showed that pre and post test mean difference values of each variables between the two groups (AMAG and CMAG). The AMAG athletes showed reduction in systolic blood and diastolic blood pressure and heart rate (-17.4, -10.2 mmHg and -5.4 bpm respectively), but the CMAG athletes registered a pre and post test mean difference vales increased in systolic and diastolic blood pressure and heart rate (3.3, 16.8 mmHg and 1.6 bpm respectively) so this result verified that the diastolic blood pressure of the CMAG athletes was increased significantly.

The resistance training with active muscle action group also showed an improvement between the pre and post test mean difference values in muscle hyperplasia (4.1 cm) and muscle strength (7.8 1-RM), thus AMAG athletes showed dominant benefit in muscle length. Whereas, the CMAG athletes showed performance benefits in muscle hypertrophy (5.4 cm) and muscle strength (11.3 1-RM). This indicated that the CMAG athletes showed a dominant effect in muscle hypertrophy and strength.

Resistance training results in hemodynamic alteration with marked elevation of blood pressure (BP), leading to pressure overload in the heart, resulting in the parallel addition of sarcomeres or increase in cardiomyocyte cell width and consequently to an increase in left ventricular wall thickness without reducing the size of the internal cavity in diastole, with the development of concentric left ventricular hypertrophy. In dynamic exercise/isotonic exercises (e.g., swimming, cycling, and running), the main hemodynamic changes are increased heart rate and stroke volume, the two components of cardiac output. In parallel, an increased effectiveness of the skeletal muscle pump and decrements in peripheral vascular resistance increase the venous return to the heart [10]. With regard to the cardiovascular effects, resting bradycardia has been considered to be the hallmark of aerobic exercise training adaptation.

Resistance training is a modality of exercise that has a role in improving athletic performance by increasing muscular strength, power and speed, hypertrophy, local muscular endurance, motor performance, balance, and coordination [1]. During hypertrophy, contractile elements enlarge and the extracellular matrix expands to support growth. This is in contrast to hyperplasia, which results in an increase in the number of fibers within a muscle [7]. Hyperplasia occurs in certain animal species under experimental conditions as a result of mechanical overload. Stretch overload yielded larger increases in fiber count than exercise. So that, the AMAG athletes used their full muscle contraction and relaxation during the resistance training, this means that the muscles were stretched fully with the overload effect of the resistance training [11].

5. Conclusions

This study clearly indicates that resistance training with active and controlled muscle action has a different effect on the footballer's performance. It suggested that resistance training with CMAG directly declines the players endurance abilities due to the elevation in blood pressure and heart rate and also they possess an increased muscle mass which is important to those short burst sport activities (power sports). But football players could be benefited from the resistance training with active muscle action in order to decrease blood pressure and heart rate and to develop muscle abilities to work for a long periods of time without fatigue.

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7. Conflict of Interest

The authors declare that there is no conflict of interest concerning the publication of this paper.

References

[1] Pluim BM, Zwinderman HA, van der Laarse A, van der Wall EE, The athlete's heart. A meta-analysis of cardiac structure and function. 2000; 101: 336-344.
[2] Dorn GW, The fuzzy logic of physiological cardiac hypertrophy. 2007; 49: 962-970.
[3] Longhurst JC, Kelly AR, Gonyea WJ, Mitchell JH, Echocardiographic left ventricular masses in distance runners and weight lifters. *J Appl Physiol*. 1980; 48: 154-162.
[4] Grossman W, Jones D, McLaurin LP, Wall stress and patterns of hypertrophy in the human left ventricle. *J Clin Invest.* 1975; 56: 56-64.
[5] Maughan RJ, Watson JS, Weir J, Strength and cross-sectional area of human skeletal muscle. *J Physiol*, 1983; 37–49, 1983.
[6] Kraemer WJ, Ha¨kkinen K, Newton RU, Nindl BC, Volek JS, McCormick M, Gotshalk LA, Gordon SE, Putukian M, Evans, WJ, Effects of heavy resistance training on hormonal response patterns in younger vs. older men. *J Appl Physiol*, 1999; 87: 982–992.
[7] Vierck J, O'Reilly B, Hossner K, Antonio J, Byrne K, Bucci L, Dodson M, Satellite cell regulation following myotrauma caused by resistance exercise. 2000; 24: 263–272.
[8] Mazzetti SA, Kraeme WJ,, Volek JS, The influence of direct supervision of resistance training on strength performance. *J. Med. Sci. Sports Exerc.*, 2000; *32:1175*-1184.
[9] Bogin B, Inês Varela-Silva M, Int. J. Environ. Res. Public Health 2010, 7, 1047-1075; doi:10.3390/ijerph7031047.
[10] Pluim BM, Zwinderman HA, van der Laarse A, van der Wall EE, The athlete's heart. A meta-analysis of cardiac structure and function. 2000; 101: 336-344.
[11] Kelley G, Mechanical overload and skeletal muscle fiber hyperplasia: A meta-analysis. *J Appl Physiol*, 1996; 81: 1584–1588

Author Profile

Jemal Awel is a M.Sc. holder in coaching therapy sciences with special interest in physiotherapy, Haromaya University, Dire Dawa – Ethiopia. I am employed in Adigrat University, Adigrat- Ethiopia with the rank of lecturer. I have research interest in physiological and therapeutically aspects of exercise.