EFFECT OF CIRCUIT TRAINING PROGRAM ON SELECTED PHYSICAL FITNESS VARIABLES OF WAHEL PRIMARY AND SECONDARY SCHOOL FEMALE STUDENTS IN DIRE DAWA ADMINISTRATIVE REGION

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ABSTRACT

This study attempted to explore effects of circuit training program on selected physical fitness variables of female students. Purposive sampling technique was used to select 24 novice female students aged 15 to 16 years from grade 9 students. The main objective of the study was to investigate the effect of circuit training program on selected physical fitness variables of Wahel Primary and Secondary School female students in Dire Dawa Administrative Region. All subjects under this study took part in experimental design pre- and post test without control group from April to June in 2013, 3 days per week for 3 months and 40 minutes per session. The physical fitness variables selected for the study were: cardio respiratory endurance (1.6 km run in minutes), muscular endurance (sit-ups reps/60 seconds), muscular strength (modified push-ups reps/30 seconds), power (standing long jump in meter) and agility (4x10 m shuttle run in seconds). Data were analyzed by using SPSS paired samples t- test with pair wise comparison of means at 95% confidence interval by using pre, during and post tests. The results indicated that there were significantly improvements in performance on selected physical fitness variables due to the effects of circuit training with active rest (p □ 0.05). This study confirmed that circuit

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training with active rest was significant to improve the physical fitness variables. The mean difference (MD) between pre and post tests for: 1.6 km run was -1.33 in minute and second; for 30 seconds, push-ups was +5.00 in number; for 60 seconds, sit ups was +6.58 in number; for standing long jump was +0.26 in meter and for 4x10 shuttle run was -1.35 in minute and seconds. The main finding of the study was novice female students have discovered positive outcomes towards physical fitness variables. The study also illustrates that health and fitness level of participants can be improved as a result of circuit training program.

***Key words*:** circuit training, *cardio respiratory endurance, muscular strength, muscular endurance, power and agility.*

INTRODUCTION

Fitness, physical activity behavior and motor skill development are important components of the physical education curriculum and are potentially indicators of child health. Physical fitness in children and adolescents has also been linked to positive health outcomes in adults. Moreover, motor skills can be used for talent identification to predict sporting success in children. Previous research has demonstrated the positive effects of four-weeks after school program addressing motor skills and fitness can have in young children. Therefore, encouraging motor skill and fitness development in young children is likely to have substantial benefits on health outcomes and potentially subsequent sporting success in children (Grice, 2003; Kvaavik *et al*., 2009; Matvienko and Iradge, 2009 and Lloyd *et al*., 2010).

There is considerable epidemiological evidence that regular physical activity is protective against cardiovascular disease. It enhances mental health and can prevent or revolutionize some of the complications of conditions such as diabetes and osteoporosis. Exercising has been associated with many health benefits in women, including reduced risks of overall mortality, cardiovascular disease, diabetes, osteoporosis, obesity, colon cancer, mental illness and may also protect against female reproductive cancers (Berlin and Colditz, 1990; Helmrich *et al.*, 1991; Weyerer and Kupfer, 1994 and USDHHS, 1996).

Circuit training is a method of fitness training that is designed to develop general, all-round physical and cardiovascular fitness. It is based on sound anatomical, kinesiological and physiological principles designed to increase strength, power, flexibility, quickness and cardiovascular endurance. Circuit training provides a strenuous workout entirely suited to an individual's specific needs, existing capacity and rate of adjustment to progressive vigorous exercises. They also stressed the principles of overload and progression. It consists of a series of exercises arranged in order and designed to develop general fitness, physical fitness and/or skill-related fitness specific to a particular sport, depending on the exercises chosen. The great advantage of circuit training is that depending on the exercises chosen, it can be used to develop strength, power, muscular endurance, agility, aerobic endurance and anaerobic endurance (the ability to work without burning oxygen for an extended period of time; top class 800m runners can work an-aerobically for approximately 90 seconds) in a limited time and limited space. It can also involve large numbers of Participants in a relatively small space and participants of different fitness levels can train together. The basic assumption underlying circuit training is that improvement takes place either by doing the same amount of work in a shorter period of time or by doing more work in a given time. It utilizes three variables of load, repetition and time and this places it on an advantage over other training methods. The circuit training program is given in the form of number of exercises for different body parts in single circuit training. Single circuit training may involve the exercise for various fitness components (Scholich, 1990; Howell and Morford, 1998; Hockey, 1981). These variables are as follows:

Cardio respiratory endurance sometimes known as cardiovascular fitness, cardio respiratory fitness, aerobic fitness or aerobic capacity. It is a health-related component of physical fitness that relates to the ability of the circulatory and respiratory systems to supply oxygen during continuous physical activity. Such as 1.6 kilometer run or walking, 12 minutes run or walking. It improves oxygen transport and leads to a more efficient use of oxygen by way of an increased density of capillaries, myoglobin concentration, number and size of mitochondria and greater activity of oxidative enzymes within the mitochondria (USDHHS, 1996 and Thomas *et al.*, 2009).

Muscular endurance For true assessment of muscular endurance it would be necessary to test each major muscle group of the body. Lab and field tests of muscular endurance are similar and are based on the number of repetitions that can be performed by the specific muscle group being tested (repetitions of push-ups or abdominal curls-ups). Muscular endurance can be measured as isometrically (static contractions) or isotonically (dynamic contractions). http://www.fitness.gov/publications/digests/digest_mar2000.html

Strength is like flexibility and muscular endurance, specific in nature. For true assessment it would be necessary to test each major muscle group of the body. Lab and field tests are similar and involve the assessment of one repetition maximum (the maximum amount of resistance you can overcome one time). Strength can also be assessed using dynamometers. Strength can be measured isometrically (static contractions) or isotonically (dynamic contractions). Pull up, trunk-lift, pulling heavy object, weight lifting, standing broad jump and so on are examples of exercises for strength. http://www.fitness.gov/publications/digests/digest_mar2000.html

Power is considered to be a combination of strength and speed. It has also been defined as the ability to exert muscle force quickly. For this reason some consider it to be a combination of skill and health related physical fitness. Power includes putting the shot and vertical jumping. But, there are many different types of power and total assessment would require many different tests. http://www.fitness.gov/publications/digests/digest_mar2000.html

Agility is common as screening tests among sports teams. A shuttle or zigzag run is examples of exercises that develop agility. Critical periods of development for agility occur between the ages of 9 and 12 years old, with complexity and specificity beginning around the ages of 16 to 17 years. An athlete that displays good agility will most likely possess other qualities such as, dynamic balance, spatial awareness, rhythm, as well as visual processing. So while agility can be simply defined as an ability to quickly stop and re-start motion, there is a high degree of complexity to this motor skill (Drabik, 1996; Jason and Vescovi, 2009).

Significances of the Study

- To analyze the effect of circuit training program on selected physical fitness variables (cardio respiratory endurance, muscular strength, muscular endurance, agility and power) of grade nine female students.
- To motivate and encourage female students to engage in circuit training to enhance their physical fitness variables.
- To know the physical fitness level of Secondary School female students.
- Helps to analyze the effects of circuit training program on selected physical fitness variables with 55 - 70% intensity.

Objectives

- To investigate the effect of circuit training program on selected physical fitness variables of Secondary School female students.
- To evaluate and compare the effect of circuit training in improving muscular endurance and muscular strength before, during and after training.
- To observe changes induced by performing circuit training on cardio respiratory endurance and power on novice female students.
- To investigate the significance of circuit training program that brought up changes on agility fitness variable of novice female students.

MATERIALS AND METHODS

Research Design

The design for the study was experimental design pre- and post test without control group from April to June in 2013.

Table 1. The study design layout

Treatments	Circuit training exercise
Frequency	3days/week
Total duration	12 weeks
Duration /session	40 minutes
Intensity	55-70%HR_{max}
Exercise days	Saturday (morning), Tuesday and Thursday (afternoon)
Time of training	Morning (7:20-8:00 a. m); Afternoon (3:30-4:10 P. m).

In this study exercise training was done in circuit with instructions and supervisions of researcher and assistants. The training was given in 55 - 70% intensity by the investigator for 12-weeks 3 days per week for 40 minutes. Training session was started with warm up exercises for 8 minutes, workout for 18 minutes, cool down activities for 5 minutes and total active rest among each station for 9 minutes. Pre, during and post tests were given on selected physical fitness parameters such as cardio respiratory endurance, muscular endurance, muscular strength, power and agility.

Sample Size and Sampling Techniques

Purposive sampling was used to select the subjects from grade nine novice female students aged 15 - 16 years old. Based on these criteria 30 female students registered after the researcher informed them to register for circuit training program and 30 of them filled personal healthy history questionnaires. These questionnaires were prepared to identify whether they were free from diseases such as diabetes, stroke, musculoskeletal injury, hypertension and cardio vascular disease (CVD). Six out of thirty (30) novice female students were rejected due to health problem. Therefore, study was carried out with twenty-four (24) subjects..

Experimental Materials

For this study the following equipments were used. These equipments were ropes, measuring tape, whistle, cones, stopwatch and chalk /limestone, football field and chairs.

Method and Procedure for Data Collection

All measurements and data were collected by quantitative method through appropriate selected physical fitness variables such as cardio respiratory endurance (1.6 km run), muscular endurance (60 seconds sit-ups), muscular strength (30 seconds modified push-ups), power (standing long

jump in meter) and agility (4x10 m shuttle run in seconds). Pre, during and post tests were taken for all measurements. Source: www.brainmac.co.uk.

Experimental Measurements

1.6 kilometer run: Completed distance of 1.6 kilometer run was used to measure cardio respiratory endurance. The participants got adequate warm-up time to reduce the chances of injury. On the command of investigator they started at steady pace that could be maintained for the whole distance. As the finish line approached, they ran as fast as possible. Stop or lie down was foul. The minimum time in seconds were recorded as participants score. Source: www.brainmac.co.uk.

60 seconds sit ups: completed number of sit ups reps/60 seconds was used to measure the muscular endurance of abdominal. For this test the participants were asked to take the supine position with back on the floor and raise knees to approximately 90 degrees. The hands were placed beside ears without locking the fingers together. They completed as many sit-ups as possible in 60 seconds. Each sit-up started with the back on the floor and the body raised up to the 90 degrees position. The total number of sit-ups successfully completed in 60 seconds was taken as participants score. Source: www.brainmac.co.uk.

30 seconds modified push- ups: completed number of modified push- ups reps/30 seconds was used to measure the muscular strength of upper body. The chair placed against wall to prevent slide during the test. For this test, every participant lied on the back with arms by their sides and the soles of the feet against the chair. Then, the position of their elbows was marked with chalk that used as the position for the feet when carrying out this modified push-ups. They started modified push-ups by standing behind the marked line and leaned forward to place their arms on the front chair with approximately shoulder width apart. It ensured that their body and legs form a straight line and the arms and torso were at approximate right angles. As the time started, they perform as many push-ups as they could do in 30 seconds. A push-up is counted only if their chest touched the chair and the arms returned to a straight position. When the chest did not touch the seat and the arms were not fully returned to a straight position, push-ups were not counted. A number of push-ups successfully completed in the time period were taken as result. Source: www.brainmac.co.uk.

Standing long jump: the distance covered in standing long jump was used to measure the power of the legs. For this test, participants kept all parts of the feet just behind the take-off line. Then, without moving the feet, swung the arms back, bent the knees and moved the body forward to perform a standing long jump. They landed with both feet together and continued moving forward. Participants were suppose to land both feet together and continued moving forward then, the distance from the take-off line to the heels landed mark was measured by measuring tape. They performed the test again if they fell backwards. The distance in meters from the take-off line to the heels was taken as result. Source: www.brainmac.co.uk.

4x10 m shuttle run: four completed number of shuttles on 10 m shuttle run course was used to measure agility. Participants began this test behind the start line in a push-up position with the forehead on the start line; on the 'go' signal they moved as quickly as possible to touch the opposite line, then returned to touch the start line, and again touch the opposite line. And finish by turning to sprint back across the start line. Starting before the 'go' signal was foul and each line must be touched with the fingers, except for the finishing line as the shuttles were completed. Time to the nearest 0.1 of a second to complete the shuttles was taken as participants result**.** Source: www.brainmac.co.uk.

Methods of Data Analysis

The paired t-test was used to compare the pre, during and post training tests of data. All comparisons were made at ($p < 0.05$) level of significance.

RESULTS AND DISCUSSION

Effects of Circuit Training on Health Related Physical Fitness.

Table 2. Mean and SD for CRE (m), MS (rep/30sec) and ME (rep/60sec)

Dependent Variables	PT	DT	PoT	Sig.
CRE	10.56 ± 0.93	9.84 ± 0.90	9.23 ± 0 .91	0.00*
MS	4.96 ± 2.46	7.46 ± 1.98	9.96 ± 2.22	0.00*
ME	17.46 ± 2.19	20.75 ± 1.75	24.04 ± 2.79	0.00*

PT = Pre-Test; DT = during Training Test and PoT = Post Test, CVE=cardiovascular endurance, MS=muscular strength, ME=muscular endurance, $p < .05$ * = *Significant and the data in the form of Mean ± SD*

The pre and during training test mean values for cardio respiratory endurance was 10.56 and 9.84 respectively. This showed that the novice female students were at hazardous health level according to the standard for their age category. Therefore, they must work hard to improve their performance capacity immediately; if not, they may suffer an injury and long-term damage. The post test mean value of CRE (9.23) indicated that they were at caution health level. But, there was progressive improvement of cardio respiratory endurance throughout the training due to circuit training program.

Alike, other variables muscular endurance also showed improvement in performance from pre to post test. The pre- test mean value of muscular endurance 17.46. showed that the novice female students were at hazardous health level. Therefore, they must work hard to improve this performance capacity. However, in during and post test mean values there was significantly improvement in the performance of the participants. The mean values for during and post tests were 20.75 and 24.04, respectively. This showed that their performance capacity of muscular endurance enhanced due to the circuit training program. But, according to the standard of their age category, they were at caution health level. Due to this, they must work hard to improve this performance capacity. But, mean difference among tests showed that there was progressive improvement in performance of muscular endurance during 12 weeks training periods.

Effects of Circuit Training on Skill Related Physical Fitness

Table 3. Mean and SD for agility (sec) and power (m)

Dependent Variables	PT	DT	PoT	Sig.
Agility	13.24 ± 0.64	12.51 ± 0.65	11.89 ± 0.55	0.00*
Power	1.28 ± 0.11	1.39 ± 0.10	1.54 ± 0.09	0.00*

Note: PT= Pre-Test, DT = During Training Test, PoT = Post Test, $p < .05$, * = Significant *and the data in the form of Mean ± SD*

As indicated in table 3, there was significantly improvement in performance on agility and power of female students during pre, during and post tests. In agility, the pre-training test mean value 13.24 showed that the novice female students were at hazardous health level at the beginning of the training program. Therefore, they must work to improve/enhance their performance capacity immediately; if not, they may suffer an injury and long-term damage might already be in progress. Whereas, during and post test mean values (12.51 and 11.89) which indicated that they were at enhanced health level. These mean values indicated that they were heading in the right direction of health level.

The findings on agility revealed that there was significantly improvement in performance. The improvement in agility performance level was due to the circuit training program in which they were engaged in for twelve weeks. The lower time spent in covering distance, the greater effects of training on speed, direction change and acceleration were indicating improvement of agility. The above table illustrates the improvement of agility, because there was decline in time throughout 12 weeks training.

Alike agility there was significantly improvement in the power of participants. The pre- and during training test mean values (1.28 and 1.39) illustrated that novice female students were at hazardous health level .Therefore, they must do training in order to improve their performance capacity and health level. Whereas, post test mean value 1.54.showed that they were at caution health level. As a result, they should do some exercises to improve their performance capacity. But, the mean difference between pre, during and post tests indicated that the progressive improvement in performance on power during 12 weeks periods of training. The rationale behind their improvement in performance of power was the circuit training program held for 12 weeks. The standing long jump was used to measure power of the subjects.

The findings on power, as discovered by the paired samples t-test, showed statistically significances. The significant mean difference in power was due to the 12 weeks circuit training exercises of the regular training. The longer distance covering during standing long jump reveals the greater effects of training on power. The above table also illustrates that improvement of power mean increment in the distance they jumped.

The results of this study was in agreement with the result of Adeniji (2007) who conducted study to examine the comparative effects of circuit training program on Speed and Power of Pre- and

Post-Menarcheal girls. Pre- to post test control group experimental design was used to carry out the study. A total of eighty secondary school girls from St. Peter's College, Olomore, Abeokuta, in Ogun State of Nigeria, ages 10-17 years took part in the study. The findings of Adeniji indicated that the circuit training on speed and power were significantly better for experimental group.

Summary

This research was conducted on twenty-four, grade 9 novice female students of Secondary School aged 15-16 years old in Dire Dawa Administrative Region. All subjects under study took part in experimental design before and after without control group from April to June in 2013. Major findings of this investigation were the increment or the improvement of cardio respiratory endurance, muscular strength, muscular endurance, agility and power. Circuit training provides strenuous work entirely suited to an individual's specific needs, existing capacity and rate of adjustment to progressive vigorous exercises.

Conclusions

Selected circuit training exercises contribute to the improvement of Cardio respiratory Endurance, muscular strength, muscular endurance, agility and power of novice female students as tested by 1.6 km run, 30 seconds push-ups, 60 seconds sit ups, 4x10shuttle run and standing long jump test. This study found that there was progressive improvement in the selected physical fitness variables during training periods. Regular participation in circuit training program 3 days/ week can improve the physical fitness of female students. In the study circuit training was found better in improving the cardio respiratory fitness, muscular endurance and muscular strength performance of the participants. It was also found as significant to improve the performance of the participants on agility and power physical fitness.

Recommendations

Based on the results of study, these recommendations are made:

- School should include the needed information and guidelines for health and physical education for students.
- Emphasis should be given to have adequate diet and regular physical activity.

- Circuit training should be included as an integral part of training in physical education program in school.
- Further study is essential on sedentary female students along with well planned program of specific circuit training exercises with an increase in the training period.

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